

Advances in the Analysis and Measurement of Vocational Interest  
Profiles: A Case for the Profile-Centered Perspective

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# Abstract

Vocational interests are a central predictor of individuals' behavior and attitudes in vocational and educational contexts. Theoretical conceptualizations of vocational interests are commonly based on classifications of work-related activities into discrete sets of broad interest domains. In this tradition, individuals' vocational interests are represented by their intraindividual configuration of likes and dislikes for these interest domains: their interest profile. Among these conceptualizations, John L. Holland's prominent RIASEC model, which establishes a classification system of six distinct interest domains, stands out as one of the most widely studied career theories of the last century.

The multidimensionality of the interest construct poses several challenges for the analysis of the relationships between vocational interests and relevant outcomes, the analysis of the similarity between individuals' vocational interests, and the analysis of the stability and change of vocational interests over time. These challenges predominantly arise from the fact that the majority of research methods in the social sciences focuses on relationships between variables in a population, that is, they analyze associations from a strictly variable-centered perspective. However, in the case of vocational interests, it seems obvious that a more appropriate approach for many important research questions would be to consider the entire intraindividual interest profile at once. To this day, investigations on the level of vocational interest profiles often amount to mere descriptions of average profile similarities, while attempts to tap the full potential of a profile-centered perspective are scarce. Moreover, the peculiarities of vocational interest domains, such as their well evidenced adherence to a circumplex structure—a structural model

that describes the interrelationships between these domains—or the existence of normative profile components (e.g., the pronounced gender differences in particular interest domains), further complicate the analysis and interpretation of such similarities in ways that have seldom been recognized.

This dissertation pursued two superordinate goals. First, based on two interesting applied research questions concerning 1) the stability and change of vocational interests and their congruence with the environment during vocational education and training and 2) the similarity of vocational interests between family members, the aim was to identify particular challenges of analyzing vocational interests from a profile-centered perspective and to propose and apply appropriate means to overcome these challenges. Second, the intention was to provide and validate a German translation of the Personal Globe Inventory (PGI), a self-report questionnaire used to assess vocational interests in the sense of the spherical model of vocational interests, and its abbreviated short version: The Personal Globe Inventory - Short (PGI-S). A particular benefit of this extension of the RIASEC model, besides the introduction of an entirely new dimension to the interest construct domain, is its more sophisticated classification system, which opens up the possibility of assessing more differentiated interest profiles compared to those obtained from traditional instruments.

# 1

## Introduction and Theoretical Background

Profile research is necessarily faced with many difficulties.

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L. J. CRONBACH & G. C. GLEESER, 1953

Every day, thousands and thousands of people are faced with the question of which profession best suits their character. The academic endeavors to find answers to this central question reach back as far as to Plato's *The Republic*, where the famous Greek scholar philosophized about assigning people to jobs that match their temperaments and aptitudes (Kaplan, 1950). In the early decades of the 20th century, the pursuit to understand the psychological processes involved in making vocational choices inspired many researchers to develop theories of vocational development and choice that are still acknowledged to this day. (e.g., Darley & Hagenah, 1955; Ginzberg, Ginsburg, Axelrod, & Herma, 1951; Parsons, 1909; Roe, 1956, 1957; Super, 1957).

However, all of the early works were eventually outshone by the exceptional scientific contributions of John Holland (e.g., 1959; 1968; 1973; 1997). In his seminal *theory of vocational personalities and work environments*, Holland (1997) emphasizes the predominant role of vocational interests and their congruence with the work environment for vocational choice, success, and satisfaction. He developed a comprehensive typology to describe both individuals' vocational interests and entire work environments with the help of six overarching interest domains: Realistic, Investigative, Artistic, Social, Enterprising, and Conventional—RIASEC. Moreover,

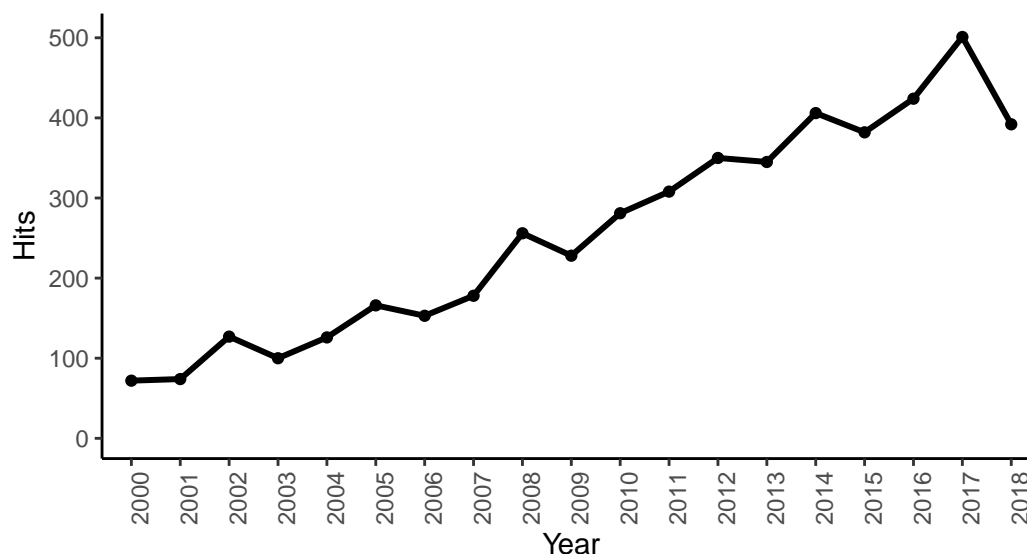


Figure 1: Google Scholar hits per year for the search keyword “RIASEC”.

Holland introduced an empirically approved structural model to describe the interrelations between these domains (i.e., the hexagon or its generalization: the circumplex) and consolidated the widely acknowledged idea that vocational interests are dispositional and relatively stable characteristics of the human personality.

Today, Holland’s theory is unambiguously considered “the most widely studied career theory in history” (Swanson & Gore, 2000, p. 234) and has led both researchers and practitioners from the field of career development to declare the end of the 20th century to be the “Age of Interests” (Blustein & Flum, 1999, p. 345). To the present day, it provides a fruitful basis for research on the relationship between vocational interests and central occupational outcomes, such as choice behavior (e.g., Hansen & Swanson, 1983), satisfaction (e.g., Volodina, Nagy, & Köller, 2015), dropout (e.g., Allen & Robbins, 2008), and work performance (e.g. Nye, Su, Rounds, & Drasgow, 2017). The continuing relevance of Holland’s work is apparent in the reliably high and ever increasing number of scientific publications referring to his famous RIASEC typology. Figure 1 visualizes this impressive continuance by displaying the yearly number of Google Scholar hits for the keyword RIASEC from 2000 to 2018.

This dissertation, too, picks up on Holland’s theory and tries to advance it by making the case for a profile-centered perspective towards analyzing and assessing vocational interests. In the first part of the dissertation, two studies present novel approaches towards analyzing

associations between vocational interests on the level of multivariate interest profiles instead of on the level of single interest scales. It is argued that this perspective enables researchers to reveal specific relationships that cannot be unveiled on the scale level because the answers to the respective research questions rely on the entire information about individuals' likes and dislikes for certain work activities. Specifically, in Study 2, the stability and change of vocational interest profiles and the development of the congruence between vocational interest profiles and the environmental demands of young adults in vocational education and training (VET) is examined. Study 3 addresses the question of the similarity between vocational interest profiles of mothers, fathers, and their children over and above similarity that is due to gender-normativeness.

The second part of the dissertation is concerned with the thorough validation of a German translation of the Personal Globe Inventory (PGI; Tracey, 2002) and its associated short version (PGI-S; Tracey, 2010). The PGI is an instrument used to assess vocational interests in accordance with the spherical model of vocational interests (Tracey & Rounds, 1996b), a relatively new extension to Holland's RIASEC model. A major advantage of the PGI is that it allows the assessment of more differentiated interest profiles than the traditional instruments. In Study 4, the focus is put on the structural, convergent, and concurrent validity of the PGI's interest sphere. Finally, in Study 5, the question of the validity of the dimensions underlying the spherical model and their invariance between the long and short version of the PGI is addressed.

This introductory chapter pursues two major goals. First, the aim is to provide a theoretical framework for the vocational interest construct and to introduce the particular models of vocational interests that constitute the basis of the four studies. To this end, the concept of vocational interests is derived from a general theory of interest, and their close relationship with personality characteristics is discussed (Section 1.1). Next, a thorough review of Holland's theory is given in Section 1.2. Thereby, the focus is put on two of the theory's core aspects, namely, the importance of person-environment congruence and the structural model underlying the RIASEC domains (i.e., the circumplex). Lastly, in Section 1.3, the spherical model of vocational interests is introduced as an extension of Holland's RIASEC model.

The second aim of this introduction is to explicate the importance of vocational interest

profiles and to illustrate the methodological possibilities and challenges of taking a profile-centered perspective towards analyzing interest-outcome relationships and, especially, interest similarity. To this end, the central components of psychological profiles and their relative importance for vocational interest profiles in particular are discussed in Section 1.4. Moreover, it is demonstrated that the underlying circumplex structure has important consequences for individual-level interest profiles. Finally, in Section 1.5, a brief review of different approaches towards analyzing research questions in the social sciences is given, from which the particular opportunities and challenges of analyzing the similarity of vocational interests within and between persons from a profile-centered perspective are derived.

## 1.1 Conceptualizing Vocational Interests

The term “interest” is used quite liberally in everyday speech and everyone has an intuitive and more or less clear understanding of what is meant when someone is said to be *interested* in something. When, for example, Paul is said to be interested in jazz music, most people will expect Paul to enjoy listening to jazz music and maybe to even play an instrument himself. Perhaps he is a member of a semi-professional local jazz quartet or even plays the jazz guitar for a living. One would further expect to come across Paul at venues that are renowned for hosting jazz concerts rather than at the football stadium. It would not be surprising to be stood up by Paul because his favorite jazz artists are coming to town. Finally, more often than not, one would consider Paul to have a sustained preference for jazz music and similar topics rather than it being just a temporary whim.

In the scientific literature, the different conceptualizations and definitions of interest, both etymologically and psychologically, are manifold<sup>1</sup>. The most thoroughly developed theoretical foundation of interest as a psychological construct originates from educational psychological research, where two types of interest are distinguished between: *individual interest* and *situational interest* (e.g. Hidi, 1990; Krapp, Hidi, & Renninger, 1992; Schiefele, 1999). In this tradition, individual interest describes a “dispositional motivational characteristic” (Schiefele,

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<sup>1</sup>Comprehensive overviews of the nature of interests and the different approaches towards defining them can be found, for example, in Berlyne (1949), Savickas (1999), or Silvia (2006).

1999, p. 260) of the person—a trait. On the other hand, situational interest refers to a current psychological state elicited by a person’s engagement with an environmental stimulus. Because Holland’s RIASEC domains can be regarded as a typology for the content structure of individual interest at a high level of generality (Krapp & Prenzel, 2011) and with a strong reference to the world of work, this theoretical framework poses a suitable basis for the conceptualization of vocational interests used in this dissertation.

Although the introductory example of Paul and his interest in jazz music relied on a commonplace conception of the term “interest”, the next sections will show that many of the aspects that characterize individual interest are embodied in our everyday understanding of the meaning of this word. In the following sections, the concepts of situational interest and individual interest are explicated and the differences between them are carved out.

### 1.1.1 *Situational Interest*

It is appropriate to start with a delimitation of what vocational interests, in terms of Holland’s theory, are *not*. To this end, a brief introduction will be given on the concept of situational interest. Situational interest is an important concept in educational psychology that was developed in the context of learning from text<sup>2</sup> (Krapp, 1992). Situational interest is defined as a psychological state elicited by objects or conditions in the environment. This state is characterized by 1) a heightened attention, awareness, and arousal, 2) the experience of positive emotions, and 3) an increased likelihood to attach a deeper value to the object of interest (Linnenbrink-Garcia, Patall, & Messersmith, 2013). In this regard, situational interest does not reveal much about an individual’s preferences for certain content domains because it is primarily triggered by specific characteristics of the stimulus object<sup>3</sup>.

Situational interest is hypothesized to fulfill two important roles. First, it is said to foster learning and achievement through an increased engagement with the learning material. For

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<sup>2</sup>In earlier works on this topic, situational interest was referred to as “text-based interest” (e.g., Hidi & Baird, 1988). However, this conceptualization was quickly abandoned because it suggests that the concept is restricted to textual stimuli. The term “situational interest”, on the other hand, appropriately generalizes this concept to any kind of attention eliciting external stimuli.

<sup>3</sup>These characteristics include, among others, personal relevance, novelty, vividness, and comprehensibility and are commonly summarized under the term “interestingness” (e.g., Hidi & Baird, 1986).

example, Rotgans and Schmidt (2011) were able to show that students with higher situational interest were more likely to show achievement-related classroom behavior, which, in turn, predicted academic achievement. Second, situational interest is considered to be a central factor in the development of enduring interests in specific topics, activities, or content domains (i.e., individual interest). For instance, in their four-phase model of interest development, Hidi and Renninger (2006) postulated that individual interest develops as a consequence of triggered and maintained situational interest. This general conception of interest development is largely supported by other authors in the psychological community (e.g., Krapp, 2002; Linnenbrink-Garcia et al., 2013) and has been corroborated by empirical research findings (Rotgans & Schmidt, 2017).

### 1.1.2 *Individual Interest*

In contrast to the concept of short-term situational interest, which describes “an affective reaction that may or may not last” (Hidi, 2000, p. 312), individual interest typically refers to a person’s relatively enduring, dispositional preferences for objects of interest<sup>4</sup> (Hidi, 1990; Krapp, 1992; Krapp et al., 1992; Schiefele, 1999, 2009). Individual interest has been defined as a “relatively stable affective-evaluative orientation toward certain domains” (Schiefele, 2009, p. 201), “personality-specific orientations, reference valuations, or an awareness of possibilities for actions” (Krapp et al., 1992, pp. 6–7), or “an individual’s relatively enduring predisposition to attend to certain objects, stimuli, and events, and to engage in certain activities” (Hidi, 2000, p. 313).

These quotes highlight several key characteristics of the individual interest construct. First, individual interest is a relational concept that describes the enduring relationship between an individual and an object of interest. These objects of interest can be more or less specific. For example, they can be particular activities, school subjects, or broader content domains (e.g., natural sciences). The concept of individual interest is, thus, rooted in the tradition of other

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<sup>4</sup>It should be noted that individual interest can also elicit psychological states that are commonly referred to as “actualized individual interest” (Krapp et al., 1992). Because this specific conceptualization of individual interest has no relevance for this dissertation, the term individual interest will hereafter be used solely to refer to interest as a dispositional characteristic of the person.



prominent psychological theories that consider the individual and the environment to form an inseparable unit (e.g., Deci & Ryan, 1985; Lewin, 1936). Individual interest increases the likelihood to engage in activities or to seek out environments that are associated with the object of interest. Lastly, individual interest is considered to be composed of feelings-related and value-related valence beliefs (Schiefele, 1999, 2009). This means that the object of interest is of personal significance to the individual and that the engagement with it evokes positive affective reactions (e.g., excitement, stimulation, or enjoyment; Schiefele & Krapp, 1996). Taken together, the aforementioned characteristics justify the conceptualization of individual interest as an intrinsic motivational construct that influences the quality (direction) and quantity (intensity) of an individual's engagement with objects from the environment (Krapp, 2002; Schiefele & Köller, 2010).

In educational psychological research, students' objects of interest are usually particular school subjects (e.g., math, physics, or biology). This specific form of individual interest is commonly termed "academic interest" (Köller, Baumert, & Schnabel, 2001). Students with high interests in particular school subjects are assumed to invest their cognitive resources predominantly in these school subjects, to perceive the engagement with these subjects as enjoyable, and to be drawn toward activities and environments that foster an active engagement with related topics. Consequently, it can be expected that these students will achieve higher performance attainments in these subjects compared to students who are not interested<sup>5</sup> (Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005).

Taken together, interest can be defined either as a psychological state or as a dispositional motivational characteristic of the person. An individual's state of "being interested" can be elicited by an activated individual interest ("actualized individual interest") or by particular characteristics of the stimulus object (evoked by a stimulus' "interestingness"). Individual interest, on the other hand, is a relatively enduring and intrinsic characteristic of the individual

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<sup>5</sup>For the sake of completeness, it should not go unmentioned that this simplistic depiction of the interest-achievement relation excludes the important role of academic self-concept, a construct that is strongly interrelated with academic interest. The causal paths and the interrelations between these three constructs (academic self-concept, academic interest, and academic achievement) are still debated to the present day (e.g., Grigg, Perera, McIlveen, & Svetleff, 2018).

that guides her or his actions and attitudes toward certain objects of interest through feelings-related and value-related valence beliefs. Returning once more to the introductory example of Paul (person) and his interest in jazz music (object of interest), it was argued that one would expect Paul to enjoy listening to or playing jazz music (feelings-related valence belief) and that it would be important to him to engage in activities that are related to jazz music, maybe even to the point that he would cancel a long confirmed appointment to see his favorite jazz artists (value-related valence belief). His interest, furthermore, was expected to draw him towards environments that allow the engagement in such activities (interest-induced action). Lastly, it was hypothesized that his interest in jazz music was a persistent character trait (dispositional motivational characteristic).

At this point, it should be clear that basically anything can be an object of interest and that such objects of interest can vary in specificity (e.g., jazz music as a rather specific object of interest versus natural sciences as a very broad interest domain subsuming many specific objects of interests). In the next section, vocational interests are defined as a special case of individual interest. Specifically, it is argued that vocational interests are individual interests that relate to objects of interest that are associated with the world of work. In this regard, Holland's (1997) RIASEC domains, as a comprehensive, yet parsimonious classification system of the world of work, can be understood as a typology of six broad content domains that a person's individual interests may relate to<sup>6</sup>.

### 1.1.3 *Vocational Interests*

Based on the aforementioned distinction between interest as a state versus interest as a trait, it is now possible to define the concept of *vocational interests* as individual interests that relate to activities or contexts that are associated with the world of work or to broader domains that subsume such activities and contexts. The appropriateness of this definition is illustrated by the obvious overlap between the definition of individual interest (Section 1.1.2) and definitions of

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<sup>6</sup>During the writing process of these sections, two new works (one article and one book chapter) on the interest state versus trait issue and potential ways to unify these perspectives have been published (Su, 2018; Su, Stoll, & Rounds, 2018). Because much of what is written in those two publications agrees with the rationale presented in this introductory chapter and further extends the arguments by introducing a dynamic interest trait-state model from a vocational interest perspective, those works are recommended for further reading on this topic.

vocational interests from relevant publications in the vocational interest literature. For example, Rounds and Su (2014) defined vocational interests as “traitlike preferences for activities, contexts in which activities occur, or outcomes associated with preferred activities that motivate goal-oriented behaviors and orient individuals toward certain environments” (p. 98).

This particular definition touches on yet another important issue that has been extensively discussed in the vocational interest literature: Are vocational interests actually personality traits? Researchers who set out to answer this question commonly relied on examining the theoretical and empirical similarities and differences between the RIASEC domains and the personality types of the Five Factor Model (FFM) of personality [Openness to Experiences (O), Conscientiousness (C), Extraversion (E), Agreeableness (A), and Neuroticism (N); Digman, 1990]. Although, historically, these two sets of variables were developed independently and with very different approaches (empirically driven versus lexicographical), researchers have widely acknowledged their relatedness for a long time. An important reason for this is that Holland himself repeatedly emphasized his belief that vocational interests are a characteristic of the human personality<sup>7</sup> (Holland, 1978, 1985, 1997, 1999). This view is supported by Costa, McCrae, and Holland (1984), who considered the RIASEC types to depict an “attempt to infer the structure of personality from the clustering of vocational interests” (p. 391).

From a theoretical point of view, Nauta (2012) highlighted three shared characteristics that support the idea of vocational interests as personality traits, namely 1) their relative stability over considerable periods of time (e.g., Low, Yoon, Roberts, & Rounds, 2005), 2) their predictive power for behavioral outcomes (e.g., vocational choice; Hansen & Swanson, 1983; Nagy, 2006), and 3) the comparable magnitude of agreement between self-ratings and other-ratings (i.e., from parent-child and friend dyads; Nauta, 2012). Despite these striking similarities, there are also some conceptual differences between the two variable groups. For example, while personality traits describe individuals’ behavioral tendencies across different situations, that is, the way they think, act, and feel, vocational interests describe individuals’ likes and dislikes for particular activities or contexts. In other words, a person’s personality traits primarily define *how* she or he

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<sup>7</sup>The general idea of a conceptual relationship between personality and interests, however, can be traced back even further (e.g., Darley & Hagenah, 1955; Parsons, 1909).

reacts when confronted with certain activities, contexts, or situations, and a person's vocational interests predominantly (but not exclusively) determine *what kind* of specific activities, contexts, or situations she or he is likely to seek out in the first place. Empirical evidence for this particular distinction can be found in the fact that vocational interests play an extraordinary role for individuals' vocational choice behavior (e.g., Nagy, 2006; Volodina, Nagy, & Retelsdorf, 2015), whereas the role of the FFM personality traits for such behavior is less significant (e.g., Rubinstein, 2005; Tokar, Fischer, & Mezydlo Subich, 1998; Zhao & Seibert, 2006).

There is sound empirical evidence for a considerable overlap between the two construct domains. Several highly cited studies (Ackerman & Heggestad, 1997; Armstrong & Anthony, 2009; Barrick, Mount, & Gupta, 2003; Hoff, Song, Einarsdóttir, Briley, & Rounds, 2018; Larson, Rottinghaus, & Borgen, 2002; McKay & Tokar, 2012; Sullivan & Hansen, 2004; Tokar & Fischer, 1998) have examined the associations between vocational interests (in terms of the RIASEC model) and personality traits (in terms of the FFM model or its most recent extension: the HEXACO model<sup>8</sup>). The most commonly observed associations are (in no particular order) those between 1) Extraversion and Enterprising, 2) Extraversion and Social, 3) Openness to Experience and Investigative, 4) Openness to Experience and Artistic, and 5) Conscientiousness and Conventional<sup>9</sup>. Some researchers have regarded that the fact that the magnitude of these associations is only moderate and the fact that some domains (e.g., Realistic or Neuroticism) typically show no significant relation with either scale from the other content domain is an indication of a lack of commonality between the construct domains. However, this presumed shortcoming is overcome when multivariate measures of association are considered. For example, McKay and Tokar (2012) as well as Volodina, Nagy, and Köller (2015) were able to show that sets of vocational interests and personality types (in terms of the HEXACO and the FFM model, respectively) shared substantial amounts of variance (see also Tokar & Fischer, 1998). These relatively new findings suggest that the overlap between the two construct domains could be even stronger than previously assumed.

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<sup>8</sup>The HEXACO model is an alternative to the FFM that extends it by including one additional personality type called Honesty-Humility (Ashton & Lee, 2007; K. Lee & Ashton, 2004).

<sup>9</sup>The meaning of the particular RIASEC domains will be detailed in the following section. Readers with no previous knowledge of the particular meaning of the RIASEC domains may refer to Table 1 on page 12.

Taken together, vocational interests describe individuals' preferences for certain activities and contexts that are associated with the world of work. They motivate goal-oriented behavior that is manifested, for example, in individuals' exploration of environments that enable them to engage in such activities. Vocational interests, as dispositional characteristics of the human personality, are relatively stable over considerable periods of time (Low et al., 2005). Therefore, they are considered to be closely related to personality traits, an assumption that has found reasonable empirical support (Volodina, Nagy, & Köller, 2015). Nevertheless, there is one particular feature that distinguishes them from traditional personality traits: they also direct individuals' behavior towards particular activities and environments. In the next sections, Holland's RIASEC typology, as the most prominent classification system of such activities and environments, and the central assumptions of his theory are explicated in detail.

## 1.2 The RIASEC Model

At the core of Holland's theory of vocational personalities and work environments are the six interest domains—RIASEC. Although Holland's theory goes far beyond the mere categorization of potential objects of interest, specifically by postulating six corresponding *personality types* and six *environmental models* (each corresponding to one of the RIASEC domains), the most common use of the six RIASEC domains in vocational research is that of a classification system of the world of work that allows for a parsimonious description of individuals' vocational preferences or the characteristics of particular work (or educational) environments. Because this dissertation, too, relies on this particular purpose of the RIASEC domains, the parts of Holland's theory that go beyond this use<sup>10</sup> are not further attended to hereafter. Table 1 summarizes the central characteristics of the RIASEC domains by presenting general task descriptions as well as exemplary work activities and environments associated with either domain. On the basis of these interest domains, Holland developed two important principles that are central to the success and widespread acknowledgment of his theory: The importance of the congruence

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<sup>10</sup>For example, Holland's personality types also include descriptions of associated avocational preferences, life goals and values, self-beliefs, and problem-solving strategies. Detailed accounts of the personality types and environmental models can be found, for example, in the works of Holland (1997, pp. 21–29; 43–48) and Nagy (2006, pp. 41–42).

Table 1: Descriptions and Examples of Work Tasks and Environments Associated with each RIASEC Domain

Interest Domain	General Task Description	Exemplary Tasks	Exemplary Environments
<b>Realistic</b>	<ul style="list-style-type: none"> <li>• manual tasks</li> <li>• tasks involving the use of tools/machines</li> <li>• engineering tasks</li> </ul>	<ul style="list-style-type: none"> <li>• cutting metal</li> <li>• repairing cars</li> <li>• operating a forklift</li> </ul>	<ul style="list-style-type: none"> <li>• workshop</li> <li>• garage</li> <li>• construction site</li> </ul>
<b>Investigative</b>	<ul style="list-style-type: none"> <li>• analytic tasks</li> <li>• research</li> <li>• problem solving</li> </ul>	<ul style="list-style-type: none"> <li>• calculating risks</li> <li>• writing research articles</li> <li>• conducting experiments</li> </ul>	<ul style="list-style-type: none"> <li>• insurance company</li> <li>• research lab</li> </ul>
<b>Artistic</b>	<ul style="list-style-type: none"> <li>• creative tasks</li> <li>• craftwork</li> <li>• design</li> </ul>	<ul style="list-style-type: none"> <li>• playing the jazz guitar</li> <li>• sculpturing</li> <li>• writing advertising slogans</li> </ul>	<ul style="list-style-type: none"> <li>• concert hall</li> <li>• artist's workshop</li> <li>• marketing agency</li> </ul>
<b>Social</b>	<ul style="list-style-type: none"> <li>• consultative tasks</li> <li>• teaching tasks</li> <li>• nursing tasks</li> </ul>	<ul style="list-style-type: none"> <li>• career consulting</li> <li>• teaching a class</li> <li>• tending patients</li> </ul>	<ul style="list-style-type: none"> <li>• information center</li> <li>• school</li> <li>• hospital</li> </ul>
<b>Enterprising</b>	<ul style="list-style-type: none"> <li>• management tasks</li> <li>• executive tasks</li> </ul>	<ul style="list-style-type: none"> <li>• delegating staff</li> <li>• running a business</li> <li>• holding a meeting</li> </ul>	<ul style="list-style-type: none"> <li>• small to large companies</li> <li>• retail store</li> <li>• bureau</li> </ul>
<b>Conventional</b>	<ul style="list-style-type: none"> <li>• regulative tasks</li> <li>• structured tasks</li> <li>• administrative tasks</li> </ul>	<ul style="list-style-type: none"> <li>• accounting</li> <li>• administering information systems</li> <li>• managing databases</li> </ul>	<ul style="list-style-type: none"> <li>• accounting firm</li> <li>• public administration</li> <li>• bank</li> </ul>

*Note.* These itemizations merely depict a short abstract of possible tasks and environments that are commonly associated with the six interest domains and make no claim to be complete.

between the person and the environment and a structural model for the interrelations between the RIASEC domains. These principles will be addressed in the following sections.

### 1.2.1 *The Congruence Hypothesis: The Role of Person-Environment Fit*

The first central assumption of Holland's theory, which is commonly referred to as the *congruence hypothesis*, states that individuals are drawn towards environments whose specific characteristics (e.g., demands and opportunities for engaging in particular tasks) are congruent with their vocational interests. For example, a person who is primarily interested in activities from the Realistic domain is hypothesized to seek out environments where such tasks are required and supported and is more likely to be employed in such an environment at any point in her or his life<sup>11</sup>. Moreover, the degree of congruence between individuals' vocational interests and the characteristics of their current environment is said to have important consequences for their work-related behavior and their attitudes towards the particular environment. Specifically, it is postulated that a high person-environment (P-E) congruence<sup>12</sup> leads to higher performance, higher satisfaction, and greater continuance in the respective environment.

Empirical investigations of these assumptions have produced more or less unambiguous results. The most robust and uncontroversial empirical finding is the predictive power of vocational interest for occupational and educational choice behavior. In particular, vocational interests have been found to predict the selection of college majors (e.g., Hansen & Swanson, 1983; Holland, 1968; Le, Robbins, & Westrick, 2014; Nagy, 2006; Perera & McIlveen, 2018), secondary school profiles (e.g., Volodina, Nagy, & Retelsdorf, 2015), vocational education and training courses (Volodina & Nagy, 2016), and occupations (e.g., Holland, 1997; Lent, Brown, Nota, & Soresi, 2003; Prediger, 1998; Tracey & Hopkins, 2001). P-E congruence has further

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<sup>11</sup>In this regard, Holland's theory is complemented by the Attraction-Selection-Attrition (ASA) model (Schneider, 1987; Schneider, Goldstein, & Smith, 1995). In this framework, it is assumed that organizations comprise employees with similar personality structures that homogenize over time through dynamic cycles of selection and attrition.

<sup>12</sup>Although there are many possible characteristics of persons and environments between which congruence could be established (for example, between needs and supplies or between demands and abilities; Dawis & Lofquist, 1984; Etzel & Nagy, 2016), the term P-E congruence will be used exclusively to indicate congruence between individuals' vocational interests and characteristics of work (or educational) environments throughout this dissertation. A comprehensive overview of different conceptualizations of P-E congruence can be found in the meta-analysis of Kristof-Brown, Zimmermann, and Johnson (2005).

been found to be positively associated with environmental persistence and negatively related to individuals' intention to drop out of their current environment (e.g., Etzel & Nagy, 2016; Le et al., 2014; Volodina, Nagy, & Köller, 2015). Moreover, individuals who dropped out of their current work environment were found to move towards environments that were more congruent to their vocational interests (Donohue, 2006; Oleski & Subich, 1996).

While there is widespread agreement about the validity of the aforementioned associations, the relationships between P-E congruence and other relevant educational and occupational outcomes are more ambiguous. For example, Spokane (1985) found support for a positive relationship between P-E congruence and academic performance and grades. In two recently published meta-analyses, P-E congruence has been shown to be positively related to work and academic performance as well as organizational citizenship behavior and negatively related to counterproductive work-behavior (Nye et al., 2017; Van Iddekinge, Roth, Putka, & Lanivich, 2011). The corresponding effect sizes, however, were only of small to moderate magnitude. Finally, concerning what is quite surprisingly the most controversial congruence-outcome association, two prominent meta-analyses did not find any support for the theoretically rather obvious association between P-E congruence and satisfaction (Assouline & Meir, 1987; Tokar & Subich, 1997; Tranberg, Slane, & Ekeberg, 1993; Tsabari, Tziner, & Meir, 2005). However, the reasons for this lack of empirical support have been largely attributed to potential flaws in the methods employed to analyze these relationships, especially with regard to the lack of commensurate measurement of person and environmental characteristics in order to operationalize P-E congruence, rather than to theoretical deficiencies (Tinsley, 2000).

Specifically, it has been criticized that almost all of the studies concerned with the congruence-satisfaction relationship relied on different measures of congruence that have been shown to moderate the congruence-satisfaction relationship (e.g., Tranberg et al., 1993) and that are commonly based on the congruence of individual and environmental 1-, 2-, or 3-letter Holland codes. An individual's *k*-letter Holland code is obtained from her or his results from a self-report questionnaire, by identifying the *k* RIASEC scales on which she or he scored the highest. For example, if an individual's set of scale scores was: R = 2.00, I = 2.50, A = 3.00, S = 3.50, E = 3.25, and C = 2.00, her or his 3-letter Holland code would be SEA. Likewise, it is possible to



create corresponding  $k$ -letter Holland codes to describe environments<sup>13</sup>. These individual and environmental codes are then combined to a measure of P-E congruence (commonly referred to as the “congruence index”) through the use of one of many different calculation rules (e.g., Brown & Gore, Jr., 1994; Camp & Chartrand, 1992). Although Holland’s coding system is invaluable for counseling practice, in order to keep it straightforward and easy to interpret, it depicts a strongly reduced account of individuals’ interest profiles and the corresponding environmental characteristics. As argued in the subsequent sections, the ambiguity of these findings could potentially be resolved by taking into account the entire information encoded in individual and environmental profiles and by combining them by means that grasp the essential aspect of these profiles: their shape.

### 1.2.2 *The Calculus Hypothesis: A Structural Model for the RIASEC Domains*

The second central assumption of Holland’s theory, the *calculus hypothesis*, provides a structural model for the relationships between the six RIASEC domains. Specifically, it is assumed that the RIASEC domains can be represented in a two-dimensional space by ordering them at the vertices of a hexagon<sup>14</sup>. Thereby, the proximity between any two domains on the hexagon is said to resemble their psychological similarity (Figure 2). In other words, it is assumed that the closer any two domains are placed on the hexagon, the more similar they are. For example, because Realistic and Investigative are adjacent to each other, they are assumed to be more similar than Realistic and Artistic. Likewise, because they are placed exactly on opposing sides of the hexagon, Realistic and Social are assumed to be most dissimilar.

Figure 2 also displays an alternative representation of the structural relations between the

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<sup>13</sup>The most common techniques to do so are the Environmental Assessment Technique (EAT; Holland, 1997), which relies on identifying the “prototypical” individuals who form the environment in question and using their modal Holland code, or the use of the *Dictionary of Holland Occupational Codes* (DHOC; Gottfredson & Holland, 1996), which displays a comprehensive list of occupations and their corresponding, empirically derived Holland codes.

<sup>14</sup>It should not go unmentioned that there are alternative views on the overarching organization of vocational interests. For example, Gati (1991) has challenged the circular model presented in this section and proposed an alternative model implying a hierarchical structure of the RIASEC domains. However, recent methodological advances have demonstrated the superiority of the circular model (Nagy, Trautwein, & Lüdtke, 2010; Tracey & Rounds, 1993). A recent attempt to impose a dimensional model of vocational interest (Su, Tay, Liao, Zhang, & Rounds, 2018) has yet to withstand such a comparative examination.

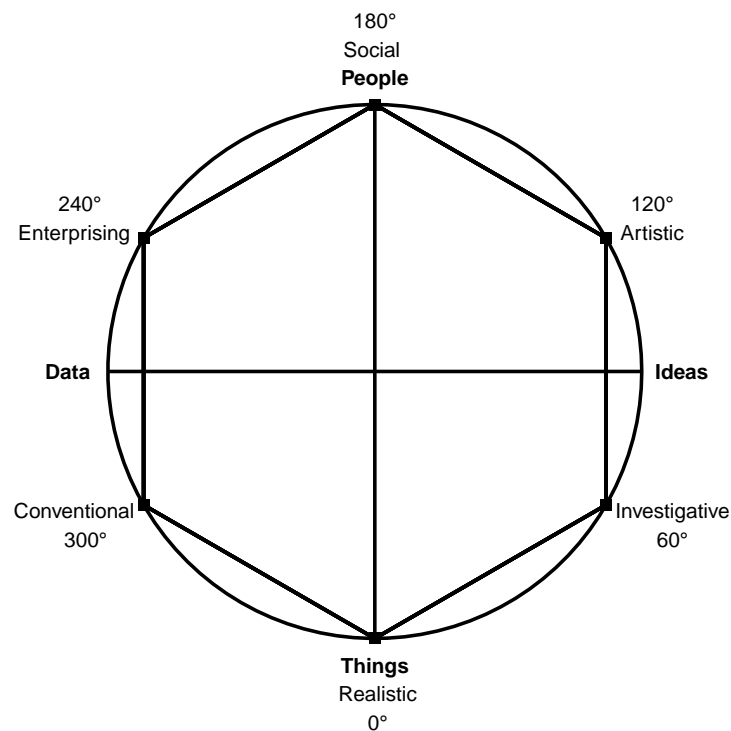


Figure 2: The circumplex representation of the six RIASEC domains and Holland's hexagon. Angular scale positions are relative to the Realistic domain that is set as a reference domain at  $0^\circ$ .

RIASEC domains: a circumplex (Guttman, 1954). Although these two alternative representations are basically interchangeable, the circular representation has at least two particular advantages. First, as argued by Nagy et al. (2010), the circumplex representation allows for a description of the domains' positions around the perimeter of the circle by means of their angular location. This then defines a metric according to which the relative similarities between the RIASEC domains can be judged straightforwardly. Specifically, in this representation, the similarity between two interest domains is given by the size of the smallest separating angle between them. Second, the circumplex structure is not unique to the vocational interest construct domain but is also found in other fields, for example, in research on interpersonal behavior (Wiggins, 1979), mood (Watson & Tellegen, 1985), and affect (Russell, 1980). Relying on the circumplex representation can thus be expected to foster the communication with colleagues from other fields and to enable researchers from either field to develop, advance, and apply common research methods to analyze the implied structural assumptions of circumplex models

and their relations to other variables.

Another important feature of this structural model is the two dimensions underlying the circumplex. Although there are, theoretically, infinite possibilities to define two coordinate axes for the circumplex, only two prominent alternatives have received considerable attention over the years. First, Hogan (1983) proposed the two dimensions of *sociability* and *conformity*. The conformity dimension is spanned by the Conventional and the Artistic domains and the sociability dimension is orthogonal to the former. This conceptualization of the dimensions underlying the circumplex follows a socioanalytic tradition and describes rather general behavioral tendencies associated with Holland's personality types. The second prominent conceptualization, Prediger's (1982) *People-Things* and *Ideas-Data* dimensions (see Figure 2), on the other hand, defines two superordinate content dimensions. The People-Things dimension is spanned by the Realistic and Social interest domains and indicates preferences for interpersonal versus impersonal activities. The Ideas-Data dimension is orthogonal to the People-Things dimension and implies preferences for highly structured, data-driven tasks versus unsystematic tasks that involve theorizing, creativity, and abstraction. Because these particular dimensions are more closely related to the notion of the RIASEC domains used in this dissertation and because they have been proven to be relevant for research on vocational interests (e.g., as a the central dimension for gender differences in vocational interests Lippa, 1998; Su, Rounds, & Armstrong, 2009), these dimensions will be used to define the two-dimensional space on which the circumplex lies throughout this dissertation (Figure 2).

*Methods for analyzing the structural assumptions of circumplex models.* From a methodological point of view, the structural assumptions of the circumplex model imply particular constraints on the covariance or correlation structure of the variables in question. In the case of a perfect, equidistant circumplex, such as the one depicted in Figure 2, they imply a circulant correlation matrix of the six RIASEC domains (e.g., Gurtman & Pincus, 2003; Guttman, 1954). Such a matrix is depicted in Table 2. The circulant matrix requires the correlations between variables that are equally far away from each other to be identical. Furthermore, correlations between variables that are closer together must be larger than those between variables that are further apart. Because researchers have acknowledged the rigidity of these assumptions and the

Table 2: Circulant Correlation Matrix of the RIASEC domains

	R	I	A	S	E	C
R	1					
I	$\rho_1$	1				
A	$\rho_2$	$\rho_1$	1			
S	$\rho_3$	$\rho_2$	$\rho_1$	1		
E	$\rho_2$	$\rho_3$	$\rho_2$	$\rho_1$	1	
C	$\rho_1$	$\rho_2$	$\rho_3$	$\rho_2$	$\rho_1$	1

Note.  $\rho_1 > \rho_2 > \rho_3$ .

implausibility of inferring such highly specified correlation structures from observed data, it is widely agreed upon that the equidistant circumplex represents an idealized model of the true relationships between the RIASEC domains. Therefore, it is widely recognized that one would much rather expect to find a “misshapen polygon” (Holland, 1997, p. 138) or, equivalently, a quasi-circumplex (i.e., a circumplex where the variables’ locations are not strictly equidistantly distributed around the perimeter of the circle Guttman, 1954; Holland & Gottfredson, 1992; Prediger & Vansickle, 1992). Such a depiction of the structural model, which is more realistic, is displayed in Figure 3.

Based on the aforementioned arguments, it is self-evident that the appropriate means for analyzing the validity of the structural assumptions of the (quasi-)circumplex are statistical methods for investigating covariance and correlation structures (e.g., Browne, 1992) and methods for reducing the dimensionality of sets of variables based on their covariance or correlation pattern<sup>15</sup>. Three of the most widely applied methods, which are also used in some of the studies that make up this dissertation, are the *principal component analysis* (PCA), the *randomization test of hypothesized order relations* (RTOR; Hubert & Arabie, 1987), and the *circular stochastic process model with a Fourier series* (CSPF; Browne, 1992). Whereas the PCA is primarily used as a descriptive and exploratory method that can be applied to obtain estimates for the coordinates of the scales on the perimeter of the circumplex (see, for example, Study 4), the

<sup>15</sup>Comprehensive overviews of such methods can be found in Tracey (2000) and Rounds, Tracey, and Hubert (1992).

RTOR and the CSPF are more or less powerful confirmatory tests of the circular ordering (see Studies 3, 4, and 5).

The RTOR is a test used to investigate the extent to which the interrelationships between the correlations in a particular correlation matrix are in line with a prespecified order (for example, as implied by a circulant correlation matrix). The proportion of predictions met is indicated by the Correspondence Index ( $-1 \leq CI \leq 1$ ). A CI of 1 indicates that all prespecified predictions are met and a CI of -1 indicates that none of the prespecified predictions are met. The size of the CI is tested for statistical significance by means of a permutation test of the correlation matrix. The CSPF, on the other hand, is a much more elaborate model that allows the estimation of the correlation function underlying the true scores of the circumplex variables by means of a Fourier series approximation<sup>16</sup> (Nagy, 2006; Nagy, Marsh, Lüdtke, & Trautwein, 2009). Specifically, the correlation between the true scores of circumplex indicator variables ( $c_j$  and  $c_k$ ) is assumed to be equal to

$$\rho_{c_j, c_k} = \beta_0 + \beta_1 \times \cos(\theta_j - \theta_k) . \quad (1)$$

Thereby,  $\beta_0$  and  $\beta_1$  are the characteristic parameters of the underlying correlation function, and  $\theta_j$  and  $\theta_k$  are the angular positions of the variables  $j$  and  $k$  on the circumplex. In order for the  $\beta$ -parameters to define a correlation function, they are restricted to be larger than zero and their sum is restricted to be equal to one. The CSPF can be expressed as a confirmatory factor analysis (CFA) model with nonlinear constraints and can thus be estimated in any structural equation modeling (SEM) software that can handle such constraints (e.g., *Mplus* or the R package *lavaan*; Rosseel, 2012). The integration of this model into the flexible SEM framework enables researchers to estimate the specific parameters of the circumplex model (e.g., the scales' angular positions, residual variances, and the parameter of the underlying correlation function) and to test specific hypotheses about them (e.g., whether or not the scale positions are equidistantly distributed around the circumplex), to test the equality of such parameters across independent groups (see Study 5), or to integrate external variables into circumplex structures (Nagy, Etzel,

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<sup>16</sup>Here, only the simplest version of the model with  $m = 1$  components of the Fourier series is referred to. A more general model is applied in Study 5.

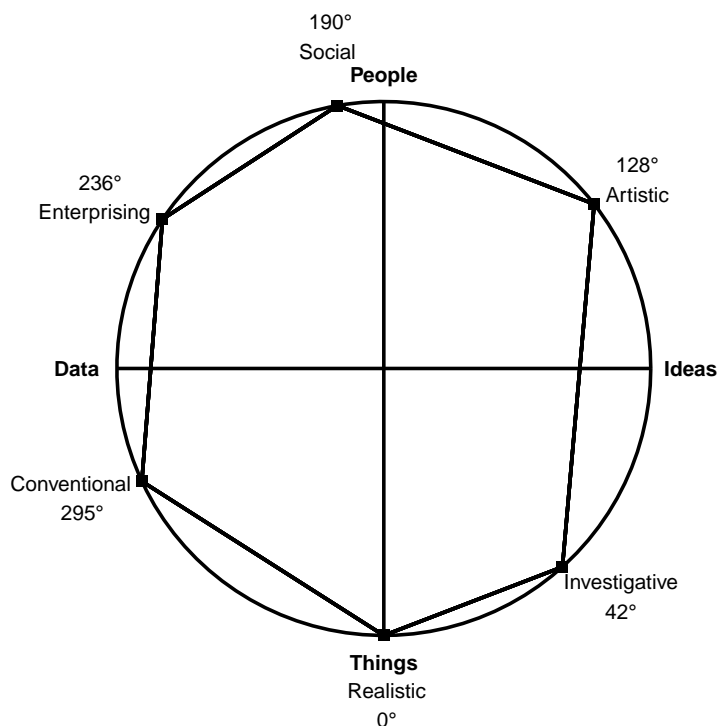


Figure 3: A quasi-circumplex representation of the six RIASEC domains and a corresponding “misshapen polygon”. Angular scale positions are relative to the Realistic domain that is set as a reference domain at 0°.

& Lüdtke, in press). Beyond this, the CSFP has also been shown to be superior to the RTOR with regard to its ability to detect nuanced differences between covariance structures due to its higher statistical power (Nagy et al., 2010).

*Empirical evidence for the RIASEC circumplex.* Empirical evidence for the structural assumptions underlying Holland’s RIASEC domains has been predominantly positive, especially in samples from Western countries. For example, in their meta-analysis of over 100 RIASEC correlation matrices, Tracey and Rounds (1993) were able to show that there is ample support for Holland’s assumptions concerning the circular order of the RIASEC scales in US and Australian samples across different age groups. Moreover, the works of Nagy et al. (2010) as well as Lent, Tracey, Brown, Soresi, and Nota (2006) demonstrated the validity of the circumplex model in European samples. Respective findings from US ethnic and minority samples and samples from Eastern countries were somewhat more ambiguous (Rounds & Tracey, 1996) but not entirely confutative (Day & Rounds, 1998; Day, Rounds, & Swaney, 1998; Ryan, Tracey,

& Rounds, 1996). Moreover, there is some evidence that these inconsistencies vanish when more differentiated classifications of vocational interests are considered (Tracey, Watanabe, & Schneider, 1997). The circular structure is assumed to develop during the middle school years (around the age of 14) and to solidify in middle to late adolescence (Tracey, 2002; Tracey & Robbins, 2005; Tracey & Ward, 1998). Although there is plenty of evidence for the existence of large gender differences in mean scores of vocational interests (Lippa, 1998; Su et al., 2009), the circular structure was found to be invariant between male and female participants (e.g., Anderson, Tracey, & Rounds, 1997; Darcy & Tracey, 2007).

Due to the widely affirmative evidence for the validity of the structural assumptions, more and more researchers have come to agree that the interest circumplex, together with its underlying dimensions (People-Things and Ideas-Data), should be regarded as the central aspect of the vocational interest construct and that the RIASEC domains depict just one possible, and ultimately arbitrary, classification of the construct space (Tracey & Rounds, 1995). In other words, the RIASEC domains can be viewed as one possible set of indicators for the interest circumplex. Tracey and Rounds (1995) were able to empirically support this assumption by demonstrating that interests are distributed uniformly around the circumplex instead of being clustered in particular groups. This realization has led researchers to explore the validity of alternative classifications of the interest construct space (e.g., Tracey & Rounds, 1994). The most dedicated of those examinations ultimately resulted in a more differentiated classification system of eight basic interest domains (see Figures 4 and 5), thus providing a reasonable compromise between parsimony and applicability (particularly with regard to counseling practice) on the one hand, and thoroughness and breadth (with regard to a differentiated assessment of the interest circumplex and individuals' interest profiles) on the other hand<sup>17</sup>. This alternative classification was incorporated into what might be considered the most elaborate extension of Holland's model to this day: *The spherical model of vocational interests* (Tracey & Rounds, 1996b), which will be introduced in the next section.

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<sup>17</sup>A dilemma that, in reference to Cronbach and Gleser (1965), has been referred to as the *bandwidth-fidelity trade-off* (Rounds, 1995).

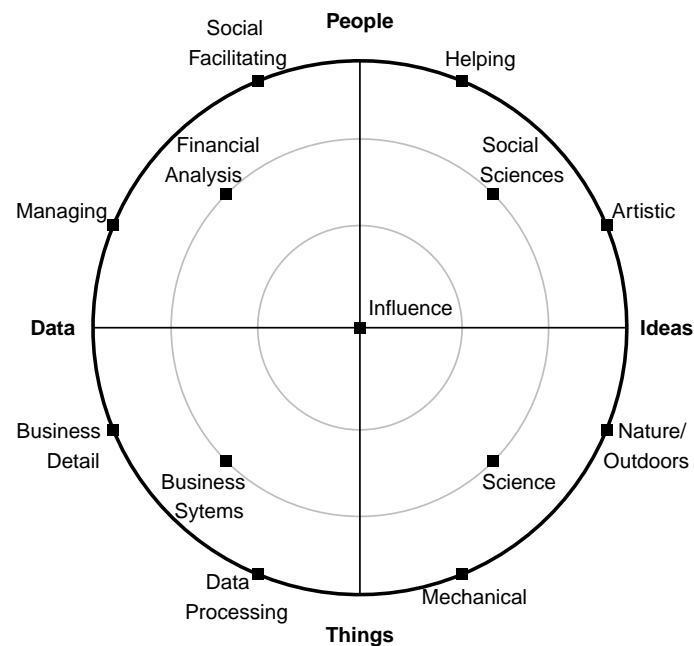


Figure 4: Upper hemisphere of the spherical model of vocational interests. Concentric circles represent contour lines at  $0^\circ$ ,  $45^\circ$ , and  $67.5^\circ$  latitude.

### 1.3 The Spherical Model of Vocational Interests

The spherical model of vocational interest was introduced in an article by Tracey and Rounds (1996b). It presents a novel approach towards interest assessment that extends Holland's traditional RIASEC model in two meaningful ways. First, because of their strong belief in the arbitrary nature of interest classifications (see Section 1.3.1) and in the superordinate importance of the circumplex, they decided to implement an eight-type classification. Second, they proposed a third dimension which they assumed to be orthogonal to the two circumplex dimensions: Prestige<sup>18</sup>. In this conceptualization, the two circumplex dimensions indicate preferences for activities from eight different content domains, which represent particular blends of the poles of the People-Things and Ideas-Data dimensions. Occupational prestige, on the other hand, is defined as a broad concept said to distinguish preferences for activities on different levels of "status, prestige, socioeconomic status, level of training, occupational level, and level of

<sup>18</sup>The authors make no secret of the importance of the exceptional contributions of Roe (1956) and Roe and Klos (1969), who laid the groundwork for the spherical model by proposing a "truncated cone", which was organized horizontally by eight occupational fields (which were, however, different from the eight domains that make up the circumplex of the spherical model) and involved a vertical dimension indicating different levels of required knowledge and skill.



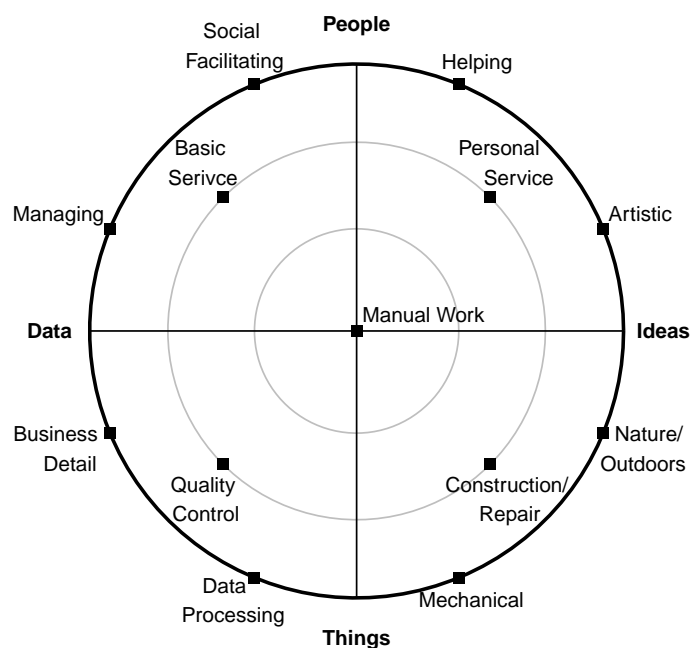


Figure 5: Lower hemisphere of the spherical model of vocational interests. Concentric circles represent contour lines at  $0^\circ$ ,  $-45^\circ$ , and  $-67.5^\circ$  latitude.

difficulty and responsibility” (Tracey & Rounds, 1996b, p. 4).

After some refinements of earlier versions of the model (Tracey & Rounds, 1996b), the current day conceptualization of the interest sphere was eventually introduced with the implementation of the Personal Globe Inventory (PGI; Tracey, 2002). In this form, the spherical model, as displayed in Figure 4 (viewed from above; high prestige hemisphere) and Figure 5 (viewed from below; low prestige hemisphere) comprises 18 distinct interest domains. The equator of the sphere is defined by eight basic interest domains (Social Facilitating, Managing, Business Detail, Data Processing, Mechanical, Nature/Outdoors, Artistic, and Helping) at an intermediate level of prestige. This means that the equator of the sphere defines the traditional interest circumplex with its underlying dimensions People-Things and Ideas-Data. Additionally, there are five interest domains to represent the high prestige hemisphere (Influence, Social Sciences, Financial Analysis, Science, and Business Systems) and five interest domains that represent the low prestige hemisphere (Manual Work, Construction/Repair, Quality Control, Personal Service, and Basic Services). A detailed description of each of these interest domains can be found in Tracey (2002, pp. 120–121).

In the PGI, the 18 interest domains are conceptualized in three different ways. First, the PGI

includes a list of activity descriptions. Test takers are asked to rate these activities according to how much they *like* to undertake these activities (activity preferences item type) as well as how *competent* they consider themselves to be in practicing these activities (activity competence beliefs item type). The PGI further consists of a set of occupational titles that test takers are asked to judge with regard to how much they would like to work in each profession (occupational preferences item type). Tracey (2002) provided a comprehensive psychometric examination of the central psychometric characteristics of the instrument and found strong support for the PGI's reliability and validity across all item types. The findings are further supported by the results of several studies from around the world (Darcy, 2005; Hedrih, 2008; Holtrop, Born, & de Vries, 2015; Long, Adams, & Tracey, 2005; Sodano & Tracey, 2008; Šverko, 2008). Again, findings from non-Western samples (Wilkins, Ramkissoon, & Tracey, 2013) were somewhat more ambiguous (cf. Long et al., 2005).

### 1.3.1 *Four, Six, or Eight Domains?*

A central aspect of the spherical model is its representation of the interest circumplex based on eight basic interest domains. This then raises the question of what arguments can be made to justify the use of this particular number of interest domains instead of relying on the traditional six RIASEC domains or just the four domains that are defined by the poles of the People-Things and Data-Ideas dimensions. After all, the authors themselves strongly emphasize the arbitrariness of categorizing the interest circumplex in whichever way (Tracey & Rounds, 1995) and argue that the different classification systems can be considered *pari passu* in many ways (Tracey & Rounds, 1996a). However, they argue that an eight-type model—in comparison to the traditional six-type classification—facilitates the translation between the circular and the dimensional representation (in the sense of Prediger's People-Things and Ideas-Data dimensions). Moreover, they were able to show that, when more elaborate methods are applied to evaluate the fit of a six-type or eight-type classification to the underlying circular order (i.e., confirmatory factor analysis models such as the CSPF instead of the rather liberal RTOR), the eight-type model tends to be superior to the six-type model in some subsamples (Tracey & Rounds, 1995) and in samples from non-Western countries (Tracey et al., 1997). Finally, they

rightfully argue that an eight-type model is more compatible with other circumplex models from the field of personality psychology. One of the most prominent circumplex models from this field is the interpersonal circumplex (e.g., Wiggins, 1979), which is commonly assessed with the help of adjective lists (Wiggins, 1995) that are then summarized into eight interpersonal behavior domains.

A particularly striking argument, which is implicit in the authors' rationale but not conveyed straightforwardly, is that viewing the interest domains as indicators of the underlying circumplex also means that the number of categories used to classify the interest construct space specifies the number of data points used to infer the circumplex from. In other words, the finer the underlying classification system, the more information is available to derive the circumplex structure from because the respective covariance or correlation matrices are larger (namely, with a size of  $k \times k$  for a system with  $k$  categories). Although the relationship between the information content of the covariance or correlation matrices and the fit to the circular order have, to the best of the present dissertation's author's knowledge, not yet been analyzed systematically, the aforementioned findings of Tracey and Rounds (1995) and Tracey et al. (1997) suggest that this is a possibility worthy of deeper consideration. For example, it could be argued that the use of a larger number of categories might robustify the circumplex structure to the extent that the information provided by many appropriate indicator variables could compensate for a potential misfit of one or two particular indicator scales that might otherwise lead to a complete renunciation of the circular order<sup>19</sup>. With the help of elaborate methods, such as the CSPF, it would be possible to clearly identify such deviant scales and to provide a rough idea about possible improvements. This argument might be even more significant for analyses on the level of interest profiles, especially regarding questions of interest profile similarity, which are commonly assessed by means of different profile similarity indices that summarize particular aspects of the agreement between all profile data points simultaneously. Again, it could be argued that the use of more differentiated profiles might lead to more accurate assessments

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<sup>19</sup>However, it should be noted that too many categories might even be detrimental to this cause. Specifically, with too many indicator scales, that are, in all likelihood not perfectly reliable due to measurement error, the covariance structure could become unstable. Therefore, eight indicator variables seems to be a good compromise.

of profile similarity, because more information is available to infer the similarity. Moreover, because the specific scales that make up a psychological profile are only a subset of potentially infinitely many such indicators, it can be expected that the use of more indicator variables leads to a more accurate assessment of intraprofile variability.

### 1.3.2 *Sphere, Cylinder, or “Truncated Cone”?*

The introduction of a third orthogonal dimension opens up several possible extensions to the two-dimensional circumplex model to describe the spatial ordering of the scales, all of which entail particular implications for the relationship between the circumplex dimensions and the Prestige dimension. Tracey and Rounds (1996b) discuss the possibility of a cylindrical structure, which would imply that the circumplex is defined even-handedly on all levels of prestige. In this case, the content dimensions (i.e., People-Things and Data-Ideas circumplex dimensions) and the Prestige dimension could just as well be assessed independently because they do not affect each other. In what can be considered one of the most influential works for the development of the spherical model, Roe and Klos (1969) considered the possibility of a “truncated cone”, that is, a structural model where different levels of the third dimension (which they considered to reflect different levels of required knowledge and skill) imply different levels of differentiation for the circumplex dimensions. Specifically, they assumed that occupations that require higher levels of skill and knowledge would be more distinguishable than occupations on lower levels.

Again, Tracey and Rounds (1996b) argue that such a structural model would imply that prestige and the circular order of the interest scales are largely independent and that a failure to include prestige would merely result in an underrepresented construct space. The proposed spherical structure, however, implies that the circular order is not independent of prestige. Specifically, it predicts that the differentiation of the circumplex decreases with increasing or decreasing levels of prestige until the content dimensions ultimately collapse at the prestige poles. This then necessitates the conjoint assessment of the three interest dimensions because they are all considered to entail unique and interdependent information about the construct space.

### 1.3.3 *The PGI in Applied Research*

Although the PGI was introduced about 15 years ago, relatively few applied studies have used the PGI as a means to assess vocational interests to this day. A mentionable exception can be found in the work of Holtrop et al. (2015), who investigated the relationships between the PGI scales and the personality traits of the HEXACO model (Ashton & Lee, 2007; Ashton, Lee, & de Vries, 2014; K. Lee & Ashton, 2004). The authors were able to show that the relationships between the PGI basic interest scales, which define the traditional interest circumplex, and the HEXACO personality types were largely in line with what would be expected based on previous research on the relationships between vocational interests and personality traits (Barrick et al., 2003). Moreover, they found that prestige was significantly, but weakly related to Emotionality, Extraversion, and Openness to Experience. A second application can be found in the work of Leung et al. (2014), who were able to show that prestige contributed to the prediction of different vocational pathways, although the relative contribution of the Prestige dimension was substantially smaller than those of the content dimensions.

Given the many obvious strengths of the PGI, namely, its thoroughly and well documented validity (e.g., Tracey, 2002), its compatibility with the traditional RIASEC domains, which can be computed on the basis of the eight basic interest scales via simple linear transformations, and its extension of the vocational interest construct space through the introduction of a third dimension, the relatively sparse use of the PGI in applied research is quite astonishing. A possible reason for this lack of attention could be its comprehensiveness. With three item types for each of the three underlying dimensions, the full PGI consists of  $3 \times 108 = 324$  items, which might be too extensive for many research settings, especially in the context of large scale assessments. Therefore, Tracey (2010) developed a short version of the PGI which will be introduced in the following section.

### 1.3.4 *The PGI-Short*

The PGI is an extensive measure to assess vocational interests. The major reason for this is that the underlying model, the spherical model of vocational interests, comprises no less than

18 interest domains, each of which needs to be measured with sufficient reliability and validity. Consequently, as with any assessment tool, developers have to consider the ubiquitous trade-off between thoroughness and efficiency. Although the PGI can be considered to be well balanced in this regard (in practice, researchers are free to use only one or two of the three item types, thus reducing the length of the instrument considerably), Tracey (2010) intended to provide a maximally efficient version of the PGI. To this end, he developed the Personal Globe Inventory - Short (PGI-S). The PGI-S comprises only the activity preferences and activity competence beliefs item types, each of which is assessed with 40 items. Thereby, a strong focus is put on the reliable and valid assessment of the two circumplex dimensions (People-Things and Ideas-Data) by means of the eight basic interest scales (4 items per scale). Consequently, the assessment of the Prestige dimension is reduced to a minimum of two indicator scales for high and low prestige, respectively (again, 4 items per scale).

The items for the PGI-S were taken from the full version of the PGI. In order to select the best marker items for each subscale, a data-driven, nonparametric item response theory (IRT) approach was pursued. This resulted in the PGI-S, which was then evaluated in an independent subsample, where Tracey (2010) was able to find positive evidence for the scales' reliability (internal consistency and two-week test-retest reliability), the invariance of the item functioning between male and female participants and participants from different ethnic groups, and the fit of the eight basic interest scales to the hypothesized circular order. The PGI-S has been further validated in subsequent studies with samples from non-US countries (e.g., Vardarli, Özyürek, Wilkins-Yel, & Tracey, 2017; Zhang, Kube, Wang, & Tracey, 2013) and has been successfully applied to assess vocational interests in several studies concerned with applied research questions (e.g., Holtrop, Born, & de Vries, 2018; Šverko & Babarović, 2016). However, what is still missing to this day is a thorough investigation and comparison of the pros and cons of the two PGI versions (besides the obvious thoroughness-efficiency trade-off) and a more elaborate examination of the extent to which the two instruments measure the same underlying dimensions. As things are now, the PGI-S poses an apparently viable alternative to the extensive PGI and presents an efficient tool to assess vocational interests and vocational interest profiles based on a differentiated categorization system.

## 1.4 Vocational Interest Profiles

The considerations presented in the previous sections make it clear that, whether four (People-Things, Ideas-Data), six (RIASEC), or eight (PGI) interest domains are used to categorize the construct space, vocational interests are a multidimensional construct. Consequently, a holistic account of individuals' vocational interests must always consider their likes and dislikes for the interest domains, however they may be classified, simultaneously. In other words, a thorough analysis of individuals' vocational interests and their relationships to other variables has to consider entire interest profiles<sup>20</sup>. Vocational interests are typically assessed via self-report questionnaires that comprise occupational titles or activity descriptions that serve as indicators of the respective underlying interest domains. Most instruments then require test takers to indicate how much they like or dislike these activities or occupations on a rating scale (most commonly a 5-point or 7-point Likert scale). These individual judgments are then summarized (typically by summation or averaging of the respective item ratings) to indicate individuals' liking (or disliking) of each interest domain. The particular configuration of these scale scores is what is typically referred to as an individual's interest profile.

The illustrative example used here, considers the interest profile of a fictional individual as assessed with an instrument that relies on the traditional RIASEC classification and that measures individuals' likes and dislikes for work-related activities on a 5-point Likert scale. Figure 6 displays this profile on the instrument's raw metric (solid black line). Such a profile<sup>21</sup> can be described by three characteristic components or parameters. First, *profile elevation* describes the average level of the profile, that is, the mean of the six scale scores (represented here by the solid gray line). Second, *profile differentiation* or *scatter* describes the variability within the profile. This variability can be operationalized by means of any appropriate disparity measure (e.g., range, variance, standard deviation). In this example, the common standard deviation of the scale scores was used (indicated by the gray arrows and dotted lines). Finally,

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<sup>20</sup>Holland (1997) often uses the terms "personality pattern" and "interest profile" interchangeably. Because this dissertation does not attend to the personality type aspects of the RIASEC model, the term interest profile will be used throughout this dissertation.

<sup>21</sup>In fact, basically any psychological profile (for example, a profile of personality trait scores, or performance test scores, or self-concept scores, etc.) can be summarized by these three components.

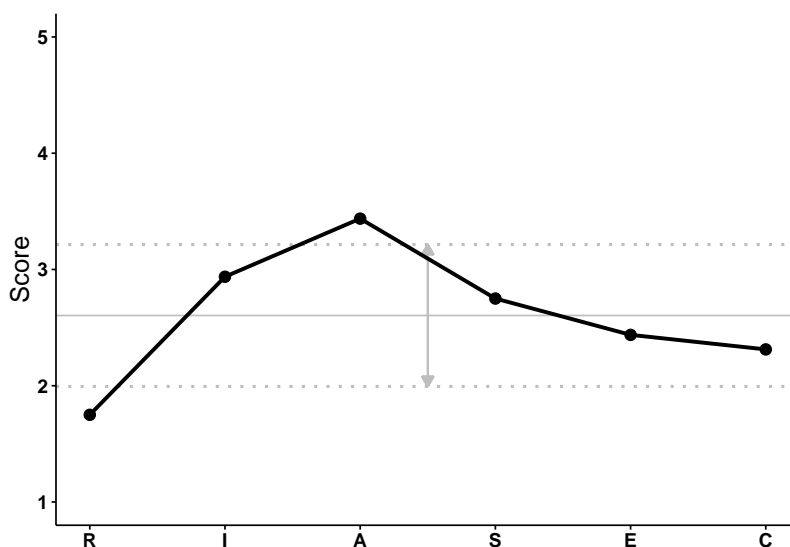


Figure 6: Raw RIASEC interest profile of a fictional individual.

*profile shape* describes the relative configuration of the scales that make up the profile in relation to one another. In the case of vocational interest profiles, profile shape indicates which interest domains—and therefore which kinds of activities—an individual prefers the most and which she or he prefers the least. In our illustrative example, the individual displays preferences for activities from the Artistic and Social domains and appears to be not particularly fond of activities from the Realistic domain. Undoubtedly, profile shape is the central parameter of the interest profile because individuals' specific patterns of likes and dislikes for particular activities (or activity domains) ultimately predict which particular environments they will be drawn to and how they will act, think, and feel in reaction to particular environmental conditions.

#### 1.4.1 *The Structural Summary Method*

Given the validity of the structural assumptions underlying the interest domains, the circular ordering of the scales in the population has important consequences for individuals' interest profiles. In particular, it is assumed that individuals' interest profiles also conform to the circular structure. Via what is known as the Structural Summary Method (SSM; Gurtman & Balakrishnan, 1998), it is possible to approximate model-based circumplex profiles from individuals' standardized observed scale scores with the following cosine function:



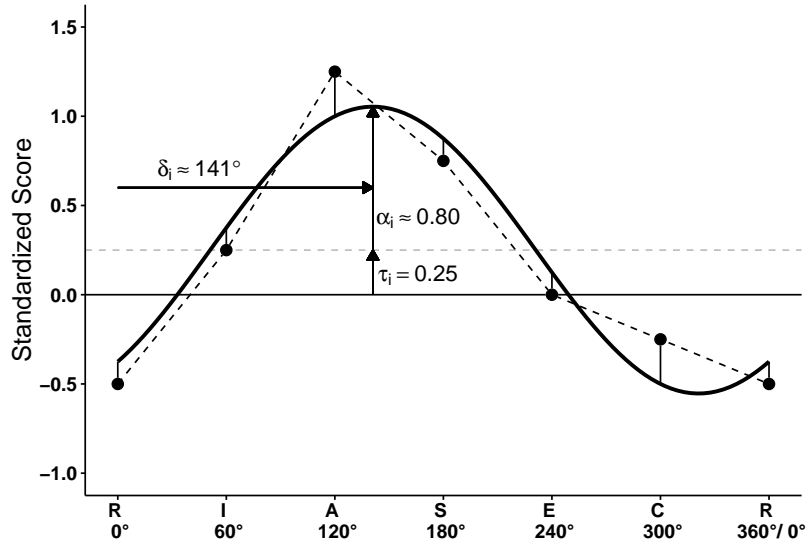


Figure 7: Model-based circumplex profile (solid black cosine function) and standardized observed profile (black dots and dashed line) of the same individual as in Figure 6.  $\tau_i$  = profile elevation (indicated by dashed gray line);  $\alpha_i$  = profile differentiation;  $\delta_i$  = profile orientation in reference to Realistic at  $0^\circ$ . Scale specific deviations  $\epsilon_{ij}$  are indicated by the thin lines connecting the observed values and the cosine function.

$$z_{ij} = \tau_i + \alpha_i \times \cos(\theta_j - \delta_i) + \epsilon_{ij} \quad (2)$$

In Equation 2,  $z_{ij}$  refers to individual  $i$ 's standardized scale score<sup>22</sup> on interest scale  $j$ .  $\tau_i$  is the profile elevation (i.e., the mean of the standardized scale scores), which indicates the vertical shift of the cosine function in relation to 0.  $\alpha_i$  is the profile differentiation parameter (i.e., the intraprofile variability), reflecting the amplitude of the cosine function, which is given by the difference between the maximum of the cosine function and its elevation.  $\delta_i$  is the profile orientation parameter (i.e., the angular displacement of the profile in relation to the reference scale at  $0^\circ$ ), denoting the angular position where the cosine function reaches its maximum. Profile orientation thus summarizes the information about the (model-based) profile's shape in a single parameter.  $\theta_j$  stands for the angular locations of scale  $j$  on the circumplex (see also Tracey, Wille, Durr, & De Fruyt, 2014).

Figure 7 displays the standardized interest profile of the same individual whose observed

<sup>22</sup>Standardization is required because the structural model assumes the metrics of the scales to be comparable. In applied settings with genuine research data, scales will, in all likelihood, have different psychometric sample properties, which must be accounted for by appropriate standardization techniques. In these situations, the formula given in Equation 2 generalizes to a formula for the interest profiles on the raw metric with  $y_{ij} = \mu_j + \zeta_j \{ \tau_i + \alpha_i \times \cos(\theta_j - \delta_i) + \epsilon_{ij} \}$ , where  $\mu_j$  refers to the mean of scale  $j$  and  $\zeta_j$  indicates a scale-specific scaling factor (Nagy, 2006).

interest profile on the raw metric was illustrated in Figure 6 and her or his model-based circumplex profile <sup>23</sup>. One way to obtain these profile parameters is to fit a multiple linear regression model to the individual's standardized observed scale scores with the sine and the cosine of the scales' positions on the circumplex (i.e.,  $R = 0^\circ, I = 60^\circ, \dots, C = 300^\circ$ ) as predictors. The resulting regression intercept is equal to  $\tau_i$ , and the respective regression weights can be interpreted as the individual's respective weight on the two underlying dimensions [People-Things ( $b_{PT_i}$ ) and Ideas-Data ( $b_{ID_i}$ )], which represent the Cartesian coordinates of the profile's projection onto the circumplex. Such a projection is illustrated in Figure 8. In this alternative representation,  $\alpha_i$  is equal to the vector length and  $\delta_i$  is equal to the vector's angular orientation. The major advantage of this representation is that it allows researchers and practitioners to easily interpret the main components of the interest profile, namely, the area of maximal preference (indicated by the direction the vector points in) and the clarity of this preference pattern (indicated by the vector length).

The two different representations convey the same information and are interconvertible (with the exception of the information about profile elevation, which cannot be inferred from the circumplex projection). Specifically, the two regression weights can be converted to the profile differentiation and profile orientation parameters from the SSM notation by applying the following formulae:

$$\delta_i = \arctan2\left(\frac{b_{ID_i}}{b_{PT_i}}\right) \times \frac{180}{\pi} \quad (3)$$

$$\alpha_i = \sqrt{b_{ID_i}^2 + b_{PT_i}^2}. \quad (4)$$

Consequently, individuals' standardized scale scores may be expressed as a function of profile elevation and the two underlying dimension scores:

$$Z_{ij} = \tau_i + b_{PT_i} \times \cos(\theta_j) + b_{ID_i} \times \sin(\theta_j) + \epsilon_{ij}. \quad (5)$$

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<sup>23</sup>Sample scale means were assumed to be  $\mu_R = 2.50, \mu_I = 2.75, \mu_A = 2.50, \mu_S = 2.00, \mu_E = 2.25$ , and  $\mu_C = 2.50$ . All scaling factors were set to  $\zeta_j = \zeta = 0.75$ . For simplicity's sake, a perfect, equidistant circumplex will be assumed throughout this chapter. A thorough exemplification of a more realistic data situation with a quasi-circumplex can be found in Nagy (2006).

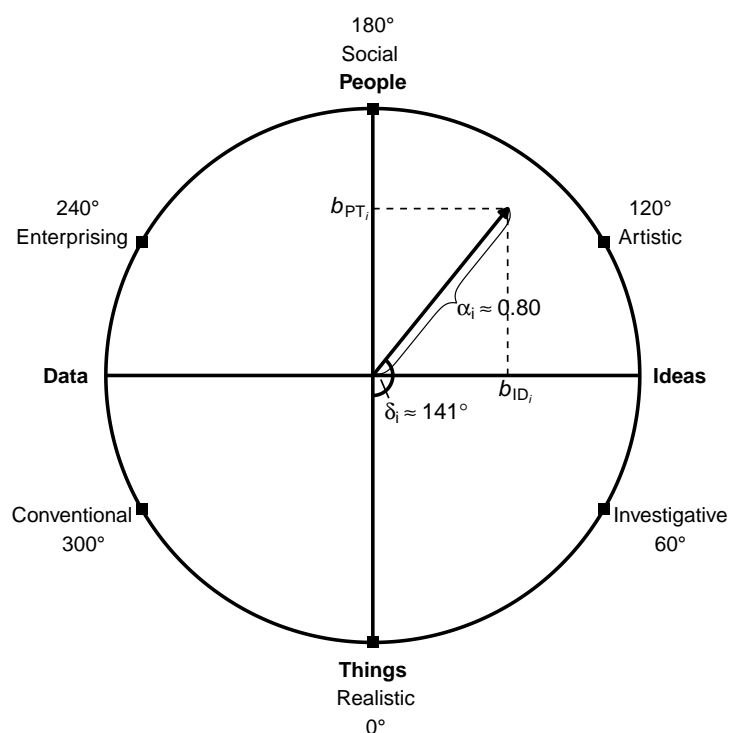


Figure 8: Circumplex projection of the model-based interest profile.  $\alpha_i$  = profile differentiation;  $\delta_i$  = profile orientation in reference to Realistic at  $0^\circ$ ;  $b_{ID_i}$  and  $b_{PT_i}$  = regression weights indicating the Cartesian coordinates of the vector (compare Equation 5).

As can be seen in Figure 7, individuals' standardized interest profiles, more often than not, deviate to some extent from the strict structural order underlying the interest domains of which they are comprised. This leads to the question of how to quantify the extent to which an individual's interest profile fits the underlying circular order. An obvious and often consulted measure for this fit is the coefficient of determination ( $R^2$ ) from the regression model described above (Gurtman & Pincus, 2003). This coefficient will amount to  $R^2 = 1$  if and only if the individual's interest profile perfectly follows the circular structure. In the circumplex literature, values of  $R^2 \geq .70$  are considered to indicate a good fit, whereas values of  $R^2 < .70$  are considered to indicate a poor fit to the circular ordering. Some authors have advised caution in such cases because a bad fit to the circular order negatively affects the reliability of the derived parameters (Wright, Pincus, Conroy, & Hilsenroth, 2009). The  $R^2$  goodness-of-fit measure can thus be seen as a profile-level quantification of Holland's *consistency* concept, which describes the correspondence of the intraindividual rank order of RIASEC scales to the postulated order

defined by the hexagon (Holland, 1997). In the present example, the individual's standardized interest profiles displays a very good adherence to the postulated circular structure ( $R^2 = .91$ ).

To this day, the SSM and the structural components that characterize the model-based profiles have received relatively little attention in the vocational interest community. A few mentionable examples are the works of Nagy (2006), who demonstrated the predictive value of the profile orientation component for students' choice of university majors and school tracks. Moreover, he was able to show that students' relative ability (after controlling for general cognitive ability) was substantially related to their profile orientation. Specifically, profile orientations in the Artistic and Social domains were associated with better relative abilities in English and profile orientations in the Realistic and Investigative domains were associated with better mathematical abilities. Very similar findings were reported by Warwas, Nagy, Watermann, and Hasselhorn (2009), who were furthermore able to show that the ability-interest orientation relationship was moderated by profile differentiation. Both Nagy, Trautwein, and Maaz (2012) and Volodina, Nagy, and Retelsdorf (2015) found that interest profile orientation was a central predictor of secondary school profile and school track choice. Lastly, Tracey et al. (2014) were able to show that a model-based approach yielded more theoretically consistent results regarding an investigation of Holland's concepts of consistency and differentiation compared to more traditional methods. In sum, these studies provide strong support for the assumption that the SSM parameters, especially profile orientation, contain the essential information that is responsible for the observed predictor-criterion relationships and, thus, that these parameters depict an appropriate, model-based summary of the observed interest profile.

Taken together, regardless of the underlying classification system, vocational interests are unequivocally considered to be a multidimensional construct. Consequently, a complete characterization of individuals' vocational interests can only be given by their multivariate interest profiles. Their isolated scores on particular interest domains, on the other hand, only present a narrow cutout of the intraindividual interest configuration. Interest profiles can be summarized by three meaningful components: profile elevation, scatter, and shape. Moreover, due to the underlying circular order of the interest domains, individuals' profiles can be used to approximate model-based interest profiles that also conform to the postulated circumplex structure. The

studies cited above provide strong evidence for the validity and utility of this structural modeling approach for analyzing associations between vocational interests and external variables. Moreover, as will be shown in the course of this dissertation, this approach also has important consequences for the analysis of similarities between vocational interest profiles.

#### 1.4.2 *Implications of the Importance of Interest Profiles*

The theoretical remarks of the previous sections highlight the crucial role of vocational interest profiles and, in particular, the exceptional relevance of the shape component, which indicates the intraindividual configuration of an individual's likes and dislikes for particular activity domains. The particular research questions addressed in this dissertation also rely on the analysis of vocational interest profiles. The following paragraphs aim to give a first overview of these research questions, to briefly illustrate the particular data situations they impose, and to touch on the challenges these data situations entail. In particular, these questions can be grouped into three distinct types of problems.

The first type of problem concerns the analysis of the stability and change of vocational interest profiles as well as the stability and change of the congruence between these interest profiles and corresponding environmental characteristics (P-E congruence). These particular questions arise from the traitlike conceptualization of vocational interests and the assumed importance of P-E congruence for individuals' vocational behavior and work-related attitudes (Holland, 1997). Investigations of such questions confront the data analyst with highly complex data structures. On the one hand, there is the multivariate profile information of many individuals in a sample obtained at several points in time. On the other hand, there is commensurate profile information about stable environmental characteristics. Beyond that, there is also information about individual-level outcomes on all measurement occasions.

Based on this information, appropriate analysis strategies have to be employed in order to analyze averages of and interindividual differences in profile stability, P-E congruence, and changes in P-E congruence over time. Moreover, the methods used should also make it possible to examine both the relationships between P-E congruence and the individual-level outcomes and relationships between changes in P-E congruence and corresponding changes in these out-

comes. One particular problem this situation entails is that individual-level indicators of profile agreement (within the same individual over time or between the individual's interest profile and the environmental profile) are not perfectly reliable and are therefore subject to sampling variability. This is problematic, because the failure to consider this variability typically leads to an overestimation of interindividual differences and an underestimation of the relationships with external variables. A possible solution to this problem is to employ meta-analytical aggregation strategies that take this sampling variability into consideration (e.g., M. W. Cheung, 2013).

The second type of problem relates to questions about the similarity of vocational interest profiles within families. These questions can be expected to be relevant for both research on couple similarity and research on parental influences on children's vocational interest development. Analyses of such questions typically involve very unique data constellations. On the one hand, there is the multivariate information of many individuals in a particular role (e.g., mother). On the other hand, there is commensurate multivariate information of other individuals in a different role (e.g., son). A potential approach towards analyzing the average similarity between members of such dyads could be to calculate dyad-level indicators of profile similarity (e.g., profile correlations) and to then simply average them across the entire sample.

However, different roles might be accompanied by normative profile components attached to the particular role (Furr, 2008), which could lead to a baseline similarity or dissimilarity between the dyad members merely because of their affiliation to these respective roles. Consequently, it is important to take this possibility into consideration and to account for potential normative profile components in the evaluation of the statistical significance of these average profile similarities. One possible way of taking this circumstance into account would be to employ pseudo-couple techniques. Two particular benefits of such approaches are that they do not rely on distributional assumptions of the profile similarity indices and that they make it possible to also account for other potentially biasing relationships (for example by accounting for the similarity between mothers and fathers).

Finally, the third type of problem pertains to the investigation of relationships between interest profiles and individual-level covariates. In the context of this dissertation, these relationships are presumed to reveal important evidence on the external validity of the instruments

under examination (see for example Mcardle & Prescott, 1992). In this final scenario, there is multivariate information about interest profiles of many individuals on the one hand and there are particular individual-level covariates of these individuals on the other hand (e.g., gender, school grades). In order to analyze the relationships between these particular sources of information the multivariate profile information must be adequately reduced, for example by deriving meaningful profile components, and these components must then be correlated with the covariates. The most obvious of such profile components are the dimensional scores (People-Things, Ideas-Data, and Prestige) that can be calculated as linear transformations of each individual's scale scores. This approach is very similar to the SSM approach (Gurtman & Pincus, 2003; Zimmermann & Wright, 2017) and yields estimates for the relationships between the covariates and the central components of the dimensions underlying the intraindividual interest profiles.

The problems explicated above briefly introduce the kinds of questions that this dissertation aims to answer and the challenges they pose for analyzing these questions. On a more general level, they pertain to the analysis between the relationships of vocational interest profiles and external variables and to the analysis of the similarity in vocational interest profiles between individuals (organized in dyads) or within individuals over time (stability). Because the former issues are discussed in greater detail elsewhere (e.g., Nagy et al., in press; Yik & Russell, 2004; Zimmermann & Wright, 2017) and because much less is known about the particular challenges of the latter, the following section aims to take a broader perspective on the topic of analyzing interest similarity and it presents an elaborate delineation of the importance of taking a profile-centered perspective towards this issue.

## **1.5 Methodological Challenges in Analyzing Profile Similarity**

The issues discussed in the next paragraphs reach back to the very origins of differential psychology, where Stern (1911) first emphasized the importance of distinguishing between *interindividual* variability and *intraindividual* variability. To this day, the majority of research is concerned with questions that advocate the analysis of the former, that is, the variability of variables *between* individuals in a population. However, recent trends in various fields of

psychological research suggest a shift towards a more serious appreciation of variability *within* individuals. Moreover, not least because of the fact that researchers are increasingly considering the underlying circular structure to be the central aspect of the interest construct (see the previous sections), vocational interests are inherently eligible for analytical strategies that simultaneously consider entire intraindividual trait configurations.

In the next sections, first, an overview of the different types of approaches taken towards analyzing research questions in the social sciences is presented: variable-centered, person-centered, and person-specific approaches (Section 1.5.1). Next, a brief review of different measures of profile similarity and their specific implications and limitations is provided and a case is made for the use of the profile correlation coefficient as a measure of profile shape similarity (Section 1.5.2). Finally, some illustrative examples are presented in order to demonstrate particular challenges in the analysis of the similarity between vocational interest profiles, some of which arise from the different analytical perspectives and some of which are due to the distinctiveness of the underlying circumplex structure (Section 1.5.3).

### 1.5.1 *Variable-centered, Person-centered, and Person-specific Approaches*

This brief overview of the three different approaches taken towards analyzing research questions in the social sciences is largely adopted from the recently published, comprehensive review paper of Howard and Hoffman (2018). The primary aim of this section is to exemplify the different approaches with regard to their relevance for and application in vocational interest research. Finally, it is argued that the analysis of vocational interest profile similarities displays a special case that can, to some extent, be considered a to be a combination of the person-specific and the variable-centered approach.

*Variable-centered approaches.* Variable-centered approaches are the traditional and most widely applied approaches in the social sciences (Howard & Hoffman, 2018). The aim of these approaches is to analyze relationships between variables in a population. To this end, data from many subjects on one or more (but typically just a few) measurement occasions are summarized by a single set of parameters to describe the characteristic moments of the population distributions of the variables under examination. The most commonly applied



analysis methods that depict variable-centered approaches are: one- or two-sample *t*-test, between- and within-subjects analysis of variance (ANOVA), correlation analysis, regression analysis (uni- or multivariate, linear or nonlinear), factor analysis (confirmatory or explanatory), and path analysis.

Howard and Hoffman (2018) distinguish between the three different approaches with regard to two particular attributes of the respective underlying theoretical perspective: specificity and parsimony. In this regard, the variable-centered approaches are the most parsimonious of the three approaches, yielding relatively easily interpretable results, but are also the least specific because results from variable-centered analyses only allow conclusions to be drawn about the average individual in the population.

With regard to vocational interest research, any analysis concerned with the relationships between particular interest domains and one or more external variables or with the interrelationships between the different interest domains can be considered to depict a variable-centered approach. For example, the aforementioned examinations of the relationships between the RIASEC interest domains and the FFM personality traits (e.g., Barrick et al., 2003; Larson et al., 2002) are concerned with the pairwise correlations between any two traits from either construct domain in a population. Likewise, analyses of the structure of vocational interests (e.g., Nagy et al., 2010; Tracey & Rounds, 1993) ultimately come down to analyses of the structural pattern underlying the pairwise correlations between any two interest domains in a population. Finally, analyses of the rank-order or mean-level stability of vocational interest domains are concerned with relative or normative relationships between particular interest domains in a population across time (e.g., Hoff et al., 2018).

*Person-centered approaches.* Whereas the conceptualization of variable-centered approaches is more or less unambiguous, there are slightly different uses of the term “person-centered” in the literature. On the one hand, the term is sometimes used to signify that variables are not analyzed in isolation and that, rather, an entire array of variables within individuals is considered simultaneously. For example, in their study of the relationships between situational similarity and behavioral consistency, Furr and Funder (2004) use the terms “person-centered” and “idiographic” interchangeably to describe their approach to deriving a consistency mea-

sure for each individual in their sample by correlating each individual's array of judgments for two particular situations. However, by subsequently averaging these consistency measures and analyzing properties of the underlying population distribution of these indices, the analyses ultimately present a variable-centered approach.

On the other hand, the term "person-centered" is often used to describe approaches that relax the assumption of a homogenous population by considering the possibility of the existence of distinguishable subpopulations<sup>24</sup> (Howard & Hoffman, 2018). The aims of such analyses (the most prominent of which are latent class analysis, latent profile analysis, latent transition analysis, cluster analysis, and growth mixture models) are twofold. First, they aim to identify an appropriate number of subpopulations to describe sufficiently homogenous (within) and distinguishable (between) subpopulations, classes, or "types"<sup>25</sup>. Second, such analyses aim to relate individuals' belonging to either of these classes to relevant external variables. For example, one could aim to determine potential predictors of class membership or to examine whether or not class membership predicts relevant outcomes.

When conceptualized in this way, person-centered approaches can be placed in the middle of the parsimony-specificity spectrum, because they yield several sets of parameters to describe the population (i.e., one set for each subpopulation). This then warrants a more specific description of "types" or classes of individuals within a population, but necessarily complicates the interpretation of the obtained results. An application of such a person-centered approach from the vocational interest literature can be found in a recently published study by Perera and McIlveen (2018). Therein, the authors identified six distinct classes of students' RIASEC score configurations and were able to show that these classes differed with regard to the likelihood of class members' choosing a college major from the STEM (science, technology, engineering, and mathematics) field.

*Person-specific approaches.* Lastly, Howard and Hoffman (2018) consider person-

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<sup>24</sup>In the opinion of the author of the present dissertation, this particular use of the term "person-centered" should be preferred. The following paragraphs aim to disambiguate these different notions.

<sup>25</sup>While most of these approaches consider the existence of discrete classes underlying the general population, some researchers have argued for continuous approaches to consider intraindividual heterogeneity (e.g., Asendorpf, 2006).

specific or idiosyncratic approaches, which depict the most specific and least parsimonious approaches under consideration. Person-specific approaches take a holistic-interactionist perspective and are thus primarily applied to examine idiosyncratic effects of particular individuals. Such analyses are often conducted on single (rarely more than a few) individuals but utilize data from many measurement occasions<sup>26</sup>. Methods for analyzing such intensive longitudinal data within particular subjects comprise time-series analysis, state-space modeling, p-technique factor analysis, and dynamic factor analysis. To this day, the person-specific approach has rarely been considered in the vocational interest literature. A rare exception can be found in the work of Phan (2018), who analyzed vocational interests with experience-sampling techniques and found strong support for substantial intraindividual variability in vocational interests that was, nonetheless, largely in line with results from between-subjects analyses of vocational interests.

Taken together, different research questions require researchers to take different theoretical perspectives, which can be distinguished between by the degree of relative specificity and parsimony they entail. The different approaches presented in the previous sections all have specific advantages and drawbacks. For example, traditional variable-centered approaches do not allow for the simultaneous consideration of intraindividual trait configurations. On the other hand, person-centered and person-specific approaches yield results that might be too specific for particular research questions and, thus, might impede the generalization of findings obtained from such analyses.

*The profile-centered perspective.* A particular type of research questions, which necessitate a combination of some of the aforementioned approaches, are questions about the average similarity between vocational interest profiles, such as the similarity between the interest profiles of members of particular dyads (e.g., couples in relationships, children and their parents) or between profiles of the same individuals at different points in time<sup>27</sup>. Specifically, these questions typically aim at the examination of averages of or interindividual differences in in-

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<sup>26</sup>Newer but computationally demanding methods also allow the analysis of intensive time-series data across multiple subjects (e.g., Gates & Molenaar, 2012).

<sup>27</sup>Naturally, many of the arguments presented in the following sections are not limited to the analysis of interest profile similarity but, rather, can be generalized to the analysis of the similarity between any kind of psychological profiles (e.g., test scores, personality traits, self-concepts, etc.).

traindividual or intradyadic profile similarity. Therefore, they require researchers to assess the similarity between multivariate profiles at the level of the individual or dyad (“person”-specific part) and to then aggregate these similarity indices in an appropriate way in order make inferences about the underlying population distribution (variable-centered part). This then makes it possible to analyze, for example, group differences in profile similarity or the covariation of profile similarity and external variables.

Because such an approach neither aims to identify distinct “types” or classes of profile similarity (as in the person-centered approach) nor to estimate idiosyncratic models for each individual over a large number of observations (as in the person-specific approach), it does not quite fit into any of the three categories presented above. Rather than anything else, it fits to what Furr and Funder (2004) referred to as a person-centered approach. However, this approach was revealed to be, strictly speaking, a variable-centered approach with the particular feature that the variable in question was an indicator of the similarity between two multivariate profiles. Because a large part of the present dissertation is concerned with questions that demand the application of precisely such approaches, it seems appropriate to give them an appropriate label. Due to the fact that the primary goal of such approaches is to describe the population distribution of profile similarities, they will be referred to throughout this dissertation as variable-centered approaches from a *profile-centered perspective*<sup>28</sup>.

### 1.5.2 *Measures of Profile Similarity*

In order to analyze distributions of profile similarity in a population, it is necessary to decide how profile similarity should be assessed in the first place. This particular question has occupied researchers for almost a century and several indices have been proposed as a means to this end (e.g., Burt, 1937; Cattell, 1949; Cronbach & Gleser, 1953; Du Mas, 1946; McCrae, 1993, 2008; Osgood & Suci, 1952; Stephenson, 1950). Profile similarity has thereby been conceptualized both at the individual level (e.g., to assess the similarity between parents and their children;

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<sup>28</sup>The observant reader will notice that, just as in Furr and Funder (2004), the term *person-centered* is used to describe this particular approach in the empirical substudies. The reason for this inconsistency is that the target audience of these studies was expected to be more familiar with this particular term. However, future research should aim to disambiguate these terms in order to avoid confusion

Table 3: Overview of some of the most Prominent Indices of Profile Similarity

Symbol	Proponent	Description	Considers Similarity in		
			Elevation	Scatter	Shape
$D$	Osgood and Suci (1952)	Euclidean distance	✓	✓	✓
$D^2$	Cronbach and Gleser (1953)	Squared Euclidean distance	✓	✓	✓
$D'^2$	Cronbach and Gleser (1953)	Squared and centered Euclidean distance	✗	✓	✓
$D''^2$	Cronbach and Gleser (1953)	Squared, centered, and standardized Euclidean distance	✗	✗	✓
$r_p$	Cattell (1949)	Transformation of $D$ rescaled to range from -1 to 1	✓	✓	✓
$r$ (or $Q$ )	Burt (1937) Stephenson (1950)	Product-moment correlation	✗	✗	✓
$r_{ps}$	Du Mas (1946)	Slope similarity of corresponding profile segments	✗	✗	✓
$r_{ICC}$	McCrae (2008)	Double-entry intraclass correlation between profiles	✓	✓	✓

*Note.* The use of the symbol  $Q$  for the common product-moment correlation of two profiles stems from the  $Q$ -sort technique and was introduced to clearly distinguish the method from the variable-centered use of the correlation coefficient.

Grotevant, Scarr, & Weinberg, 1977) and at the group level (e.g., to assess the similarity between the average personality trait profiles of different cultures; McCrae et al., 2005), or even with mixtures thereof (e.g., to assess the similarity of individuals interests to a group-specific reference profile; Le et al., 2014). Table 3 presents a selection of the most prominent measures that have been suggested over the years and some of their properties.

In their seminal article on profile similarity, Cronbach and Gleser (1953) highlighted several important aspects that need to be considered when applying such measures and introduced several indices of their own. One of the most important contributions of their article is the sophisticated recognition of the underlying profile components (elevation, scatter and shape) and the extent to which the several profile similarity measures consider each of these components. For example, they introduced  $D^2$  as a measure of the squared Euclidean distance between two profiles in  $k$ -dimensional space ( $k$  denoting the number of variables in each profile). As such,  $D^2$  considers the similarity (or rather the dissimilarity) in all three components simultaneously. Furthermore, they derived two other versions of their measure to present alternative indices that consider the similarity based on shape and scatter ( $D'^2$ ) or on shape alone ( $D''^2$ ). Thereby, it can be shown that  $D''^2$  is a function of the common Pearson product-moment correlation  $r$  between the two profiles<sup>29</sup>.

The plethora of possible indices necessarily raises the question of which index is preferable for which kind of situation. In a recent discussion, McCrae (2008), among others, advocated the use of the double-entry intraclass correlation  $r_{ICC}$ , because this measure, similar to  $D^2$ , considers all three profile components at once. In McCrae's opinion, this particular feature renders the  $r_{ICC}$  superior to alternative measures, such as the product-moment correlation, which only considers the similarity between profile shapes. However, despite the presumed advantages of the  $r_{ICC}$  in comparison to the product-moment correlation, empirical tests have not clearly favored one over the other. Moreover, Furr (2010) highlighted several issues with the simultaneous consideration of all profile components that can lead to very peculiar results. For example, he demonstrated that situations can be constructed where the  $r_{ICC}$  takes on a negative

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<sup>29</sup>Specifically, it can be shown that  $D''^2 = 2(1 - r)$ .

value although the profile shapes are very similar. This then led him to conclude that rather than representing an index of “absolute” similarity, the  $r_{ICC}$  tends to confound different aspects of profile similarity. Therefore, he recommended a more differentiated analytical approach towards assessing profile similarity by considering each of the three profile components separately as “different but potentially complementary facets of profile similarity” (Furr, 2010, p. 9).

In the case of vocational interests, the arguments presented in the earlier sections of this introductory chapter have clearly demonstrated that the central profile component is profile shape, because it indicates the relative configuration of individuals’ likes and dislikes and because it is the component that is largely responsible for explaining the relationships between individuals’ interests and external variables, such as vocational choice behavior (e.g., Volodina, Nagy, & Retelsdorf, 2015), subject-specific competencies (Nagy, 2006), or literacy (Warwas et al., 2009). Profile elevation, on the other hand, has repeatedly been shown to be of lesser importance to many applied research questions (e.g., Gottfredson & Jones, 1993; Prediger, 1998) and profile scatter has been identified mostly as a moderator of the relationships under scrutiny (e.g., Hirschi, 2010; Warwas et al., 2009).

Consequently, it can be reasoned that the most important aspect of vocational interest profile similarity is the similarity between the profile shapes, which would seem to advise the use of a similarity index that captures this particular aspect of profile similarity independent of the similarity between the other two profile components. The most obvious of such indices is the product-moment correlation between the profiles because it is an easily interpretable and widely known measure of linear association. The product-moment correlation has already been applied as a measure of interest profile stability (Low et al., 2005), interest congruence (Le et al., 2014; Tracey, Allen, & Robbins, 2012), and parent-child interest profile similarity (Grotevant et al., 1977). Moreover, as illustrated in detail in Study 3, the SSM (see Section 1.4) also provides a model for examining the similarity between model-based profiles. Specifically, it can be shown that the correlation between two model-based profiles is exactly equal to the cosine of the smallest separating angle between the vectors in the circumplex projection (see Figure 8), or, equivalently, the cosine of the difference between profile orientations. However, despite the fact that researchers have long recognized the benefits of assessing vocational interest profile

similarity and congruence by means of profile correlations, the potential of these approaches and the methodological and conceptual challenges they entail have not yet been recognized to the full extent.

### 1.5.3 *Illustrative Examples*

This introductory chapter will now be concluded with two examples that illustrate the potential of the analysis of the similarity between vocational interests from a profile-centered perspective, as well as the challenges that may arise in such analyses. First, these examples demonstrate why the profile-centered perspective towards analyzing the stability of vocational interests is preferable to the traditional variable-centered analysis of the rank-order stability of isolated interest domains. Second, it is shown that the underlying circular order of the interest domains entails some peculiarities that must be considered when interpreting profile correlations between vocational interest profiles and that can have severe consequences for the statistical evaluation of the significance of average profile correlations.

*Example 1: Profile stability versus rank-order stability.* Profile-stability and rank-order stability are the most commonly analyzed types of vocational interest stability (Low et al., 2005) but they depict two very different concepts. Whereas profile stability (as assessed via profile correlations) indicates the average intraindividual stability of vocational interest profile shapes, rank-order stability “reflects the degree to which the relative ordering of individuals on a given trait is maintained over time” (Caspi, Roberts, & Shiner, 2005, p. 466). The very different pictures these two types of stability can convey are exemplified in an extreme case in Figure 9. The figure displays the interest profiles of two fictional individuals measured at two points in time (black = individual A, gray = individual B, left panel = Time 1, right panel = Time 2). As can be seen, the two profiles remained unchanged with regard to shape and scatter. However, the profile level has changed by  $-0.50$  (individual A) and  $+0.33$  (individual B), respectively. Because the profile correlation is only sensitive to profile shape, the two individuals each have perfect profile correlations ( $r_{T1,T2} = 1$  for both individuals and, consequently,  $\bar{r}_{T1,T2} = 1$ ). The respective rank-order correlations for each scale, however, paint the exact opposite picture.



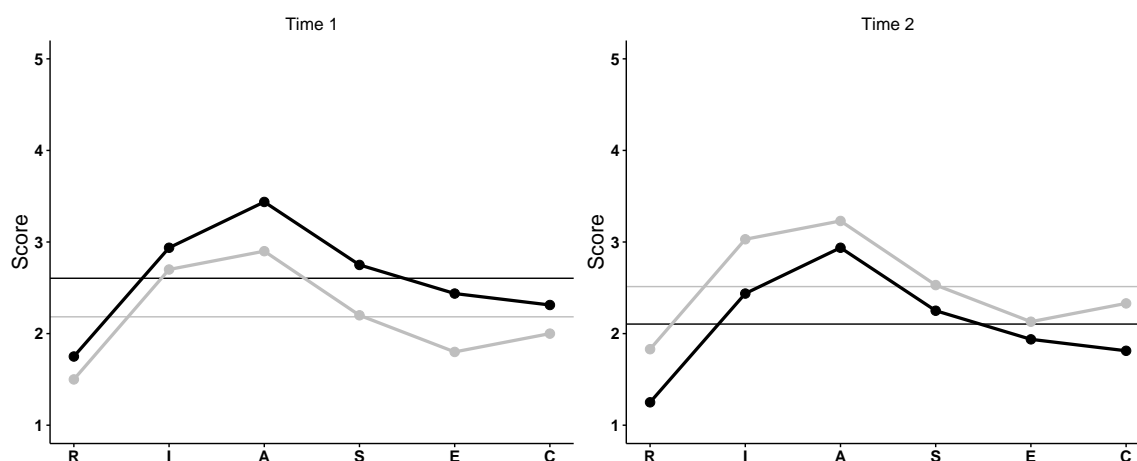


Figure 9: Raw score interest profiles of the fictional individuals *A* and *B* at two points in time.

Specifically, because  $y_{Aj} > y_{Bj}$ <sup>30</sup> for all  $j$  at Time 1 and  $y_{Aj} < y_{Bj}$  for all  $j$  at Time 2, the rank order correlations all amount to  $r_j = -1$ .

This example is, of course, an extreme case<sup>31</sup> and data from real participants will, in all likelihood, not behave this way. In fact, empirical findings suggest that both average profile agreement and rank-order correlations tend to be quite high (Low et al., 2005). Furthermore, more often than not, there will be more or less severe changes in all profile components rather than in just one particular component. This example is intended to raise awareness of the particular meaning of either index of interest stability and to demonstrate that the profile-centered perspective can often paint a much clearer picture, especially when the three profile components are examined separately. In the present example, it can be unequivocally concluded that profile shape and scatter are very stable, but profile elevation is not. Although this particular issue is demonstrated here using the example of interest profile stability, it can be generalized to any kind of profile similarity. This is, of course, not to say that rank-order correlations should be generally dismissed. In fact, the decision to use either approach should always be guided by the specific question under examination and the specific features of the analyzed constructs. In the case of vocational interests, where profile shape plays an extraordinarily important role, the profile perspective will, more often than not, be the appropriate perspective to take.

<sup>30</sup> $y_{Aj}$  = score of individual *A* on RIASEC domain  $j$ .

<sup>31</sup>Similar, yet not quite as extreme examples can be constructed where the profiles' shape and elevation stay exactly the same and only their scatter changes over time.

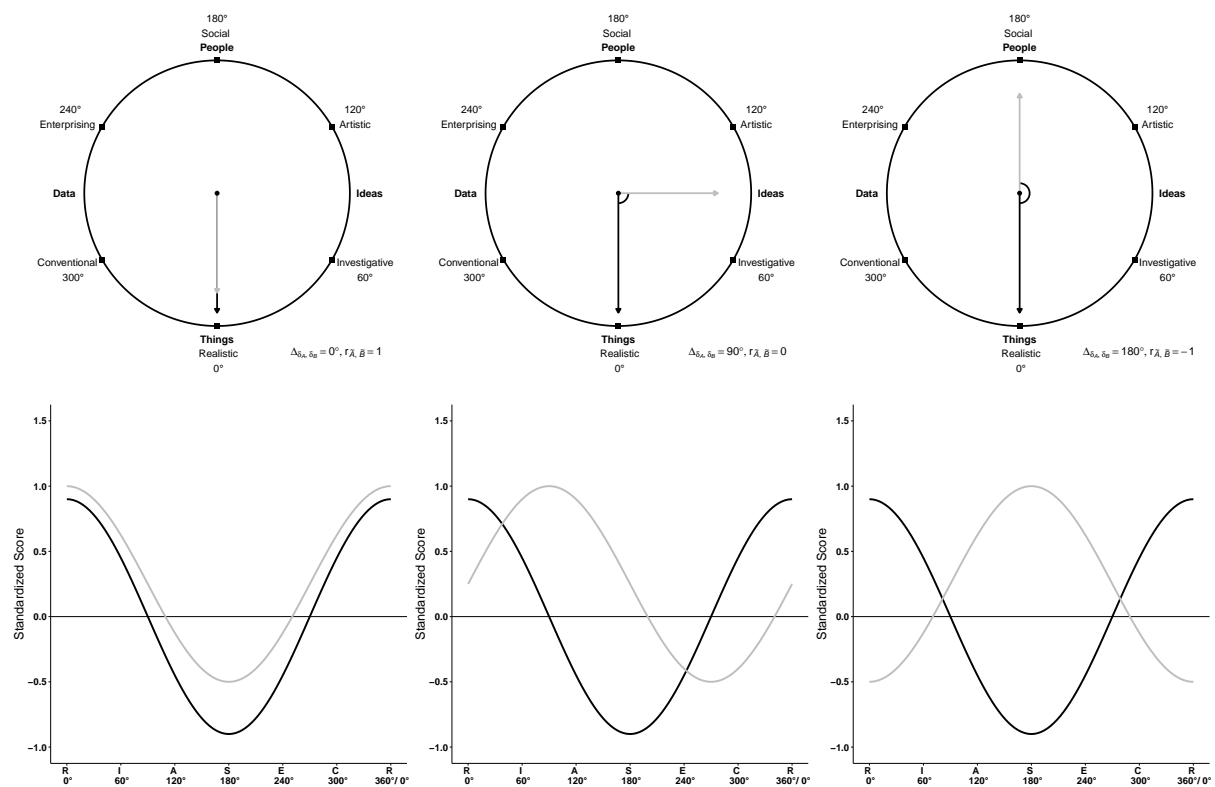


Figure 10: Circumplex projections (upper panels) and corresponding profile representations (lower panels) of two individuals' model-based interest profiles with different degrees of similarity.  $\Delta_{\delta_A, \delta_B}$  = smallest separating angle between the vectors of  $A$  and  $B$ ,  $r_{\tilde{A}, \tilde{B}}$  = product-moment correlation between the model-based profiles of  $A$  and  $B$ .

*Example 2: Profile-correlations of circumplex measures.* The second illustrative example aims to explicate two peculiarities of profile correlations obtained from sets of variables that adhere to a circumplex structure. First, the example demonstrates that the resulting profile correlation directly translates into a measure of the similarity between the two profiles  $A$  and  $B$ , with  $r_{AB} = -1$  indicating maximal dissimilarity and  $r_{AB} = 1$  indicating maximal similarity (of the profile shapes). Moreover, on the level of model-based profiles (Section 1.4.1), these profile correlations are direct functions of the difference between profile orientations. Second, the example shows that this special meaning of profile correlations can have serious consequences for the evaluation of the statistical significance of average profile similarities.

The first issue is best demonstrated on the level of model-based circumplex profiles and by means of the vector representation of such profiles (i.e., their projection onto the circumplex) in particular. The upper three panels of Figure 10 display three such projections, each containing

the vector of two individuals  $A$  (black) and  $B$  (gray). The three panels below present the corresponding profiles in the cosine function representation. In Scenario 1 (left column), the profile orientations are identical ( $\delta_A = \delta_B = 0^\circ$ ). Consequently, the vectors point in the same direction. Because the correlation between the model-based profiles  $\tilde{A}$  and  $\tilde{B}$  is equal to the cosine of the separating angle, it follows that  $r_{\tilde{A},\tilde{B}} = \cos(\delta_B - \delta_A) = \cos(0^\circ) = 1$ . Obviously, one would consider these profiles to be maximally similar (with regard to profile shape). In the middle column, individual  $B$  has a profile orientation of  $\delta_B = 90^\circ$ , while  $A$  remains unchanged. In this scenario, the profile correlation amounts to  $r_{\tilde{A},\tilde{B}} = \cos(90^\circ) = 0$ . This is particularly important because, in traditional variable-centered analysis, a correlation of  $r_{x,y} = 0$  signifies that there is no linear association between the variables  $x$  and  $y$ . Here, on the other hand, the profile correlation of  $r_{\tilde{A},\tilde{B}} = 0$  indicates a moderate degree of similarity between the profiles. This is due to the underlying similarity structure of the interest domains. Finally, in the right panel of Figure 10, the profile orientation of individual  $B$  is  $\delta_B = 180^\circ$  and the respective profile correlation yields  $r_{\tilde{A},\tilde{B}} = \cos(180^\circ) = -1$ . In this scenario, the two profiles are maximally dissimilar, as indicated by the fact that the vectors point in exactly opposite directions.

The second issue concerns the evaluation of the statistical significance of average profile correlations (APCs). In the traditional variable-centered approach, a correlation of  $r_{x,y} = 0$  is an obvious reference value against which the correlation between any two variables is evaluated. This is, however, not always the most appropriate approach in the analysis of APCs. To demonstrate this, consider the following example of two distinct groups of individuals as displayed in the left and right panel of Figure 11. The left panel displays a group of individuals with primarily Investigative interests and the right panel displays individuals with primarily Enterprising interests. Imagine, that the aim is to evaluate the APCs between dyads that comprise exactly one individual from the Investigative group and one from the Enterprising group. For example, these could be project teams comprising an executive manager and a senior researcher from the same company and the hypothesis under examination could be that vocational interests of such individuals from the same company are more alike than those from respective dyads from different companies. Recalling the arguments of the previous paragraphs, the distributions of profile orientations shown in Figure 11 clearly indicate that the

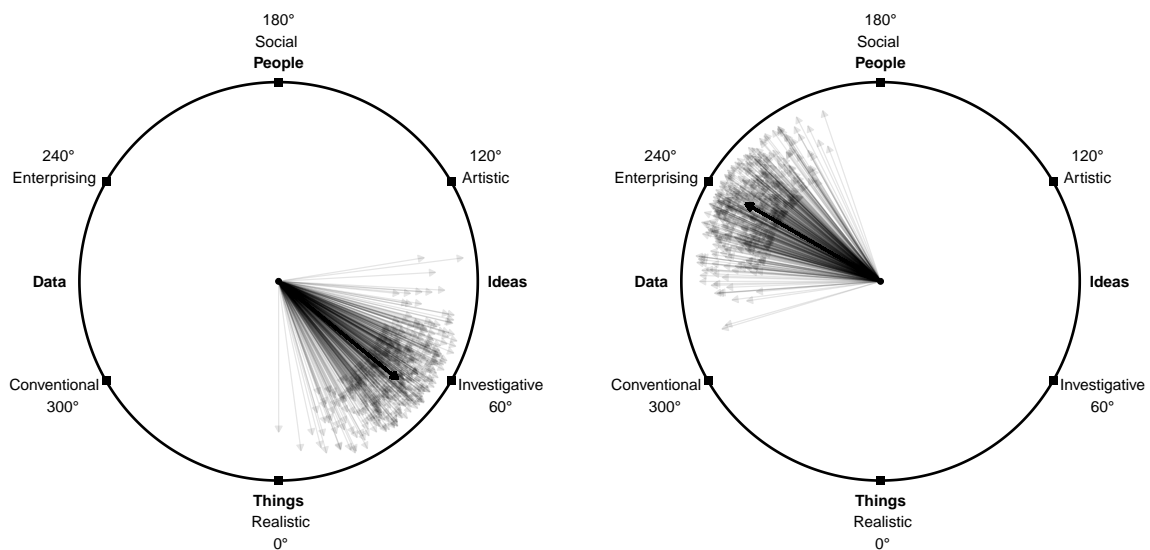


Figure 11: Circumplex projections of the model-based profiles of two groups of individuals with a high degree of profile normativeness, as indicated by the respective relative agreement of angular displacement. The thick black arrows represent approximations of the average group vector.

interest profiles from these dyads can, on average, be expected to be negatively correlated<sup>32</sup>. Consequently, an appropriate test for the aforementioned hypothesis cannot be one that evaluates the APC against 0, but rather one that considers the normative dissimilarity between the groups.

The issue of normative profile components has recently been discussed in the context of analyzing the similarity between dyads' personality trait profiles (Borkenau & Leising, 2016; Furr, 2008; Wood & Furr, 2016) but has, to this day, seldom been recognized in the analysis of the similarity between vocational interest profiles (cf. Schultz, Connolly, Garrison, Leveille, & Jackson, 2017). As argued by Furr (2008), there are two possible strategies that can be employed in order to consider normativeness in such analyses. First, researchers could adjust the profiles for normative profile components prior to the analysis of profile similarity. This can be achieved, for example, by eliminating the normative profile components, that is, by subtracting the mean profile across all individuals in the sample from each individual profile. The resulting profiles have been termed distinctive profiles and they display the person-specific

<sup>32</sup>Consider, for example, the smallest separating angle between the group mean vectors (thick black vectors in Figure 11). Because they are almost 180° apart, the groups are very dissimilar and the profile correlation between two randomly drawn individuals from either group will, in all likelihood, yield a negative value.

deviations from the normative profile. However, the interpretation of these distinctive profiles is not trivial. A second possibility would be to employ a pseudo-couple approach (Kenny, Kashy, & Cook, 2006). Such approaches have at least three particular advantages. First, they retain the original meaning of the profiles and do not alter them in any way. Second, the repeated resampling renders distributional assumptions of traditional methods (such as those of the *t*-test, which is used to evaluate the correlation between two variables against 0) irrelevant and presents a nonparametric alternative to these tests. Third, the estimation of a resampling distribution not only makes it possible to test whether or not real dyad APCs are significantly larger than would be expected by chance, but also opens up the possibility of estimating effect sizes of such differences (e.g., by contrasting the mean APC from the resampling distribution with the APC obtained from the real dyads).

To sum up, the analysis of the similarity between vocational interests from a profile-centered perspective holds many promises but it also poses nontrivial challenges for the statistical examination and subsequent interpretation of such similarities. A holistic consideration of individuals' interest profiles as the central unit of analysis can help to reveal relationships that would remain undiscovered if interest domains were analyzed in isolation. Moreover, analyses from either perspective can yield very different results that can often only be disentangled through the profile-centered perspective.

## **1.6 Aims of the Present Dissertation**

Based on the theoretical and methodological considerations presented in this introductory chapter, the present dissertation comprises four empirical studies that pursued two superordinate goals. First, in Studies 2 and 3, the advantages of taking a profile-centered perspective towards analyzing the similarity of vocational interests within persons over time, the similarity of vocational interests and environmental profiles within and across time, and the similarity between the vocational interests of family members were examined using two large datasets from prominent educational studies in Germany. To this end, novel methodological analysis strategies were applied in order to consider the particular opportunities and challenges this

perspective entails (Section 1.5). Second, in Studies 4 and 5, the German translations of the Personal Globe Inventory (PGI; Tracey, 2002) and its associated short form, the PGI-Short (PGI-S; Tracey, 2010), were examined with regard to central psychometric criteria. A particular focus was put on the validity of the underlying structural assumptions of the spherical model that these instruments intend to assess and the more elaborate eight-type circumplex that displays the equator of the interest sphere.

Specifically, in Study 2, the stability and change of vocational interests and their congruence with particular vocational environments was examined in a large sample of trainees from five different courses of vocational education and training (VET) in Germany. A particular focus was put on the apparent ambiguity between the high stability of vocational interests (both on the level of particular interest domains across individuals as well as within individuals; Low et al., 2005) and the fact that the most prominent theories of person-environment (P-E) congruence (Holland, 1997; Schneider et al., 1995) emphasize individuals' motivation to increase the fit between their interests and the environment. Because the stability estimates of vocational interests are typically not so high as to suggest that no change occurs at all, the aim was to examine whether or not this was partially due to systematic changes in vocational interests towards greater P-E congruence (i.e., occupational socialization). Furthermore, due to the inconclusiveness of previous empirical investigations on the congruence-satisfaction relationship (e.g., Tranberg et al., 1993), the goal was to investigate the relationship between changes in P-E congruence and corresponding changes in satisfaction with VET.

Based on the arguments for taking a profile-centered perspective towards analyzing these questions, profile stabilities and P-E congruence were assessed on the individual level via profile correlations (within individuals across time, and between individuals' profiles and empirically derived environmental reference profiles). In order to appropriately aggregate these individual-level estimates of stability and P-E congruence, a meta-analytical aggregation strategy was proposed. Specifically, through the application of multivariate random-effects meta-analysis models (M. W. Cheung, 2013), it was possible to examine averages of and interindividual differences in intraindividual interest stability and interest congruence. Moreover, the implementation of these models in the structural equation modeling (SEM) framework made it

possible to appropriately handle missing data, to extend these models to include submodels for multiple groups, to include additional covariates in these models (i.e., satisfaction), and to straightforwardly test specific hypotheses about the effects of interest.

In Study 3, it was attempted to shed new light on the similarity between vocational interests between family members. On the one hand, the investigation of the similarity between the interests of mothers and fathers was expected to contribute to the literature on couple similarity (e.g., Luo, 2017). On the other hand, the analysis of the similarity between the interests of parents and their children was expected to provide further insights into the development of vocational interests. Because previous studies on this topic have been rather inconclusive (e.g., DeWinne, Overton, & Schneider, 1978; Grandy & Stahmann, 1974), the aim was to identify and overcome particular limitations that could potentially distort these relationships.

Specifically, it was criticized that most studies on parent-child interest similarity did not consider the entire interest profile, or did not even assess interests psychometrically. Although there were exceptions in which the similarity between vocational interests of parents and their children was measured on the profile level (Grotevant et al., 1977), those studies fell short of considering the normative differences between vocational interests of women and men (Su et al., 2009). Consequently, the results could be assumed to over- or underestimate the actual intrafamily profile similarities of same-sex and other-sex parent-child dyads. In order to overcome this limitation, a pseudo-couple approach was employed to obtain appropriate reference distributions of corresponding randomly paired parent-child dyads. Thereby, it was expected that randomly paired same-sex dyads would, on average, be positively correlated and that randomly paired other-sex dyads would, on average, be negatively correlated. The average profile correlations of real-family dyads were assumed to be significantly larger than those obtained from the pseudo-families, but were not expected to be necessarily different from 0 (especially in the case of other-sex dyads).

Beyond these central reexaminations of parent-parent and parent-child interest similarities, it was also attempted to extend these findings in two meaningful ways. First, it was investigated whether or not the similarity between mothers and fathers affected the evaluation of the statistical significance of parent-child interest similarities. To this end, the resampling algorithm was

adjusted to consider mother-father similarity. Second, it was attempted to find further evidence for the validity of the circumplex model by examining the extent to which these relationships were replicable on the level of model-based interest profiles. Specifically, it was expected that corresponding analyses on the level of model-based interest profiles would yield similar results to those on the level of observed interest profiles, which would mean that the model-based interest profiles contained the essential information responsible for profile similarity.

The aim of Study 4 was to introduce a German translation of the PGI and to provide empirical evidence for its reliability and validity. Specifically, it was intended to analyze the structural validity of the spherical model of vocational interests and the underlying submodels (the eight-type and six-type circumplex) across item-types and gender, its convergent validity with an alternative instrument for assessing vocational interests, namely, the General Interest-Structure-Test (GIST; Bergmann & Eder, 2005), and the construct validity of the instrument with regard to its ability to detect the theoretically expected gender differences (Su et al., 2009).

A strong emphasis was put on the investigation of the instruments' structural validity. To this end, it was intended to examine the structural validity of the spherical model of vocational interests with both confirmatory and exploratory methods. First, the *randomization test of hypothesized order relations* (RTOR; Hubert & Arabie, 1987) was used to analyze the congruence of the structural patterns in the corresponding correlation matrices with the hypothesized spherical order. In a subsequent step, exploratory methods were employed in order to identify potential subscales responsible for misfit. In particular, principal components analysis with subsequent target rotations were used to find the closest possible representation of the theoretically postulated structure, based on the available data. In doing so, it was hoped to identify sources of potential improvements that might help subsequent research to refine the instruments and to maximize their ability to assess the highly complex models that they intend to assess.

Finally, Study 5 aimed to extend the validity evidence for the German translation of the PGI by taking a closer look at the validity of the three underlying dimensions: People-Things, Ideas-Data, and Prestige. Moreover, the aim was to evaluate the validity of the PGI-S (Tracey, 2010) as an abbreviated alternative to the PGI for purposes that require an efficient assessment of an elaborate conceptualization of vocational interests. To this end, the validity evidence for the



underlying dimensions was compared between versions with regard to the structural validity of the basic interest circumplex, the convergent validity of the three dimensions across item types, and the validity based on the relationships between the three dimensions and relevant external criteria (gender, school grades, and the socioeconomic status associated with the participants' desired profession).

Again, a particular focus was put on the evaluation of the structural validity of the instruments. To this end, the elaborate *circular stochastic process model with a Fourier series* (CSPF; Browne, 1992) was used to test the fit of the eight basic interest scales to the hypothesized circumplex structure across instruments and item types. Moreover, by extending this model to the multigroup framework, it was intended to analyze the invariance of the central parameters of the models (the parameters pertaining to the underlying correlation function and the angular locations of the scales on the circumplex) across PGI versions. Because the PGI-S strongly focuses on the assessment of the eight basic interest scales and the underlying circumplex structure, at the cost of a severely abridged assessment of the Prestige dimension, it was expected that the instruments would yield largely invariant results regarding the two circumplex dimensions (People-Things and Ideas-Data). However, the extent to which this would also be true for the Prestige dimension was open for investigation.



## 2

# Study 1: The Stability and Change of Vocational Interest Profiles and Interest Congruence over the Course of Vocational Education and Training

Etzel, J. M., & Nagy, G. (2019). *The stability and change of vocational interest profiles and interest congruence over the course of vocational education and training*. Manuscript submitted for publication.

This study is concerned with the stability and change of vocational interest profiles and interest congruence in highly structured vocational settings, namely, vocational education and training (VET). Specifically, we examined 1) the stability of vocational interest profiles, 2) the possibility of systematic changes in vocational interest profiles, as indicated by changes in person-environment (P-E) congruence, and 3) the relationship between P-E congruence and trainees' satisfaction with their VET course within and across time. To this end, we relied on a three-wave longitudinal sample of  $N = 2,611$  trainees from five different VET courses in Germany. Through the use of meta-analytical aggregation techniques, we were able to consider interindividual differences in intraindividual interest stability and P-E congruence on the level of trainees' activity preference profiles. This approach enabled us to consider relationships between multivariate preference patterns and commensurate environmental profiles. Overall, interest profiles were considerably stable over the entire course of VET. However, we found considerable interindividual differences in interest stability both within and between groups. On the group level, average P-E congruence increased slightly in three of the five groups and did not change in the others. Although these socialization effects were almost negligible in comparison to the very large selection effects, which were manifested in a high initial P-E congruence, we found changes in P-E congruence to be positively associated with corresponding changes in satisfaction with VET both on the group level and on the individual level.

## 2.1 Introduction

Vocational interests are considered to be dispositional, traitlike preferences for specific kinds of work-related activities. As such, they are powerful predictors of human behavior and attitudes in organizational and educational contexts (Rounds & Su, 2014). Research on their stability strongly suggests that vocational interests are considerably stable over long periods of time (Low et al., 2005). However, in line with corresponding advances in research on personality development, the long-held belief that vocational interests, once developed, are essentially inalterable has increasingly been abandoned (e.g., Neyer, Mund, Zimmermann, & Wrzus, 2014; Roberts, Wood, & Caspi, 2008; Specht et al., 2014) and researchers have begun to simultaneously consider aspects of interest stability and change (e.g., Schultz et al., 2017).

A potential source of systematic change in vocational interests over time could be individuals' striving for a high congruence between their interests or personality characteristics and the characteristics of particular work environments, which is a central assumption of several widely acknowledged vocational theories (Holland, 1997; Schneider et al., 1995). Because vocational interests have always been deeply intertwined with questions of vocational choice (Holland, 1959), and because there is ample empirical evidence of their predictive power for educational and occupational choice behavior (e.g., Hansen & Dik, 2005; Le et al., 2014; Nagy, 2006; Volodina, Nagy, & Retelsdorf, 2015), these theories predominantly assume that person-environment (P-E) congruence is established through occupational selection. Consequently, researchers following these traditions have considered P-E congruence almost exclusively from a cross-sectional perspective (cf. Wille, Tracey, Feys, & De Fruyt, 2014).

Whereas research on personality development has provided considerable, yet far from unambiguous, evidence for the existence of reciprocal effects between personality traits and environmental experiences (Denissen, Ulferts, Lüdtke, Muck, & Gerstorf, 2014; Roberts, Caspi, & Moffitt, 2003), the possibility that systematic changes in vocational interest occur in reaction to experiences in work environments has hardly ever been tested systematically (a limited exception is found in Meir & Navon, 1992).

In the present study, we addressed this desideratum by investigating the stability of and

change in the vocational interest profiles of young adults in highly structured vocational contexts, namely, vocational education and training (VET). Specifically, we aimed to answer the following research questions: 1) How stable are trainees' vocational interests over the course of VET? 2) Do trainees' vocational interests change systematically in reaction to environmental experiences over the course of VET? 3) Are changes in vocational interests related to trainees' satisfaction with their VET course? To this end, we analyzed the intraindividual stability of and change in vocational interest profiles, as well as that of the congruence between these interest profiles and commensurate environmental profiles that indicated VET course-specific patterns of demands and opportunities. Lastly, we examined whether or not changes in P-E congruence were associated with corresponding changes in trainees' satisfaction with their VET course.

In the following sections, we first briefly introduce Holland's (1997) theory and we contrast two opposing perspectives toward analyzing vocational interests: the variable-centered and the person-centered approach. We then briefly review the empirical evidence for the stability of vocational interests across the life span from both of these perspectives. Finally, we reflect on the role that P-E congruence plays in the seemingly antithetical relationship between interest stability and occupational selection on the one hand, and occupational socialization and interest development on the other hand.

### 2.1.1 *Vocational Interests and Interest Profiles*

Vocational interests, as defined in the framework of Holland's (1997) seminal theory of vocational personalities and work environments, are considered to be traitlike—and therefore relatively stable—characteristics of the human personality. Holland proposed a typology of six distinct interest domains: Realistic, Investigative, Artistic, Social, Enterprising, and Conventional (RIASEC). Each of these domains describes a broadly defined field of prototypical work activities and an associated personality type. An individual's specific configuration of these six interest domains defines what is commonly referred to as her or his personality pattern, or interest profile. The interest profile depicts an overarching compendium of the kinds of work-related activities a person likes and dislikes. The six interest domains can also be used to characterize environments. For example, they can be used to define a profile of environ-

mental characteristics that indicates the kinds of activities that are required and/or supported in particular work contexts (e.g., an organization, a college major, or a vocational training course).

In this framework, the most thorough account of an individual's interests is given by her or his multivariate interest profile. Such a profile comprises three distinct components. First, *profile elevation* is defined as the mean-level of the profile scores, which is often considered to be a mere nuisance factor (for a thorough discussion about the role of profile elevation in different situations see Tracey, 2012). Second, *profile scatter* is defined as the variability of the profile scores (e.g., Xu & Tracey, 2016). Third, profile shape is defined as the specific configuration of the six interest scores in relation to each other (Cronbach & Gleser, 1953). Indisputably, profile shape is the central component of the interest profile because it defines the intraindividual pattern of likes and dislikes for certain activities in relation to one another.

Empirical investigations of the relationships between vocational interests and relevant outcomes (e.g., occupational choice, satisfaction, or performance Le et al., 2014), of the similarity between vocational interests within important groups (e.g., within families; Grandy & Stahmann, 1974), or of their stability (e.g., over college years; Tracey, Robbins, & Hofsess, 2005) can generally be distinguished between by the perspective that was taken in approaching these analyses. The traditional and most commonly adopted perspective in psychological research is the variable-centered perspective (e.g., Furr & Funder, 2004). From this perspective, the focus is on the differential relationship of particular variables across all individuals within a group (e.g., the correlation between Artistic interests across two measurement occasions). An alternative perspective is taken in what is typically referred to as the person-centered approach (Asendorpf, 2015; Block, 1971). From this point of view, the focus is shifted towards more holistic analyses of multivariate profiles within persons (e.g., the intraindividual stabilities of individuals' entire interest profiles across two measurement occasions).

In the past two decades, there has been a slight but noticeable shift in the vocational interest literature towards a stronger focus on the more elaborate analyses that consider the entire multivariate interest profile as the central unit of analysis. For example, Warwas et al. (2009) were able to show that mathematical literacy was positively associated with interest profiles with a predominantly Realistic orientation and negatively associated with profiles with

a predominantly Artistic orientation. Furthermore, Etzel, Lüdtke, Wagner, and Nagy (2018) analyzed the similarity of vocational interest profiles within families and found the profiles of mothers and fathers, as well as those of parent-child dyads to be significantly more similar than those of corresponding randomly paired dyads. Finally, both Perera and McIlveen (2018) and Le et al. (2014) were able to show that vocational interest profiles were predictive of students' choice of and persistence in majors from the fields of science, technology, engineering, and mathematics (STEM).

In the following sections, we first briefly review the compelling empirical evidence for the relatively high stability of vocational interests. Thereby, we focus on the most commonly analyzed types of stability: rank-order stability and profile stability. We then continue with an illustration of one of the core concepts of Holland's theory, the congruence hypothesis, and, on this basis, elaborate on the ambiguity between stability and occupational selection on the one hand, and change and occupational socialization on the other hand. Finally, we illustrate the benefits of addressing these questions from a person-centered perspective and present arguments for analyzing them on the level of multivariate interest profiles.

### 2.1.2 *The Stability of Vocational Interests Across the Life Span*

Research on the question of the stability of vocational interests over the life span has produced a large body of literature (e.g., Hansen & Swanson, 1983; Hirschi, 2010; Low et al., 2005; Tracey & Robbins, 2005; Tracey et al., 2005). To the present day, most studies have approached this question from a *variable-centered* perspective. The most commonly analyzed type of stability from this perspective is *rank-order* (or *differential*) stability. This type of stability describes the stability of individuals' placement on a particular variable relative to the other individuals in a sample. In their meta-analysis of more than 60 independent studies, Low et al. (2005) found rank-order stabilities of the six RIASEC domains to be even higher than those of the Big Five personality traits. Their findings suggest that the six RIASEC domains display consistently high rank-order stability over substantial periods of time and that stability peaks in middle to late adolescence (at the age of 18–22). Recent studies provide further evidence for the high stability of vocational interests in this regard (Hoff et al., 2018; Schultz et al., 2017; Wille et al., 2014;

Xu & Tracey, 2016).

Although analyses of rank-order stability provide important insights, they do not reveal much about the stability of intraindividual interest configurations. For this reason, *person-centered* approaches toward interest stability have recently received considerably more attention. The major advantage of these approaches is that they enable researchers to consider interindividual differences in intraindividual stability and change (Nesselroade, 1991). Furthermore, they can be used to analyze different kinds of profile agreement, such as the similarities of individuals' interest profiles with a reference profile (e.g., Le et al., 2014; Wille et al., 2014). The most common type of stability from this perspective is *profile* (or *ipsative*) stability, which is commonly operationalized by means of the ordinary Pearson product-moment correlation between two profiles. A particular benefit of this measure is that it is only sensitive to the similarity (or dissimilarity) of profile shapes.

In their meta-analysis, Low et al. (2005) also aggregated average profile correlations from 30 independent studies and found them to be, on average, very high ( $\rho = .70$ ). Moreover, they found that average profile stability was even higher than rank-order stability. Schultz et al. (2017) replicated this finding and were able to extend it by showing that the high average profile correlations over time were not a mere artifact of profile normativeness (Furr, 2008; Wood & Furr, 2016). Finally, alternative indices of profile similarity that also factor in the similarity between profile elevation and scatter, such as the Euclidean distance measure, also provide some evidence for the stability of interest profiles (Tracey et al., 2005; Xu & Tracey, 2016).

Taken together, there is widely unambiguous evidence for the relatively high stability of vocational interests, regardless of the specific subpopulations [e.g., adolescents in educational settings (Tracey & Robbins, 2005) or adults in the work force (Schultz et al., 2017)], the time span [e.g., from late middle school to senior year in high school (Tracey et al., 2005) or over several decades (Low et al., 2005)], or the specific type of stability [e.g., rank-order stability (Hoff et al., 2018) or profile stability (Schultz et al., 2017)] under consideration. However, despite this broad agreement, stability estimates are typically not so high as to suggest that no change could occur at all Low et al. (2005).

The apparent ambiguity between the relatively high stability of dispositional attributes (e.g.,



vocational interests and personality traits) on the one hand and the possibility of systematic changes in these attributes (e.g., socialization) on the other hand has preoccupied researchers in the past decades (e.g., Caspi & Roberts, 2001; Wille & De Fruyt, 2014; Wille et al., 2014). Today, there is widespread agreement that personality comprises both stable and variable parts (e.g., Neyer et al., 2014; Roberts et al., 2008; Specht et al., 2014). However, whereas personality researchers have already begun to address questions of systematic changes in personality empirically (Roberts et al., 2003), the bulk of longitudinal research on vocational interests to this day has concentrated on different aspects of interest stability, while the possibility of environmental influences on interest development in early and late adulthood is still widely understudied (Wille & De Fruyt, 2014).

In the following sections, we present and consolidate theoretical arguments that explain how vocational interests could be expected to change systematically in reaction to environmental experiences. Thereby, we draw on a central aspect of Holland's theory: individuals' motivation to establish a high congruence between their interests and the demands and opportunities of their work or educational environments through occupational selection or socialization.

### 2.1.3 *The Role of Person-Environment Congruence in Occupational Selection and Socialization*

A central aspect of Holland's theory is the *congruence hypothesis*, which states that individuals are motivated to seek out environments that are in congruence with their interests because such environments confront them with demands and opportunities for action that enable them to engage in activities that they are intrinsically motivated to undertake. Consequently, a good match between individuals' interests and environmental characteristics is assumed to result in higher satisfaction and continuance in the respective environment<sup>1</sup>. In this regard, Holland's theory is complemented by another prominent theory of P-E congruence, namely the *Attraction-Selection-Attrition* model (ASA; Schneider, 1987). The central assumption of

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<sup>1</sup>Whereas the importance of perceived and actual P-E congruence for individuals' intention to stay in a particular environment has been supported by empirical evidence (e.g., Allen & Robbins, 2008; Etzel & Nagy, 2016), evidence for the congruence-satisfaction relationship is more ambiguous (Tranberg et al., 1993) and has even led some researchers to challenge the congruence concept in general (Tinsley, 2000).

the ASA framework is that work environments comprise individuals with similar personality structures because individuals are attracted by and actively choose environments that match their personality. Furthermore, it is assumed that individuals are motivated to leave work environments that are incongruent with their interests and to seek out alternatives that better suit their personality. Both frameworks thus postulate that individuals are inclined to establish a high congruence between their personality or interests and the characteristics of potential work environments.

If the proposition that central environmental characteristics are rather stable over time is accepted (cf. Harms, Roberts, & Winter, 2006), there are two potential ways for individuals to establish high P-E congruence. First, individuals could choose a fitting work environment right away or, in the case of insufficient fit, could leave their current work environment and move towards a better fitting alternative. In other words, they could establish or increase congruence through occupational selection. Empirical support for both of these propositions is plentiful. For instance, both Oleski and Subich (1996) and Donohue (2006) were able to show that career changers tended to move toward jobs that are more congruent with their interests.

The profile component that predominantly drives occupational selection is profile shape because it indicates the intraindividual configuration of a person's likes and dislikes for specific activity domains. In a systematic examination of the relative importance of these profile components for predicting occupational choices, Prediger (1998) found that profile shape contributed to the prediction of occupational group membership, but profile elevation did not. Furthermore, Nagy (2006) demonstrated that interest profiles were the strongest predictors of college-major choices over and above school type, gender, and abilities. He found that, for most of the majors under study, the estimated profile orientations (a location parameter that is ultimately determined by profile shape) within each major were rather homogenous and in line with theoretical expectations.

Second, because it might not always be possible to establish congruence right away and because leaving the current work environment is often associated with considerable costs, individuals could establish congruence by adapting their interests to better fit the current environment, that is, through occupational socialization. This could be accomplished either by

subordinating one's primary interests to activities that are required in order to succeed in the current environment (if fit is not optimal) or through an intensification of one's already existing preference structure (if fit is already quite high). The latter idea is similar to that of the *corresponsive principle*, a concept from research on personality development, which postulates that those characteristics that lead to the selection of a particular environment are also the most likely to change in reaction to this environment (Roberts et al., 2008). This concept is complemented by the central assumptions of the most prominent theory of interest development, the social cognitive career theory (SCCT; Lent, Brown, & Hackett, 1994). The SCCT assumes that interests indirectly guide behavior toward certain activities and environments and that positive performance attainments in the practice of these activities eventually lead to a consolidation of these interests (and vice versa for negative experiences).

Although the question of occupational socialization has, to the best of our knowledge, not yet been addressed systematically, there are a few mentionable exceptions that have touched on the possibility of systematic changes in vocational interests in reaction to work experiences. First, Meir and Navon (1992) found that the vocational interests of newly employed bank tellers (an occupation typically associated with strong Conventional interests) shifted towards Conventional interests after four to six months of employment. Second, Schultz et al. (2017) were able to show that women employed in Realistic, Artistic, or Conventional occupations showed an increase in corresponding interests over the course of 20 years. Finally, Wille et al. (2014) examined the stability of several interest-based P-E congruence measures and their relationship with career satisfaction. Their results also suggest that P-E congruence is highly stable over long periods of time, especially when congruence is operationalized as the agreement between individual and environmental profile shapes. However, they found that these P-E congruence measures were only marginally associated with satisfaction both within and across time.

Once more, it seems reasonable to assume that such socialization processes would be manifested in changes in intraindividual interest configurations (i.e., in changes of profile shapes). Specifically, in either of the two scenarios described above, it can be expected that the intraindividual interest configuration changes towards greater congruence with the environmental characteristics. In this regard, the previously highlighted study of Wille et al. (2014) depicts the

only empirical study to appropriately address this question on the level of multivariate interest profiles. The fact that the authors did not find any evidence for an increase in average profile correlations might be attributed to the several limitations of their design. First, congruence was assessed in reference to the participants' current job at each time point. This means that effects of selection and socialization could not be disentangled. Second, the relatively large time span between the two measurement occasions (15 years) might have been too large to detect nuanced socialization effects. Finally, it could be argued that the relatively small sample ( $N < 200$ ) of college alumni from several college majors and with very diverse career paths was too heterogeneous to detect systematic changes in P-E congruence over time.

## 2.2 The Present Study

In this article, we examined three distinct yet interrelated research questions concerning the stability of and change in the vocational interest profiles of young adults in VET: 1) How stable are trainees' vocational interest profiles over the course of VET? 2) Do trainees' interest profiles change systematically in reaction to environmental opportunities and demands over the course of VET? 3) Are changes in vocational interests related to trainees' attitudes towards their VET course?

At least two key features make the context of VET especially suitable for examining our particular research questions. First, for many young adults in Germany, VET presents the first structured vocational setting that they enter after graduating from school. Although the meta-analytic findings of Low et al. (2005) suggest that young adults (aged 18–22) display the highest average interest stability of all age groups, it is reasonable to assume that occupational socialization effects occur in the earlier stages of engaging with the demands and opportunities of a new environment (Frese, 1982). Second, VET courses in Germany are highly structured and the general conditions are laid out by VET course-specific guidelines developed by the Federal Institute for Vocational Education and Training. Consequently, trainees enrolled in any particular VET course can be expected to be confronted with highly similar work demands, despite the fact that they might actually be working in different organizations.

In this study, we relied on a large longitudinal sample of trainees from five different VET courses in Germany. This extraordinary sample allowed us to examine our desiderata in five different VET groups, each of which was characterized by particular environmental demands and opportunities, and to thus evaluate the consistency of our findings. Because each of these groups comprised trainees who were confronted with very similar environmental demands and opportunities, it was possible to investigate the stability of and change in interest profiles in reference to time-invariant, VET course-specific profiles of prototypical demands and opportunities. Therefore, we were able to study changes in P-E congruence that were solely attributable to changes in trainees' interest profiles.

### 2.2.1 *Interest Profile Stability*

Given the ample evidence for the stability of vocational interest profiles (e.g., Hoff et al., 2018; Low et al., 2005; Schultz et al., 2017; Wille et al., 2014), we expected the vocational interests profiles of trainees across all VET groups to be, on average, positively correlated over the course of VET. Specifically, based on previous findings on interest profile stability, we expected that average profile correlations would be of medium to large magnitude but still considerably below perfect agreement. Following the arguments of Frese (1982), who assumed that environmental influences on personality characteristics—if they occur at all—can be expected to arise in transitional periods, we expected vocational interest profiles in the first phase of VET to be less stable than in later stages of training.

### 2.2.2 *P-E Congruence: Selection Versus Socialization*

Whereas the role of interest congruence in occupational selection is uncontroversial (e.g., Hansen & Dik, 2005; Le et al., 2014; Nagy, 2006; Volodina, Nagy, & Retelsdorf, 2015) and constitutes a central aspect of several widely acknowledged theories of P-E fit (Holland, 1997; Schneider et al., 1995), the possibility of systematic interest development as a form of occupational socialization has received little attention in the literature. As argued above, many theories postulate that individuals establish P-E congruence primarily through processes of occupational selection. For example, in the ASA framework, it is assumed that a misfit

between the person and the environment, sooner or later, leads to individuals leaving their current environment (i.e., attrition) and to their orientation toward better fitting alternatives (e.g., Donohue, 2006).

However, the aforementioned advances in the conceptualization of personality traits and their development as well as the emergence of empirical evidence for environmental influences on changes in personality (Denissen et al., 2014; Roberts et al., 2003; Wille & De Fruyt, 2014) suggest that research on vocational interests, too, should consider the possibility of socialization processes as a means for individuals to increase P-E congruence. Based on the central assumptions of the SCCT (Lent et al., 1994) and in line with the corresponive principle of personality development, it can be expected that such socialization processes, if they occur at all, are most likely manifested in systematic changes in interest profile shapes toward greater P-E congruence.

Consequently, we expected to observe one of two possible scenarios. In scenario one, vocational interests are essentially stable, except for unsystematic fluctuations. In this scenario, we would not expect to find any systematic changes in trainees' average P-E congruence over time. In scenario two, vocational interests are subject to systematic changes in reaction to individuals' exposure to the environment. In this case, we would expect trainees' P-E fit to increase over time. In line with the arguments of Frese (1982), we would furthermore expect these changes to occur in the early stages of training. Evidence for such effects would entail the immediate follow-up question about the size of these socialization effects relative to selection effects. In this study, we addressed this question by estimating the selection effects for each VET group. Specifically, because we expected selection to be manifested in a high P-E congruence at the beginning of training, we compared the average P-E congruence estimates of the first measurement occasion with corresponding baseline P-E congruence estimates that reflected the expected average P-E congruence if trainees were assigned to VET courses by chance. The latter were derived on basis of an independent, large, and representative reference sample. This approach was necessary because psychological profiles usually contain a normative component that could result in a positive average P-E congruence even when selection occurred completely at random (Wood & Furr, 2016).

### 2.2.3 *P-E Congruence: Relevance for Occupational Attitudes*

Even in cases where no systematic socialization effects occur, trainees are likely to differ in their degree of P-E congruence. Moreover, changes in trainees' interests could go either way and either increase or decrease the extent of P-E congruence. These considerations give rise to the question of whether interindividual differences in P-E congruence and changes therein are related to trainees' attitudes towards their VET course. In this study, we investigated the relationships of P-E congruence with their self-reported satisfaction with VET. The corresponding analyses served two purposes: (1) They provide validity evidence our approach towards measuring P-E congruence, and (2) they allow investigating whether changes in interests that lead to higher or lower levels of P-E congruence are psychologically meaningful.

Although a positive association between P-E congruence and satisfaction has often been hypothesized (Holland, 1997), empirical findings are mixed (Tranberg et al., 1993; Tsabari et al., 2005). However, because the idea of a positive relationship between P-E congruence and satisfaction is so self-evident, the inability to find resilient empirical support for this association has often been attributed to methodological deficiencies rather than to theoretical fallacies (see also Tinsley, 2000). Therefore, evidence for the postulated positive relationships between P-E congruence and satisfaction would underpin the validity of our approach of assessing P-E congruence. In addition, evidence for relationships between changes in P-E congruence and changes in satisfaction would indicate that changes in interest profiles do not only represent random fluctuations but instead reflect psychologically meaningful processes that bear substantial meaning for trainees' evaluations of their VET courses.

## 2.3 Method

### 2.3.1 *Participants and Procedure*

Data were taken from the Mathematics and Science Competencies in Vocational Education and Training study (ManKobE; Retelsdorf, Lindner, Nickolaus, Winther, & Köller, 2013). The study tracked two cohorts of trainees from different VET courses in Germany over the entire course of their training. Data were collected between 2012 (beginning of training for the first

cohort) and 2017 (scheduled completion of training for the second cohort). Specifically, data were assessed via self-report questionnaires at three critical stages of training: Shortly after the beginning of training (T1), just before the intermediate examinations (T2), and just before the final examinations (T3).

We only considered data from the five VET groups that were assessed on all three measurement occasions ( $N = 2,752$ ). Within each group, trainees who participated on fewer occasions were also considered in the analyses. Prior to our analyses, we excluded participants who did not answer at least one item of each RIASEC domain ( $N = 113$ ). From those who remained in the sample, we excluded  $N = 7$  more who had no variability in their interest profile because they rated every item identically. Our final sample thus comprised  $N = 2,611$  trainees from five different VET courses ( $N = 425$  industrial mechanics,  $N = 585$  automotive technicians,  $N = 426$  electronic technicians,  $N = 525$  chemical laboratory assistants, and  $N = 650$  industrial clerks).

Participants who were excluded from the analysis based on the aforementioned criteria did not differ significantly from those who remained in the sample with regard to sex (OR = 1.05,  $p = .765$ ), age ( $t[2693] = 1.95$ ,  $p = .051$ ), or school leaving certificate (general qualification for university entrance versus lower certificates; OR = 1.31,  $p = .16$ ). The full sample comprised 28% female and 71% male trainees ( $N = 34$  participants did not provide information about their gender). The average age was  $M = 18.4$  years with a standard deviation of  $SD = 2.52$ .

### 2.3.2 *Reference Sample*

In order to warrant an appropriate evaluation of the presumed selection effects, we used additional data from a representative sample of secondary school students just before their transition to further stages of their education (i.e., at the end of the 10th grade). These data were taken from the Transformation of the Secondary School System and Academic Careers—Grade 10 (TOSCA-10) study in Germany (Trautwein, Neumann, Nagy, Lüdtke, & Maaz, 2010). We included data from students based on the same criteria that applied to our main sample (i.e., students who responded to at least one item of every RIASEC domain, and whose profile variability was larger than zero). The final reference sample thus comprised  $N = 2,565$  students. These



students were, on average, 16.8 years old ( $SD = .71$ ) and the proportion of female students was 51%.

### 2.3.3 Measures

*Vocational interests and environmental characteristics.* In both the main sample and the reference sample, participants' vocational interest profiles were assessed with the General Interest Structure Test (GIST; Bergmann & Eder, 2005). With the GIST, each RIASEC domain is measured by 10 items comprising descriptions of common work activities. Participants were asked to rate their liking of these activities on a scale ranging from 1 = *strongly dislike* to 5 = *strongly like*. The GIST assesses vocational interests reliably and there is ample evidence for its validity (Nagy et al., 2010). The internal consistency estimates of the six RIASEC domains in the full sample across all three measurement occasions were very high ( $.86 \leq \alpha \leq .93$ ).

The VET group-specific environmental profiles were created on the basis of the participants' judgments of the importance of common work activities for their training. These judgments were assessed with the Environmental Structure Test (EST; Bergmann & Eder, 2005). The EST comprises the same 60 activity descriptions as the GIST. The difference to the GIST is that participants are now asked to indicate the importance of these activities for their current work (again, on a scale ranging from 1 = *not important at all* to 5 = *very important*). Again, internal consistencies for the corresponding RIASEC scales were high across all time points ( $.86 \leq \alpha \leq .94$ ).

In the present study, both interest and environmental profiles were conceptualized as the array of the trainees' judgments of the 60 activity items. In other words, we analyzed profiles on the item level instead of aggregating these items to the six RIASEC domains. There were two major reasons for this approach. First, considering vocational interest profiles at the item level enabled us to detect much more nuanced shifts in intraindividual preference patterns because these profiles contained the complete information about individuals' likes and dislikes. Second, because we examined individuals in highly specific vocational contexts, it could be assumed that some of these contexts, in particular the three VET groups with a technical focus, would be nearly indistinguishable on the level of aggregated profiles. The use of item-level profiles, on

the other hand, allowed us to consider even slight differences between these work environments and, thus, increased the likelihood of detecting socialization effects.

*Satisfaction with VET.* Trainees' satisfaction with their VET course was measured with a three-item subscale of an established multidimensional instrument for the assessment of academic satisfaction (Westermann, Heise, Spies, & Trautwein, 1996). The phrasing of the items was adapted to fit the VET context. Participants rated the respective items on a scale ranging from 1 = *does not describe me at all* to 4 = *describes me exactly*. Internal consistencies were high across all VET groups and measurement occasions ( $.83 \leq \alpha \leq .90$ ).

### 2.3.4 *Statistical Analyses*

Our research questions required us to overcome two methodological challenges. First, we had to employ appropriate methods to adequately assess the quantities of interest on the level of individual interest profiles. Second, we had to employ methods that would allow us to appropriately aggregate the individual-level coefficients, make inferences about the underlying population distributions, and test specific hypotheses about them.

These requirements essentially break down to the issue of aggregating dependent effect sizes from independent sources. Consequently, by treating individuals in our sample as independent studies and the individual-level profile-similarity coefficients as dependent effect sizes from the same source, we solved these challenges by applying meta-analytical aggregation strategies. In particular, we adopted M. W. Cheung's (2013) structural equation modeling (SEM) specification of a multivariate random-effects meta-analysis (MREMA). In this approach, dependencies between effect sizes from the same sources are treated by accounting for their sampling variances and covariances. Moreover, the inclusion of latent random-effects variables allowed us to study individual differences in stability and P-E congruence coefficients that correspond to the variability of effect sizes between studies in conventional applications of meta-analysis. Furthermore, the SEM approach allows for a straightforward extension to the multigroup case (i.e., VET courses), and for the handling of missing effect sizes via full information maximum likelihood (FIML) estimation.

In the next sections, we first describe the approach we used to construct the VET group-

specific environmental reference profiles (ERPs). We then elaborate on how we calculated the profile similarity measures on the individual level before providing a detailed account of how we specified the meta-analytical SEMs in order to aggregate the effect sizes obtained in the first step and how we extended these models to analyze the relationships between the aggregated effect sizes and satisfaction.

*Calculation of environmental reference profiles.* In order to construct appropriate ERPs, we aimed to identify the most precise representations of trainees' subjective assessment of the relative importance of particular work activities for their specific training course. To this end, we fitted particularly specified latent profile analysis (LPA) models to each VET group's EST ratings (one separate model for each of the three measurement occasions). Thereby, a mixture distribution with two latent classes in which only profile shape determined class membership. With the help of this approach, we wanted to ensure that the ERPs represented a profile that the majority of trainees from a particular VET course could agree upon.

Specifically, the EST score of individual  $i$  on item  $j$  in class  $c$  was modeled as

$$y_{ijc} = \tau_{ic} + \lambda_{jc}\eta_i + \epsilon_{ijc}, \quad (1)$$

with  $\eta_i \sim \mathcal{N}(0, 1)$ ,  $\epsilon_{jc} \sim \mathcal{N}(0, v_c)$ , and  $\lambda_{j,c=2} = 0$  for all  $j$ . In doing so, we were able to identify, for every VET group and measurement occasion, one large group of trainees (77–97%) whose averaged profiles resembled the standardized VET group-specific ERP, and a second, much smaller group (3–23%) of trainees with somewhat different assessments of their work environment. These differences could be due to these trainees' unwillingness or inability to adequately describe their current work environments or due to their particular jobs being substantially different from those of the other trainees in the respective VET group.

Figure 1 displays the ERPs of all five VET groups on all three measurement occasions (items 1-10 belong to the Realistic subscale, 11-20 to the Investigative, etc.). As can be seen, the average judgments of the demands and opportunities that characterize a particular VET environment were highly invariant over time ( $.97 \leq r \leq .99$ ). Moreover, the particular profile shapes were in line with our expectations regarding the characteristics of our particular VET groups. For the

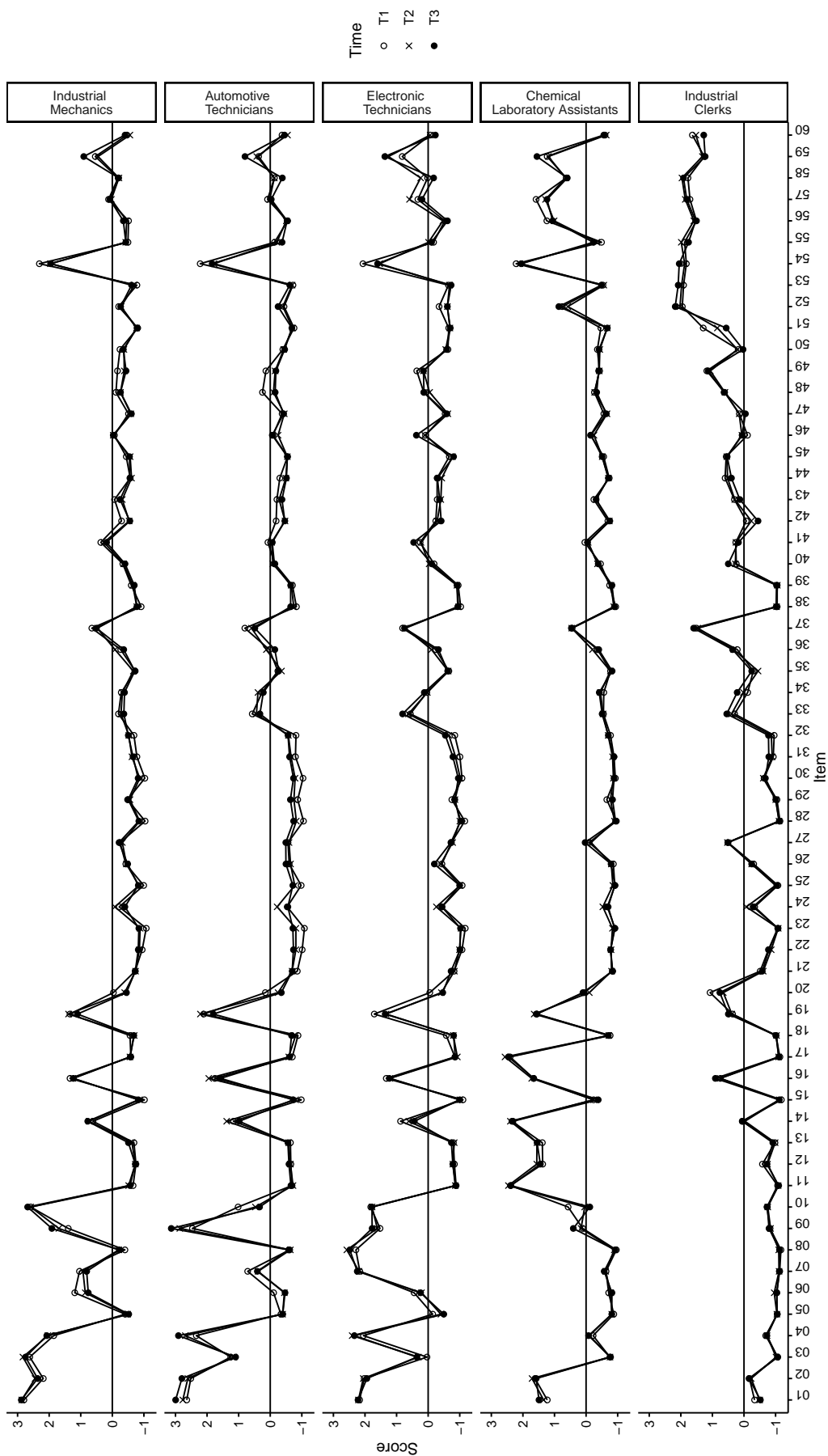


Figure 1: Environmental reference profiles of each VET course on all three measurement occasions.

three technical VET groups (automotive and electronic technicians and industrial mechanics), Realistic activities were considered to be most important. However, as can be seen by the differently peaked profiles of the first 10 items, they still differed noticeably with regard to which activities were considered to be particularly important. The chemical laboratory assistants' ERP indicates a high importance of Investigative and Conventional activities. Finally, for industrial clerks, Conventional activities were judged to be most relevant. Due to their high temporal stability, we used the average of the three time point-specific profiles as our VET group-specific ERPs for the subsequent analyses.

*MREMA Step 1: Estimation of individual-level coefficients.* For each individual on each of the three measurement occasions, we calculated the Pearson product-moment correlation between a) the individual's interest profile on different measurement occasions, and b) the individual's interest profiles and the respective ERP of the VET group to which the individual belonged to. Because the sample distribution of profile correlations tends to be skewed, we further transformed these profile correlations to  $z$  scores using Fisher's  $r$ -to- $z$  transformation. The individual-level effect sizes were estimated by fitting particularly specified fully saturated SEMs using *Mplus*, version 8.0 (Muthén & Muthén, 1998-2018), separately to each individuals' available data. The corresponding sampling variances and covariances were obtained from the asymptotic variance-covariance matrix of the parameters (given by the TECH3 output in *Mplus*).

*MREMA Step 2: Aggregation.* Figure 2 displays the general specification of a single group MREMA model with three dependent effect sizes specified as a SEM. The manifest variables ES1–ES3 hold the respective effect size estimates obtained in Step 1. Their variances and covariances ( $v_{11i}$ – $v_{33i}$ , and  $v_{12i}$ – $v_{23i}$ ) are constrained to be equal to the corresponding sampling variances and covariances of the effect sizes determined in the first step. This is achieved by the use of definition or constraint variables (Mehta & Neale, 2005), which can be used to impose person-specific constraints on variables in a model (notice the subscripted  $i$ ). The intercepts  $b_1$ – $b_3$  are the estimates of the average population effect sizes, and the variances and covariances of the person-specific latent random-effects variables  $u_1$ – $u_3$  (i.e.,  $\tau_{ii}$  and  $\tau_{ij}$ ) inherit the between-person variance components. An exemplary *Mplus* Syntax for a MREMA model with 3 dependent is provided in the online supplemental materials.

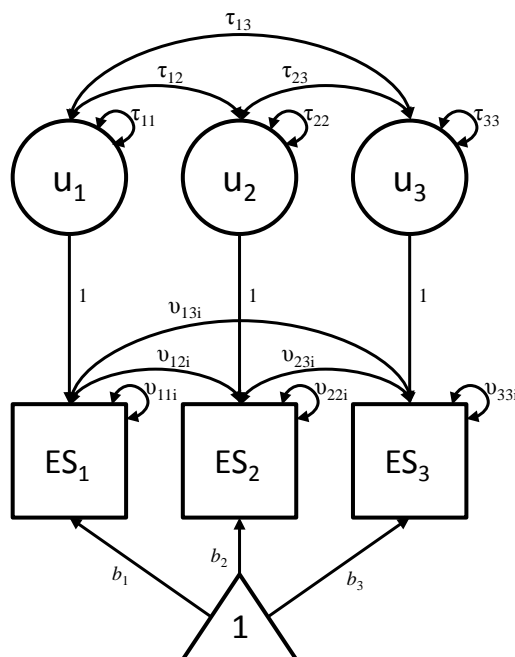


Figure 2: Specification of a multivariate random-effects meta-analysis model as a SEM.  $ES_i$  = Manifest variables holding the effect size estimates of effect size  $i$ ;  $v_{ii}$  and  $v_{ij}$  = Known sampling variances of and covariances between the effect sizes  $i$  and  $j$  implied as person-specific constraints;  $u_i$  = Random-effects variable holding the distribution of effect size  $i$ ;  $b_i$  = Estimate of the aggregated effect size  $i$  (i.e., mean of  $u_i$ );  $\tau_{ii}$  and  $\tau_{ij}$  = Variance of and covariance between  $u_i$  and  $u_j$ .

In our application, we extended the model depicted in Figure 2 to the multigroup framework. Specifically, we included VET course as a grouping variable and estimated all parameters freely within each group. The bases for our analyses were two unrestricted multigroup MREMA models: One for the three stability effect sizes ( $b_1 = \bar{z}_{12}$ ,  $b_2 = \bar{z}_{23}$ , and  $b_3 = \bar{z}_{13}$ ) and one for the three congruence indices ( $b_1 = \bar{z}_1$ ,  $b_1 = \bar{z}_2$ , and  $b_1 = \bar{z}_3$ ). In the next paragraphs, we explicate how we extended these baseline models in order to obtain estimates of profile stability, selection, socialization, and the relationship between P-E congruence and satisfaction.

*Stability.* The average profile stability between any two measurement occasions is given by the intercepts of the first MREMA model. In order to test whether or not any two stability estimates within each group were significantly different from one another, we defined new parameters in each group that indicated the difference between the respective stability estimates and we tested these new parameters against zero. For example, we subtracted the estimate of

T1  $\rightarrow$  T2 stability ( $b_1 = \bar{z}_{12}$  from the respective MREMA model) from that of T2  $\rightarrow$  T3 stability ( $b_2 = \bar{z}_{23}$  from the respective MREMA model) in order to test whether or not stability was higher in later phases of training ( $\Delta_{\bar{z}_{23}, \bar{z}_{12}}$ ).

*Selection.* As mentioned above, we defined selection effects as the difference between the VET group-specific aggregated P-E congruence effect size at T1 and the respective baseline P-E congruence estimate obtained from the reference sample. The latter was obtained by calculating the average  $z$ -scores of the correlations between the interest profiles of the participants from the reference sample and the five VET group ERPs. In order to account for the differences in the demographic compositions between the VET groups, the  $z$ -scores were averaged using a weighted mean. Thereby, the weights mirrored the proportion of male and female participants with either a higher education entrance qualification or any lower school leaving certificate in the respective VET group. In doing so, we determined the following baseline effect sizes: industrial mechanics:  $\bar{z}_0 = .13$ ; automotive technicians:  $\bar{z}_0 = .13$ ; electronic technicians:  $\bar{z}_0 = .10$ , chemical laboratory assistants:  $\bar{z}_0 = .03$ ; industrial clerks:  $\bar{z}_0 = .10$ .

*Socialization.* In order to evaluate whether or not the average P-E congruence between trainees' vocational interest profiles and the VET group-specific ERPs changed significantly over the course of training, we defined new parameters that indicated the differences between the P-E congruence effect sizes from different measurement occasions. In doing so, we obtained three indicators of occupational socialization effects (T1  $\rightarrow$  T2:  $\Delta_{\bar{z}_2, \bar{z}_1}$ ; T2  $\rightarrow$  T3:  $\Delta_{\bar{z}_3, \bar{z}_2}$ , and T1  $\rightarrow$  T3  $\Delta_{\bar{z}_3, \bar{z}_1}$ ). Furthermore, in a subsequent step, we extended the model by including the covariances between the three latent P-E congruence markers and the manifest satisfaction scale scores on each measurement occasion. From these covariances, we were able to derive, for every VET group, 1) the correlation between P-E congruence and satisfaction on each measurement occasion, and 2) the correlation between changes in P-E congruence and changes in satisfaction.

## 2.4 Results

As a preliminary, Table 1 presents the descriptive information about the trainees' average interest profiles across groups and measurement occasions. In addition, Figure 3 displays the

Table 1: Descriptive Statistics for the Average Interest Profiles

	Profile Elevation			Profile Scatter		
	T1	T2	T3	T1	T2	T3
Industrial Mechanics	2.81	2.63	2.59	0.65	0.63	0.64
Automotive Technicians	2.72	2.59	2.55	0.60	0.50	0.46
Electrical Technicians	2.81	2.68	2.64	0.56	0.46	0.50
Chemical Lab. Assistants	2.81	2.61	2.63	0.74	0.78	0.76
Industrial Clerks	2.91	2.64	2.66	0.60	0.63	0.65

*Note.* Profile elevation = Mean of person-specific profile means. Profile scatter = Mean of person-specific profile standard deviations.

standardized average interest profiles in the same way as the ERPs in Figure 1. First, in all VET groups, profile elevation estimates were higher than the scale midpoint ( $2.55 \leq M \leq 2.91$ ). Moreover, their trajectories over time were very similar across groups. For all VET groups, there was a noticeable decline in average profile elevation from T1 to T2 but no further changes were found from T2 to T3. Second, across all VET groups and measurement occasions, the average interest profiles were well differentiated ( $0.46 \leq SD \leq 0.78$ ). Profile scatter did not change noticeably over time, except in two groups (automotive and electronic technicians), where the average interest profiles became slightly less differentiated over time.

However, as can be seen in Figure 3, the central characteristic of the average interest profiles, their profile shape, was highly stable over time for all VET groups ( $.93 \leq r \leq .99$ ). In line with our expectations, trainees from the technical VET groups had high Realistic and low Artistic and Social interests. Trainees from the chemical laboratory assistant VET had high Investigative interests and lower interests in Realistic and Artistic activities. Lastly, trainees from the industrial clerks VET had lower Realistic and Investigative interests and higher Enterprising and Conventional interests.

#### 2.4.1 Profile Stability

The results of the unconstrained multigroup MREMA model for the three stability effect sizes are displayed in Table 2. Across all groups and measurement occasions, the aggregated  $z$ -transformed profile correlations were significantly larger than zero and of medium to large



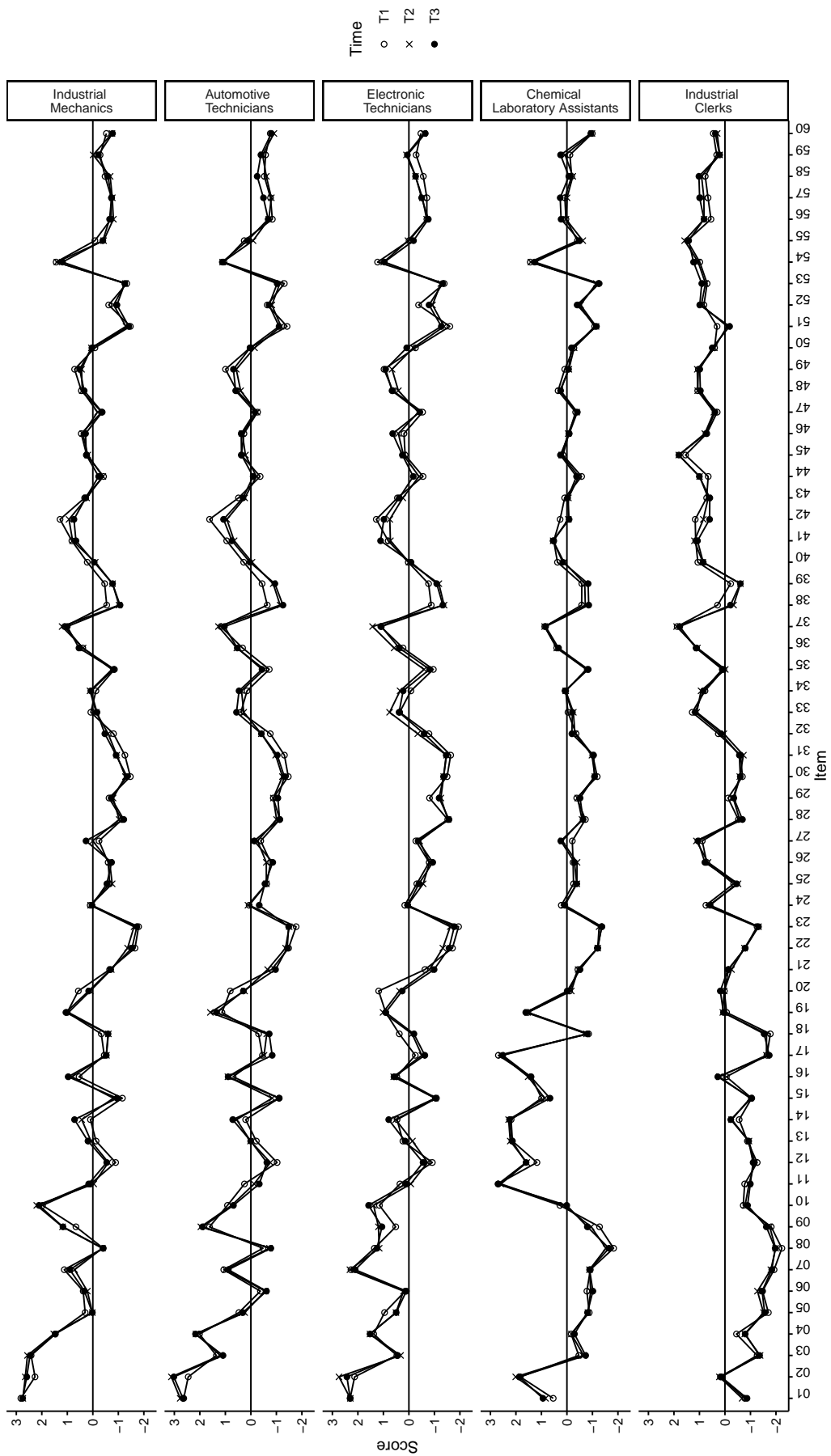


Figure 3: Average Standardized Interest Profiles of each VET course on all three measurement occasions.

magnitude ( $0.50 \leq \bar{z}_{ij} \leq 0.98$ ). All variance terms of the corresponding random-effects variables were significantly larger than zero. This means that there were significant interindividual differences in the stabilities of intraindividual interest profiles. A particularly interesting finding is that interest profile stability was highly stable across all groups and comparisons. This is indicated by the high correlations between the respective random-effects variables ( $.62 \leq \hat{\rho}_{ij} \leq .86$ , with  $\hat{\rho}_{ij} = \hat{\tau}_{ij} / \sqrt{\hat{\tau}_i \times \hat{\tau}_j}$ ). In other words, all VET groups comprised participants with different levels of interest profile stability, and participants with a higher (or lower) profile stability in the first stages of their VET tended to retain this high (or low) stability throughout the entire course of their training.

The aggregated stability estimates for each VET group are visualized in the left panel of Figure 4. As a visual aid, the estimates belonging to the same VET group are signified by a dotted gray line. Although the patterns of the average stability estimates over time were more or less similar, the absolute size of the aggregated stability indices differed significantly between VET groups (the respective Wald tests yielded:  $369.73 \leq \chi_4^2 \leq 514.49$ , all  $p < .001$ ). In line with our expectations, T2 → T3 stability was significantly higher than T1 → T2 stability and T1 → T3 stability for all but one group (automotive technicians). This finding is indicated by the fact that the respective estimates of difference variables ( $\Delta_{\bar{z}_{23}, \bar{z}_{12}}$  and  $\Delta_{\bar{z}_{23}, \bar{z}_{13}}$ ) in Table 2 were significantly larger than zero. In addition, T2 → T3 stability did not exceed the T1 → T3 stability in the electronic technicians group, whereas this comparison was significant in all other groups.

Taken together, these first analyses documented rather high average levels of interest stability that, however, differed between groups. Stabilities were on average strongest in chemical laboratory assistants and industrial clerks, and somewhat weaker in technical VET courses. With one exception, average stabilities increased over the course of training in all VET groups. Furthermore, the analyses indicated that all groups comprised individuals with higher and lower levels of stability over the entire course of VET. However, based on the average stability effects sizes and their variance terms, we were able to infer that the proportion of trainees with rather unstable interest profiles was largest in the groups of automotive and electronic technicians (smallest average stability effects coupled with largest variance components).

Table 2: Results of the Unconstrained Multigroup Multivariate Meta-Analysis Model for the Stability Effect Sizes

Meaning	Parameter	Notation	Industrial Mechanics		Automotive Technicians		Electronic Technicians		Chemical Lab. Assistants		Industrial Clerks	
			Est.	S.E.	Est.	S.E.	Est.	S.E.	Est.	S.E.	Est.	S.E.
<i>Aggregated stability effect sizes</i>												
T1 → T2		$\bar{z}_{12}$	.618***	.016	.541***	.017	.511***	.022	.899***	.011	.716***	.013
T2 → T3		$\bar{z}_{23}$	.709***	.020	.541***	.023	.576***	.025	.977***	.013	.839***	.015
T1 → T3		$\bar{z}_{13}$	.618***	.018	.495***	.020	.536***	.022	.850***	.011	.685***	.014
<i>Variance components</i>												
T1 → T2		$\hat{\tau}_{12,12}$	.070***	.007	.095***	.008	.095***	.011	.034***	.003	.072***	.006
T2 → T3		$\hat{\tau}_{23,23}$	.094***	.010	.158***	.015	.123***	.014	.043***	.004	.075***	.007
T1 → T3		$\hat{\tau}_{13,13}$	.052***	.006	.101***	.010	.083***	.011	.032***	.003	.073***	.006
<i>Correlations between stability effect sizes</i>												
T1 → T2 with T2 → T3		$\hat{\rho}_{12,23}$	.743***	.042	.746***	.037	.842***	.033	.623***	.050	.666***	.041
T1 → T3 with T2 → T3		$\hat{\rho}_{13,23}$	.697***	.049	.811***	.030	.732***	.048	.711***	.043	.686***	.039
T1 → T2 with T1 → T3		$\hat{\rho}_{12,13}$	.685***	.051	.776***	.037	.753***	.047	.775***	.038	.862***	.022
<i>Differences between stability effect sizes</i>												
T2 → T3 - T1 → T2		$\Delta_{\bar{z}_{23}, \bar{z}_{12}}$	.091***	.017	.000	.020	.065***	.019	.078***	.012	.123***	.015
T1 → T3 - T2 → T3		$\Delta_{\bar{z}_{13}, \bar{z}_{23}}$	-.092***	.018	-.046*	.019	-.040	.022	-.127***	.011	-.155***	.015
T1 → T3 - T1 → T2		$\Delta_{\bar{z}_{13}, \bar{z}_{12}}$	-.001	.016	-.046**	.017	.025	.020	-.049***	.010	-.032***	.011

Note. Est. = Point estimate; S.E. = Standard Error.  
 \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$ .

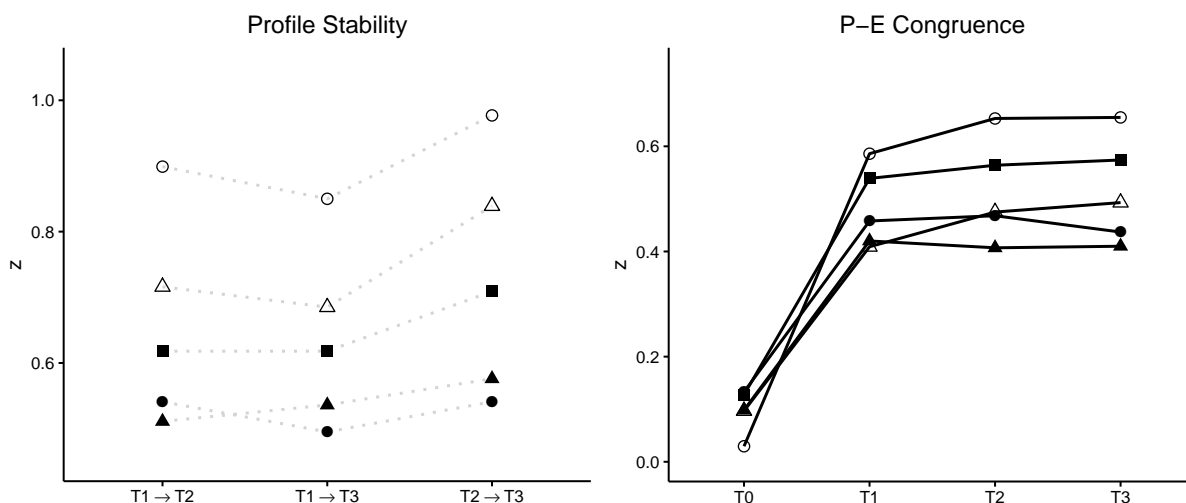


Figure 4: Aggregated effect sizes from the MREMA models. ■ = industrial mechanics ● = automotive technicians; ▲ = electronic technicians; ○ = chemical laboratory assistants; △ = industrial clerks.

#### 2.4.2 Development of P-E Congruence

The upper part of Table 3 presents the results of the unconstrained multigroup MREMA model for the three P-E congruence effect sizes, from which the estimates of selection and socialization effects were derived. Furthermore, the right panel of Figure 4 illustrates the aggregated P-E congruence effect sizes for all five VET groups (T1–T3), as well as the VET group-specific baseline congruence coefficient obtained from the reference sample (T0). Across all VET groups and measurement occasions, trainees' interest profiles were, on average, positively correlated with the respective VET group ERP ( $0.41 \leq \bar{z}_i \leq 0.66$ , all  $p < .001$ ). However, the average sizes of P-E congruence effects appeared to differ between groups at all occasions, with chemical laboratory assistants displaying the highest values (Wald test results:  $156.77 \leq \chi_4^2 \leq 181.38$ , all  $p < .001$ ).

Again, all variance terms were significantly larger than zero, indicating meaningful interindividual differences in P-E congruence in all VET groups and on all measurement occasions. Interestingly, the variance terms of P-E congruence appeared to be larger at T2 and T3 in all VET groups. Just as for the aggregated stability effect sizes, P-E congruence was found to be highly stable over time ( $.52 \leq \hat{\rho}_{ij} \leq .83$ , all  $p < .001$ ). In other words, trainees who displayed a high P-E congruence at T1 tended to illustrate high P-E fit at later time points and vice versa

Table 3: Results of the Unconstrained Multigroup Multivariate Meta-Analysis Model for the P-E Congruence Effect Sizes

Parameter	Notation	Industrial Mechanics		Automotive Technicians		Electronic Technicians		Chemical Lab. Assistants		Industrial Clerks	
		Est.	S.E.	Est.	S.E.	Est.	S.E.	Est.	S.E.	Est.	S.E.
<i>Aggregated P-E congruence effect sizes</i>											
T1	$\bar{z}_1$	.539***	.013	.458***	.011	.420***	.013	.586***	.011	.409***	.011
T2	$\bar{z}_2$	.564***	.016	.468***	.015	.407***	.020	.653***	.013	.475***	.013
T3	$\bar{z}_3$	.574***	.017	.437***	.017	.410***	.019	.655***	.014	.493***	.014
<i>Variance components</i>											
T1	$\hat{\tau}_{1,1}$	.051***	.005	.050***	.004	.051***	.005	.052***	.004	.055***	.004
T2	$\hat{\tau}_{2,2}$	.085***	.007	.091***	.007	.101***	.010	.070***	.005	.090***	.006
T3	$\hat{\tau}_{3,3}$	.085***	.008	.094***	.009	.084***	.009	.076***	.006	.077***	.006
<i>Correlations between P-E congruence effect sizes</i>											
T1 with T2	$\hat{\rho}_{1,2}$	.530***	.052	.625***	.044	.524***	.062	.737***	.029	.607***	.035
T2 with T3	$\hat{\rho}_{2,3}$	.706***	.040	.668***	.043	.607***	.055	.830***	.022	.772***	.027
T1 with T3	$\hat{\rho}_{1,3}$	.556***	.058	.609***	.053	.665***	.058	.691***	.035	.570***	.043
<i>Differences between P-E congruence effect sizes</i>											
T0 → T1	$\Delta_{\bar{z}_1, \bar{z}_0}$	.412***	.013	.325***	.011	.321***	.013	.556***	.011	.313***	.011
T1 → T2	$\Delta_{\bar{z}_2, \bar{z}_1}$	.025	.016	.010	.014	-.013	.020	.067***	.010	.065***	.012
T2 → T3	$\Delta_{\bar{z}_3, \bar{z}_2}$	.010	.016	-.031	.016	.003	.020	.002	.010	.018	.012
T1 → T3	$\Delta_{\bar{z}_3, \bar{z}_1}$	.035*	.017	-.021	.016	-.010	.018	.069***	.012	.084***	.013

Note. Est. = Point estimate; S.E. = Standard Error.

\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

for trainees who did not have a good fit to begin with. In line with the increasing stability effect sizes (Table 2), correlations between T2 and T3 P-E congruence indices were stronger than the corresponding correlations between T1 and T2 P-E congruence indices in all groups. This pattern was, however, least accentuated in the groups of automotive and electronic technicians, that also showed the weakest increases in average stability effect sizes (Table 3).

The lower part of Table 3 presents the selection effects ( $\Delta_{\bar{z}_1, \bar{z}_0}$ ), which we defined as the difference between P-E congruence at T1 and the corresponding baseline P-E congruence indices obtained from the reference sample and the corresponding standard errors. In line with our expectations, all VET groups displayed significantly higher P-E congruence at the beginning of training than would be expected by chance ( $0.31 \leq \Delta_{\bar{z}_1, \bar{z}_0} \leq 0.56$ , all  $p < .001$ ). This finding further underpins the predictive power of vocational interests as the driving force of occupational selection.

The analyses of the socialization effects, which we expected to be manifested in an increase in average P-E congruence over time, yielded more ambiguous results. Specifically, we found the expected trajectories in only two of the five VET groups (chemical laboratory assistants and industrial clerks). In these groups, P-E congruence increased significantly from T1 to T2 but no further changes occurred from T2 to T3 ( $\Delta_{\bar{z}_2, \bar{z}_1}$  and  $\Delta_{\bar{z}_3, \bar{z}_2}$  in Table 3). In the automotive and electronic technicians VET groups, no significant changes in P-E congruence occurred. Finally, in the industrial mechanics group, neither the T1 → T2 nor the T1 → T3 P-E congruence differed significantly from one another. However, the comparison of T1 → T3 was significant, suggesting that, in this particular group, P-E congruence increased gradually over the entire course of training. Again, in all five VET groups, the variances of these difference variables were significantly larger than zero ( $.097 \leq \text{Var}(\Delta_{\bar{z}_i, \bar{z}_k}) \leq .131$ , all  $p < .001$ ), indicating that there were substantial interindividual differences in intraindividual P-E congruence change over time.

Taken together, the findings presented in this section suggest that initial average P-E congruence indices and changes therein differed significantly between VET groups. Furthermore, in all groups, P-E congruence displayed extraordinary intraindividual stability, especially in the second phase of VET. Despite the partial support for an increase in P-E fit over time, our findings strikingly illustrate that average group-level socialization effects are rather negligible compared

Table 4: Descriptives of Satisfaction with VET and Correlations between Satisfaction and P-E Congruence within and across Time

VET Group	Correlations								
	Scale Means			Within Time			Change		
	T1	T2	T3	T1	T2	T3	T1 → T2	T2 → T3	T1 → T3
IM	3.49	3.20	3.10	.35***	.42***	.40***	.31***	.07	.38***
AT	3.41	3.19	2.79	.28***	.42***	.38***	.16**	.17***	.08
ET	3.25	2.95	2.79	.34***	.43***	.40***	.14**	.08	.05
CA	3.65	3.43	3.30	.23***	.36***	.28***	.09***	.04*	.14***
IC	3.34	3.12	3.10	.40***	.41***	.44***	.17***	.10**	.14**

*Note.* Correlation estimates were derived via covariance algebra from the joint variance-covariance matrix of the random-effects variables pertaining to the P-E congruence effect sizes and the manifest satisfaction scale scores. IM = Industrial Mechanics, AT = Automotive Technicians, ET = Electronic Technicians, CA = Chemical Laboratory Assistants, IC = Industrial Clerks.

\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

to the sizeable selection effects. This means that, on average, P-E congruence is primarily established through the selection of a fitting VET course rather than resulting from occupational socialization, which, however, affects all (or at least most) individuals over the course of VET. The significant interindividual variability in intraindividual P-E congruence changes indicated individual differences in the development of congruence. This finding advocated a closer examination of whether or not these changes were of any relevance for individuals’ attitudes towards their VET course.

### 2.4.3 Associations Between P-E Congruence and Satisfaction Within and Across Time

The first supercolumn of Table 4 displays the means of our satisfaction measure for all groups and measurement occasions. In all VET groups, average satisfaction was found to be very high at the beginning of training and declined slightly and more or less steadily over the course of VET. Interestingly, at each point in time, the group specific means of satisfaction (Table 4) appeared to mirror the group specific means of P-E congruence measures (Table 3). This finding is illustrated in Figure 5. In the left panel, the group means of P-E congruence and satisfaction with VET are visualized in a scatter plot. As can be seen, lower average levels of

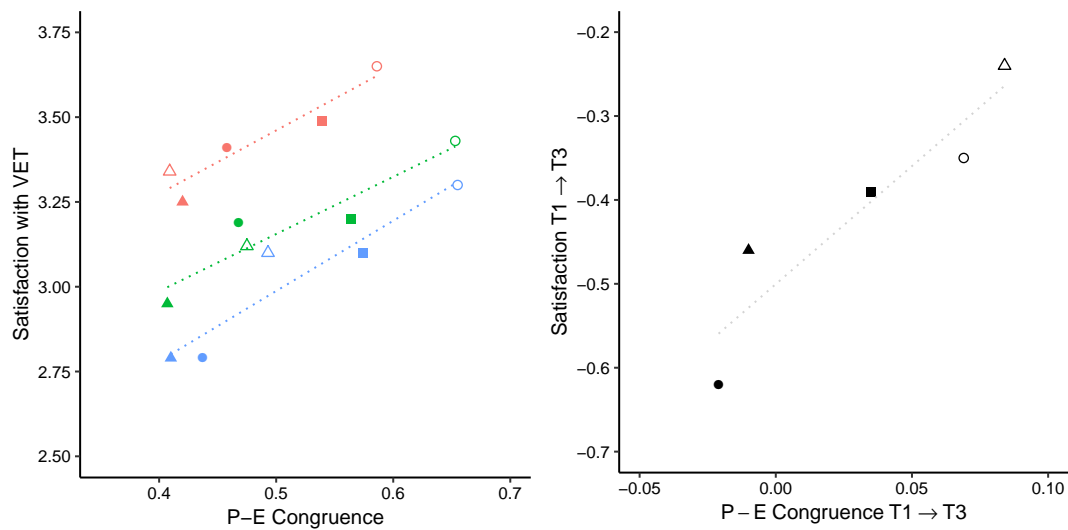


Figure 5: Correlations between P-E congruence and satisfaction within and across time. ■ = industrial mechanics ● = automotive technicians; ▲ = electronic technicians; ○ = chemical laboratory assistants; △ = industrial clerks. Color codes: red = T1, green = T2, blue = T3.

P-E congruence were accompanied by lower levels of average satisfaction. In addition, the right panel of Figure 5 illustrates the scatter plot of the T1 → T3 changes in average P-E congruence and the corresponding changes in average satisfaction ratings. Evidently, on the group level, stronger increases in P-E congruence were associated with weaker decreases in satisfaction. This result provides first indication that P-E congruence, as defined on the level of VET groups, appears to be relevant for individuals' vocational attitudes.

These relationship patterns were even more striking on the individual level. In the second and third supercolumn of Table 4, we present the time point-specific correlations between P-E congruence and satisfaction with the VET course and the correlation between changes in P-E congruence and changes in satisfaction, respectively. First, it can be seen that, in each group, P-E congruence and satisfaction were significantly and positively related on all three measurement occasions. On each measurement occasion, P-E congruence and satisfaction with the VET course yielded medium-sized correlations ( $.23 \leq r \leq .44$ , all  $p < .001$ ). Moreover, intraindividual changes in P-E congruence were associated with corresponding changes in satisfaction in all VET groups, especially for the transition from T1 → T2 ( $.09 \leq r \leq .38$ , all  $p < .01$ ). Moreover, with regard to the transition from T1 → T3, the findings mirror exactly those pertaining to the changes in P-E congruence (i.e., significant increase in P-E fit and significant



correlation between changes in P-E congruence and satisfaction in three groups and no changes or correlations in the other two groups). These findings strikingly support Holland's congruence hypothesis and further endorse the validity of our congruence measure.

Hence, it can be summarized that P-E congruence and changes therein, as assessed in our study, were clearly related to individuals' appraisals of their vocational situation. Most important, the finding that the relationships between P-E congruence and satisfaction were stronger in later phases of VET appears to be a result of psychological adjustment processes, as indicated by the significant relationships between changes in P-E congruence and corresponding changes in satisfaction. Consequently, it can be assumed that some individuals have optimized their adjustment to the environmental demands and opportunities of their VET course by adapting their intraindividual interest configurations, whereas others have failed to do so.

## **2.5 Discussion**

The present study was concerned with profile-level examinations of the stability and development of vocational interests over the course of VET. By referring to one of the core concepts of Holland's theory of vocational choice, the congruence hypothesis, we were particularly interested in the development of the congruence between vocational interest profiles and environmental reference profiles that indicated VET course-specific demands and opportunities. Through the use of meta-analytical aggregation methods, we were able to analyze population estimates of intraindividual stability and change and their relationship with satisfaction with the VET course. In the following sections, we critically evaluate our findings and discuss their theoretical and practical implications.

### *2.5.1 Stability of Vocational Interest Profiles Over the Course of VET*

One central finding of our study was that the interest profiles of trainees in highly structured vocational contexts were, on average, considerably stable over the course of three years. However, although average stability estimates were of medium to large magnitude, they were not so large as to suggest that no change or development could have occurred at all. Our findings are, thus

in line with previous research on the stability of vocational interest profiles in other educational and occupational settings (e.g., Hoff et al., 2018; Low et al., 2005; Schultz et al., 2017; Tracey et al., 2005).

Nonetheless, there was considerable variability in profile stability at both the individual and the group level. Specifically, we found that all VET courses comprised trainees with varying degrees of profile stability and that there were systematic differences in average profile stability between VET courses. Moreover, our results indicate that these interindividual differences in intraindividual profile stability were also considerably stable over the entire course of training. Consequently, these findings indicate that future work could search for possible moderators of profile stability on both the individual and the group level.

Based on our theoretical rationale, we expected P-E congruence to be one plausible correlate of interest profile stability. Specifically, it could be argued that trainees who have a good fit to their environment are less likely to display substantial changes in their interest configuration. Indeed, additional analyses provided support for this assertion. Throughout all VET groups, trainees' congruence with the ERP was correlated with their stability from the respective time point to the next ( $.26 < r < .56$ , all  $p < .001$ ; detailed results are available upon request). However, the absence of clear socialization effects in our study suggests that this issue might be more complex than it appears on first glance. Because we found no indication for a general tendency of trainees with low levels of P-E congruence to increase their interest congruence over the course of VET, more research on the relationships between P-E congruence and interest stability is called for.

Two other plausible variables that could explain differences in trainees' interindividual differences in intraindividual stability are their age and variables related to individuals' career maturity, such as their educational background, or their cognitive abilities. For example, Low et al. (2005) found interest stability to be associated with age, peaking in the age range of 18-22. Although trainees from different VET courses differed significantly with regard to age ( $F(4, 2564) = 23.03$ ,  $p < .001$ ), the absolute differences were rather small ( $17.9 \leq M \leq 19.2$ ) and, more importantly, age was not systematically related to profile stability.

Regarding the differences in educational backgrounds, the two VET groups with conspic-

uously low profile stabilities comprised 33% (electronic technicians) and 38% (automotive technicians) trainees with the lowest school leaving certificate. The group of industrial mechanics comprised only 15% trainees with the lowest certificates, and the two VET groups with the highest average profile stabilities (chemical laboratory assistants and industrial clerks) almost exclusively comprised participants from academic track secondary schools. Moreover, a closer look at these VET groups revealed that the average profile-stability indices within each group differed significantly between trainees with different school leaving certificates (detailed results of these analyses may be requested from the corresponding author). Whether or not these differences could be attributed to differences in cognitive abilities is an interesting question that should be addressed in future research.

### *2.5.2 The Development of P-E Congruence and its Role in Occupational Selection and Socialization*

Another central research question investigated in this study was the question of whether or not we could find any evidence for systematic changes in vocational interests toward greater P-E congruence. On the group level, the results of these analyses were somewhat ambiguous. In three out of the five VET groups under investigation, P-E congruence increased slightly over the course of training whereas no such changes were found for the other two groups. However, these presumed socialization effects were extensively smaller than the respective selection effects. This finding suggests that trainees establish P-E congruence primarily through occupational selection and is thus in line with other relevant literature on vocational choice (Le et al., 2014; Lent et al., 2003; Nagy, 2006; Volodina & Nagy, 2016; Volodina, Nagy, & Retelsdorf, 2015).

However, this result does not mean that changes in P-E congruence are meaningless from a psychological perspective. More specifically, our findings about the relationships of P-E congruence and satisfaction clearly support the critical role of P-E congruence for individuals' career related success. First, we found strong evidence that VET groups with more favorable trajectories of P-E congruence displayed a less steep decline in satisfaction across time. Second, we were able to replicate this finding on the individual level within each VET group. Therefore, our findings suggest that both the time stable component of group and individual differences

in P-E congruence—established by the process of occupational selection— and changes in P-E congruence over the course of VET could be crucial for securing individuals' vocational satisfaction. Therefore, our findings complement the results of (Wille et al., 2014), who also found P-E congruence to be relatively stable over time. However, a particular advancement of our findings is the fact that we assessed P-E congruence in reference to a time-invariant reference profile and were thus able to attribute this stability solely to the stability of the trainees' interest profiles, whereas the findings of Wille et al. (2014) study changes in P-E congruence could in part result from individuals' occupational transitions.

In addition, the observed positive relationships between P-E congruence and satisfaction, both from a static and a dynamic perspective accentuates the appropriateness of our approach toward operationalizing P-E fit as the similarity between the profile shapes of the trainees' interest profiles and a commensurate ERP. Most important, the fact that we found strong evidence for the covariation of changes in P-E congruence and changes in satisfaction with the VET course indicates that changes in P-E congruence and, thus, changes in vocational interest profiles are not only random fluctuations or mere indications of measurement error but, rather, have real consequences for relevant outcomes.

In this regard, our findings join those of other studies on personality development that have analyzed and partially supported the assumption that environmental experiences in general, or work experiences in particular, might affect the development of personality traits and vocational interests over time (e.g., Denissen et al., 2014; Lüdtke, Roberts, Trautwein, & Nagy, 2011; Roberts et al., 2003; Schultz et al., 2017). The fact that interest profile shapes both predicted occupational selection and changed in reaction to experiences in these environments could be considered as further evidence for and a multivariate approach toward the corresponsive principle of personality development (Roberts et al., 2008) and as a support for the use of a multivariate approach to assessing it.

### 2.5.3 *Practical Implications*

Our findings also have important implications for counseling practice. First of all, we were able to show that the driving force behind trainees' pursuit of a high congruence between

their interests and their environment is the selection of a fitting VET course. This particular finding further emphasizes the widely acknowledged importance of career counseling during middle school and the significance of conveying accurate characterizations of the demands and opportunities young adults are likely to be confronted with in particular career paths. However, our findings also suggest that P-E congruence can develop over time and that a suboptimal match at the beginning of a new phase in one's professional life might not necessarily be a reason to prematurely drop out. However, more research is needed to find out under which circumstances and to what degree young adults are able to refine their interests in order to reach a sufficient level of P-E congruence. This issue is especially important as our study suggests that some individuals do not adapt their interests to the environmental affordances and opportunities. Therefore, the success of vocational socialization processes leading to different levels of P-E congruence appears to be highly idiosyncratic. However, more knowledge about the determinants of their success would open up the possibility of career interventions to help counselees to fathom the potential of adjuvant adaptations of their preferences, self-evaluations, and attitudes toward particular tasks.

#### 2.5.4 *Limitations and Future Directions*

The sample used in this study comprised young adults enlisted in five different VET courses in Germany. Although we considered VET to be a particularly suitable context to examine our research questions, further research with more diverse samples is needed in order to further generalize our findings. For example, future research could try to replicate our findings using a sample of job entrants from various age groups and various vocational fields. By relying on profile correlations to assess the similarity between trainees' interest profiles over time and between trainees' interest profiles and the VET course-specific ERPs, we deliberately limited ourselves to the examination of agreement between profile shapes. We chose this approach because we consider profile shape to be the central parameter of the interest profile and because profile shape has been found to be a pivotal predictor of vocational choice behavior (e.g., Nagy, 2006; Prediger, 1998).

However, future research could pick up on our approach and also investigate the role of

profile elevation and scatter. For example, with regard to profile scatter, some researchers have found interest profiles to become increasingly more differentiated over time (Tracey et al., 2005), a finding that is often interpreted as an indication of individuals becoming increasingly self-aware about which kinds of activities they prefer (e.g., Super, 1980). Moreover, in an analysis of individual-level predictors of interest stability, Hirschi (2010) was able to show that differentiation was positively related to interest stability. Unfortunately, these continuative analyses were far beyond the scope of our study.

## **Conclusion**

In the present study, we analyzed both the stability of the vocational interests of young adults in highly structured vocational environments and the possibility of systematic changes in vocational interests in reaction to experiences in these environments. Overall, trainees' vocational interest profiles were considerably stable over the entire course of training. However, there were substantial interindividual differences in intraindividual stability within groups and in average profile stability between groups. Because we assumed that systematic changes in vocational interest profiles would be manifested in changes of P-E congruence over time, we examined the intraindividual trajectories of the fit between trainees' interest profiles and environmental reference profiles. In all VET groups under study, the average P-E congruence was found to be very high at the beginning of training, thus indicating large selection effects. Although group-level analyses of P-E fit development showed that P-E congruence only increased marginally, and only in three out of five VET groups, we were able to unanimously show that P-E congruence was associated with trainees' satisfaction with their VET course within and across time.

## Appendix A: Online Supplemental Materials

### *Exemplary Mplus Syntax*

Printed below is an exemplary *Mplus* syntax file containing the computer code to estimate a multivariate random-effects meta-analysis model with three dependent effect sizes. The effect sizes (e1\_est–e3\_est) are stored in three separate columns of the input data set, as are their respective sampling variances (e1\_var–e3\_var) and covariances (cov\_e1\_e2–cov\_e2\_e3). The latter are defined as constraint variables via the “CONSTRAINT:” subcommand and are then fixed in the “MODEL CONSTRAINT:” statement.

```

TITLE:      EXAMPLE SYNTAX OF A MREMA MODEL WITH 3 EFFECT SIZES;

DATA:      FILE IS example.dat;

VARIABLE:  NAMES ARE
              e1_est e2_est e3_est
              e1_var e2_var e3_var
              cov_e1_e2 cov_e1_e3 cov_e2_e3;

              USEVARIABLES ARE
              e1_est e2_est e3_est;

              CONSTRAINT ARE
              e1_var e2_var e3_var
              cov_e1_e2 cov_e1_e3 cov_e2_e3;

ANALYSIS:  TYPE=GENERAL;

MODEL:     ! INTERCEPTS TO CAPTURE THE AGGREGATED EFFECT SIZES
              [e1_est*];
              [e2_est*];
              [e3_est*];

              ! VARIANCES AND COVARIANCES WILL BE FIXED VIA CONSTRAINT COMMAND
              e1_est* (V_E1);
              e2_est* (V_E2);
              e3_est* (V_E3);

              e1_est WITH e2_est* (C_E12);
              e1_est WITH e3_est* (C_E13);
              e2_est WITH e3_est* (C_E23);

              ! DEFINE THE RANDOM EFFECTS (RE) VARIABLES
              U1 BY e1_est@1;
              U2 BY e2_est@1;
              U3 BY e3_est@1;

              ! VARIANCES OF THE RE VARIABLES
              U1* (V_U1);
              U2* (V_U2);

```

```
U3* (V_U3);

! COVARIANCES BETWEEN RE VARIABLES
U1 WITH U2 (C_U12);
U1 WITH U3 (C_U13);
U2 WITH U3 (C_U23);

MODEL CONSTRAINT:

! SETTING INDIVIDUAL LEVEL CONSTRAINTS
! VARIANCES
V_E1 = e1_var;
V_E2 = e2_var;
V_E3 = e3_var;

! COVARIANCES
C_E12 = cov_e1_e2;
C_E13 = cov_e1_e3;
C_E23 = cov_e2_e3;

! USING MODEL CONSTRAINTS TO ESTIMATE CORRELATIONS BETWEEN RE VARIABLES
NEW(R12* R13* R23*);
R12 = C_U12 / (SQRT(V_U1 * V_U2));
R13 = C_U13 / (SQRT(V_U1 * V_U3));
R23 = C_U23 / (SQRT(V_U2 * V_U3));

OUTPUT: SVAL;
```



# 3

## Study 2: Similarity of Vocational Interest Profiles within Families: A Person-Centered Approach for Examining Associations between Circumplex Profiles

Etzel, J. M., Lüdtke, O., Wagner, J., & Nagy, G. (2019). Similarity of vocational interest profiles within families: A person-centered approach for examining vocational associations between circumplex profiles. *Journal of Personality, 87*(3), 593–606. doi: 10.1111/jopy.12418

**Objective:** Our study addressed three questions concerning the similarity of vocational interests within families: 1) How similar are vocational interests of mothers and fathers? 2) How similar are vocational interest of parents and their children? 3) Is the inference about parent-child profile similarity affected by mother-father profile similarity?

**Method:** Data from  $N = 1,624$  tenth graders and their parents were used to analyze interest profile similarity by means of a pseudo-coupling approach. Similarity was assessed on the level of observed profiles and model-based circumplex profiles.

**Results:** Interest profiles of mother-father and parent-child dyads were more similar to each other than those of corresponding arbitrarily paired dyads. However, when the similarity between the parents' interest profiles was accounted for, only same-sex parent-child dyads were more similar to each other than would be expected by chance. All findings were mirrored on the level of observed profiles and model-based circumplex profiles.

**Conclusion:** In sum, our findings support the validity of the circumplex model of vocational interests and emphasize the benefits of explicitly considering its implications when analyzing profile similarity. Moreover, we were able to show that the statistical evaluation of profile similarities must account for normative profile components.

### 3.1 Introduction

For decades, vocational interests have been a central topic in organizational, educational, and personality research. While the majority of research is concerned with the structure and stability of vocational interests (e.g., Low et al., 2005; Tracey & Rounds, 1993), with their predictive power for academic success, choice behavior, and life events (e.g., Nye et al., 2017; Stoll et al., 2017; Van Iddekinge et al., 2011), as well as with associations between interests, personality traits, and abilities (e.g., Ackerman & Heggestad, 1997), little is known about intrafamily associations of vocational interests.

This comes as a surprise, because there are at least two kinds of relationships within families that could be of particular interest to different fields of psychological research. First, associations between parents' vocational interests might foster our understanding of couple similarity. Although it has been shown that individuals choose romantic partners who have similar psychological characteristics (e.g., Luo, 2017), little to nothing is known about the role that vocational interests play in partner selection. Second, associations between interests of parents and those of their children might deepen our understanding of vocational interest development. Although most theories emphasize the importance of social learning, role orientation, and genetic contributions (Holland, 1997; Lent et al., 1994), empirical findings concerning actual parent-child interest similarity are scarce and equivocal.

In recent years, vocational interest research methodology has advanced considerably. For example, researchers have begun to explicitly consider the structural implications of Holland's (1997) model of vocational interests: the circumplex (e.g., Nagy et al., 2012; Tracey et al., 2014). Using the so-called structural summary method (SSM; Gurtman & Balakrishnan, 1998), it is possible to reduce the multivariate interest profile to three theoretically meaningful components: *profile elevation*, the mean of the individual's profile scores, *profile differentiation*, an indicator of intra-profile variability, and *profile orientation*, a measure of profile direction, indicating the kinds of activities a person is primarily interested in. Furthermore, personality researchers have recently underscored the need to consider normative profile components, especially in the analysis of profile similarity (e.g., Borkenau & Leising, 2016; Furr, 2008).

While researchers concerned with the aforementioned phenomena (e.g., interest congruence and choice behavior) have already begun debating and updating their findings in the light of these methodological advances, these advances have hardly ever been considered in research on intrafamily interest similarity. In our study, we addressed this research gap by showing that these methodological advances have important consequences for the interpretation and statistical evaluation of interest profile similarity. Specifically, we employed a person-centered pseudo-couple approach to analyze 1) the extent to which vocational interests of mothers and fathers are similar to each other, 2) the extent to which vocational interests of parents and those of their children are similar to each other, and 3) whether or not the inference about parent-child interest similarity is affected by mother-father interest similarity. All research questions were examined on both the level of observed interest profiles as well as on the level of model-based circumplex profiles.

In the following sections, we will first introduce the circumplex model of vocational interests and its implications for individual interest profiles. We will then demonstrate that this structural model also poses a model for assessing the similarity between interest profiles via profile correlations, before turning our attention to methodological challenges of analyzing such similarities. Finally, we will briefly review possible explanations and existing empirical evidence for interest similarity within families in the light of these methodological arguments.

### 3.1.1 *Holland's Model of Vocational Interests*

Holland (1997) considers vocational interests to be an integral part of the human personality and defines them as relatively stable psychological representations of activity preferences. He postulates six distinct interest types: Realistic, Investigative, Artistic, Social, Enterprising, and Conventional — RIASEC. The Realistic type is characterized by preferences for manual tasks and working with machines. Individuals categorized as Investigative prefer researching, exploratory and analytic activities, and have an aversion to repetitive tasks. Artistic individuals prefer creative, unsystematic, and ambiguous activities. The Social type is characterized by a preference for informing, helping, or training other people. The Enterprising type is characterized by a preference for manipulating and leading others. Finally, people categorized

as Conventional prefer activities that involve the systematic and structured manipulation of data (Holland, 1997).

According to Holland, the vocational personality pattern or profile (i.e., the set of scores on the six RIASEC dimensions) and its fit with the environment is the central determinant of vocational choice behavior and success (Holland, 1997; Volodina, Nagy, & Retelsdorf, 2015). Therefore, vocational interests are inherently suited for the application of person-centered or idiographic approaches (PCAs). PCAs stand in contrast to the more conventional variable-centered or nomothetic approaches (VCAs; Block, 1961), which are primarily used to examine associations between variables in the population (e.g., the correlation between fathers' and daughters' Realistic scale scores). As such, VCAs yield information about the associations between the rank order of two interest trait scores over persons, and not about the actual similarity of interest profiles between two persons. On the other hand, PCAs consider entire multivariate trait configurations, thus making it possible to assess similarity between pairs of individuals instead of pairs of variables.

Another central aspect of Holland's theory is the assumption that the six interest types display a specific structure: they are distributed around the perimeter of a circumplex (left side of Figure 1). Thereby, the proximity between two interest types mirrors their psychological similarity. This so-called calculus hypothesis has been supported in various groups, contexts, and cultures (Nagy et al., 2010; Tracey & Rounds, 1993). In the subsequent sections, we will demonstrate that these structural assumptions have direct implications for individual interest profiles. Specifically, by using the SSM (Gurtman & Balakrishnan, 1998), it is possible to reduce observed interest profiles to three theoretically meaningful parameters. Moreover, we will show that the SSM also constitutes a model for assessing correlations between model-based interest profiles.

### 3.1.2 *A Person-Centered Approach to Interest Profile Similarity*

*Structural summary method.* Given the validity of the circumplex model, the SSM can be used to fit a cosine function to an individual's observed interest profile. This then results in what we will hereafter refer to as a model-based interest profile that is defined by three theoretically

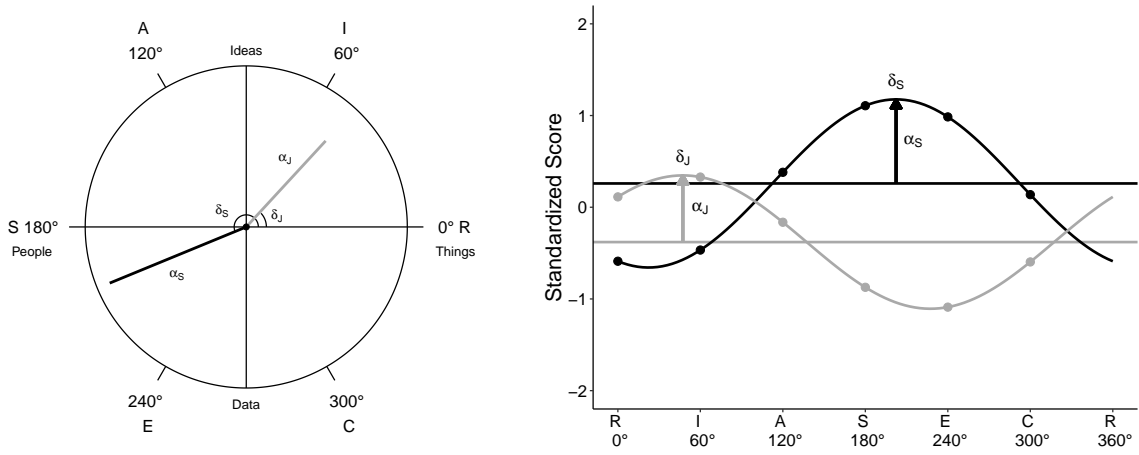


Figure 1: Circumplex projection and model-based circumplex profiles of an exemplary mother-son dyad. R = Realistic, I = Investigative, A = Artistic, S = Social, E = Enterprising, C = Conventional.  $\alpha$  = profile differentiation,  $\delta$  = profile orientation of mother Sandy (S, black) and son Jeremy (J, gray).

meaningful parameters. To facilitate the presentation of this approach, the interpretation of these parameters, and to indicate its consequences for analyzing profile similarity, we will use an illustrative example of a fictional mother-son dyad: Sandy and her son Jeremy, whose model-based interest profiles are displayed in two alternative representations in Figure 1. For example, Jeremy’s interest profile can be modeled with the SSM as:

$$Y_{Jk} = \tau_J + \alpha_J \times \cos(\theta_k - \delta_J) + d_{Jk} \tag{1}$$

In Equation 1,  $Y_{Jk}$  is Jeremy’s standardized scale score on interest scale  $k$ .  $\theta_k$  indicates the angular position of scale  $k$  relative to an arbitrary reference category (conventionally, the Realistic scale is chosen as the reference category at  $0^\circ$ ).  $\tau_J$  is Jeremy’s profile elevation, that is, the mean of the six interest scores, as represented by the vertical shift of the cosine function (right panel of Figure 1).  $\alpha_J$  is Jeremy’s profile differentiation, an indicator of his intraprofile variability or scatter, as represented by the vector length (left panel) and the amplitude of the cosine function (right panel).  $\delta_J$  is Jeremy’s profile orientation, an indicator of which kinds of activities Jeremy prefers, which is represented by the angular orientation of the vector (left panel) and the angular displacement of the cosine function relative to the reference category (right panel). Lastly,  $d_{Jk}$  is a scale-specific residual component.

Accordingly, we see that Jeremy has a slightly below average profile ( $\tau_J = -0.35$ ) that is

well differentiated ( $\alpha_J = 0.67$ ). Furthermore, he is primarily interested in a blend of Realistic and Investigative activities ( $\delta_J = 47.3$ ). Taken together, the SSM provides a parsimonious model for summarizing interest profiles that takes the theoretical implications underlying the vocational interest construct into account. Recent studies have provided empirical support for the importance of explicitly considering these implications in the analysis of associations between vocational interests and external criteria (Nagy et al., 2012; Tracey et al., 2014; Volodina, Nagy, & Retelsdorf, 2015; Warwas et al., 2009). A detailed description of how to calculate the model-based profiles and the SSM parameters from the observed interest profiles is given in the online supplemental materials.

*Similarity between model-based interest profiles.* The advantages of the SSM become even more evident when it comes to assessing the similarity between two individuals' interest profiles. The central aspect of interest profile similarity is the question of how similar individuals' preferred activities are. The SSM concentrates this information on a single parameter: profile orientation ( $\delta$ ). Consequently, the difference between two individuals' profile orientations is a natural indicator of the similarity between their model-based interest profiles. Even more, it holds that the correlation between two model-based profiles is equal to the cosine of the difference between profile orientations. In this regard, the SSM provides a model for assessing profile correlations derived from theoretically meaningful parameters.

Returning to our illustrative example, we can now compare Sandy's model-based profile to Jeremy's. In Figure 1, the similarity between the two profiles is indicated by the proximity (i.e., the smallest separating angle) of the person vectors (left panel) and, accordingly, the proximity of the maxima of the cosine functions (right panel). Because Sandy is primarily interested in Social and Enterprising activities ( $\delta_S = 202.4$ ), her interests are very dissimilar to Jeremy's, as indicated by the large difference between their profile orientations ( $\delta_S - \delta_J = 155.1^\circ$ ), or, equivalently, by the strongly negative profile correlation  $r_{\delta_S \delta_J} = \cos(-155.1^\circ) = -.91$ .

Generally, two model-based interest profiles are most similar when the corresponding vectors point in the same direction (i.e., their separating angle is  $0^\circ$  and their profile correlation equals 1). Likewise, they are most different when the vectors point in opposite directions (i.e., their separating angle is  $180^\circ$  and their profile correlation equals -1). Therefore, a profile correlation

of zero does not mean that two profiles are unrelated, but rather indicates that the respective vectors are  $90^\circ$  apart, and, thus, moderately similar.

In sum, the SSM constitutes a model for assessing profile-similarity via profile correlations. Moreover, profile correlations between model-based interest profiles can be straightforwardly interpreted as the differences between profile orientations. Consequently, further support for the validity of the structural model and the SSM would be provided if the profile correlations between model-based interest profiles were comparable to the correlations between corresponding observed interest profiles.

*The problem of gender-normativeness.* Regardless of whether profile similarity is analyzed on the level of observed or model-based interest profiles, psychological profiles inevitably contain a normative component (Borkenau & Leising, 2016; Furr, 2008; Wood & Furr, 2016). In the case of vocational interests, normativeness manifests itself in the pronounced differences between women and men (Su et al., 2009). For example, fathers and sons can be expected to be more similar than fathers and daughters, simply because they are both more likely to score high on male-typed interest scales (e.g., Realistic and adjacent scales). Consequently, on average, randomly paired same-sex dyads can be expected to be positively correlated, while randomly paired other-sex dyads can be expected to be negatively correlated. As we will argue in the upcoming sections, neglecting these normative profile components can lead to erroneous conclusions regarding the statistical significance of interest profile similarity of same-sex and other-sex dyads.

### 3.1.3 *Interest Similarity within Families*

Theoretically, there are several explanatory approaches from different fields of psychological research to explain why mothers and fathers on the one hand and parents and their children on the other hand should have similar vocational interests. While it is far beyond the scope of this study to disentangle these mechanisms, we want to briefly address the most plausible explanations before discussing the empirical findings.

*Interest similarity between parents.* Concerning interest similarity between parents, research on assortative mating and couple similarity suggests at least three plausible mechanisms

to explain why partners should have similar interests (Luo, 2017). First, interest similarity could be a result of initial selection, meaning that people choose partners who are psychologically similar to themselves. Second, interest similarity could be due to social homogamy. For example, couples that meet at the workplace or during their studies are likely to have similar interest profiles, because such environments typically comprise individuals with similar psychological characteristics (Schneider, 1987). Lastly, vocational interests of parents could be similar because their interests converge over the course of their partnership (Luo & Klohn, 2005).

Empirically, couple similarity has been found mainly for attitudes, values, and leisure interests, and less for personality traits (e.g., Gonzaga, Carter, & Buckwalter, 2010; Luo & Klohn, 2005; Watson et al., 2004). However, the question of whether or not vocational interests are a “match maker” remains unsettled. The only study so far to analyze interest similarity of mothers and fathers based on Holland’s interest typology was conducted by (Grotevant et al., 1977). Relying on both VCAs and PCAs, the authors found average profile correlations (APCs) between mothers and fathers to be small, positive, and not significantly different from zero ( $\bar{r} = .11$ ). However, as argued before, one would expect the APCs of randomly paired women and men to be negative, due to gender-normativeness. Bearing this in mind, the results of (Grotevant et al., 1977) might in fact indicate meaningful profile similarity between mothers and fathers.

*Interest similarity between parents and children.* Regarding parent-child interest similarity, there are, again, at least three plausible explanations for why their interests should be similar. First, parents shape the child-rearing environment to fit their own interests, thus providing specific environmental opportunities and limitations. The child’s interactions with this specific environment, and the people within it, should affect her or his vocational personality. Second, children tend to mimic adults they have either actively chosen as a role model, or for whose imitation they receive positive reinforcement (Bandura, 1986). Because the most plausible role models in childhood and early adolescence are the parents, children are likely to engage in and favor activities similar to those preferred by their parents. Lastly, nearly all psychological characteristics have been found to be heritable to some extent (e.g., Bouchard & McGue, 2003). Several studies show that vocational interests are no exception to this rule



(Betsworth et al., 1994; Moloney, Bouchard, & Segal, 1991).

Up to this day, only a few empirical studies have tackled the question of how similar RIASEC interests of parents and their children actually are. Thereby, interest associations have often been examined via VCAs, which fail to assess actual between-person similarity, or via specific kinds of PCAs that were, however, not optimal for several reasons. For example, Grandy and Stahmann (1974) and DeWinne et al. (1978) analyzed the correspondence of RIASEC types of parents and their children. In sum, they found correspondence between interest types for almost all parent-child dyads, but especially for father-child dyads. Although this typological approach can be considered person-centered, it reduces the multivariate profile to a single score (i.e., the highest score of the profile) and discards the remaining profile information. Moreover, vocational interests of parents were inferred from their actual occupations rather than being psychometrically assessed.

Grotevant et al. (1977) also analyzed interest similarity between parents and children in biological and adoptive families. To this end, they employed both VCAs (i.e., correlating interest trait scores of parents and children) and PCAs (i.e., correlating entire interest profiles). The authors found APCs in biological families to be positive for all parent-child dyads, while those in adoptive families were not significantly different from zero. However, just because the APC of, for example, mother-son dyads in adoptive families was not significantly different from zero, does not automatically imply that the APC of mother-son dyads from adoptive families could not be substantially larger than that of randomly paired mothers and sons. Such a finding would support either of the first two explanations for parent-child similarity stated above. In a more recent study, Holtrop et al. (2018) found normative and distinctive interest profiles of parent-child dyads to be positively correlated, while gender had no impact on parent-child interest similarity.

However, parent-child interest similarity was not analyzed separately for same-sex and other-sex parent-child dyads. Although the authors considered the normativeness problem by analyzing distinctive profile similarity, they did not calculate these distinctive profiles separately for male and female participants, which would have been necessary in order to thoroughly address gender-normativeness. After reviewing the existing body of literature on interest

similarity between couples on the one hand and parents and children on the other hand, it stands out that the question of whether or not the former could affect the inference about the latter has never been addressed. This is surprising, because neglecting mother-father similarity could obscure potentially differential associations of same-sex and other-sex parent-child dyads. For example, research has shown that adolescent children identify more with their same-sex parent than with their other-sex parent (Starrels, 1994). Consequently, if vocational interest development is at least partially influenced by social learning, this could also affect the inference about the similarity between the child and the same-sex and other-sex parent. In order to appropriately identify such differences, mother-father similarity must be accounted for.

### **3.2 The Present Investigation**

In the present study, we addressed three interrelated questions about interest profile similarity within families, while trying to overcome the aforementioned methodological challenges. To this end, we analyzed vocational interests of secondary school students and their parents. The students were at the stage of their education, where they had to decide which vocational or higher secondary education program to apply for. This phase is marked by the emerging disengagement from the parents and the search for a (vocational) identity.

The first two questions involved the examination of interest profile similarity between mothers and fathers as well as between parents and children. Results of previous research concerned with these questions have been equivocal and could be challenged for methodological reasons. As argued above, a thorough analysis of interest profile similarities should explicitly consider 1) the entire interest profile, 2) the underlying circular ordering of the scales that define it, and 3) gender-normativeness, as well as the challenges these specificities pose for the statistical evaluation of these similarities.

Consequently, we hypothesized that randomly paired same-sex dyads (fathers and sons, mothers and daughters) would have similar interest profiles, as indicated by positive, non-zero APCs. Furthermore, interest profiles of corresponding dyads within families were expected to be even more similar, resulting in even larger APCs. Likewise, we expected interest profiles of

randomly paired other-sex dyads (mothers and fathers, mothers and sons, fathers and daughters) to be rather dissimilar, as indicated by negative, non-zero APCs. Again, interest profiles of corresponding dyads within families were expected to be more similar, as indicated by larger APCs.

Finally, we examined whether or not accounting for mother-father interest similarity affected the inference about parent-child interest similarity. If, for example, vocational interest profiles of mothers and sons within real families were significantly more similar than those of randomly paired mothers and sons, there could be two alternative explanations for this finding. First, a mechanism of interest development could directly cause mother-son interest similarity (e.g., social learning or genetics). Second, mother-son interest similarity could be caused indirectly because both the interest profiles of fathers and sons (e.g., due to a developmental mechanism) as well as those of mothers and fathers (e.g., due to assortative mating) are similar.

If scenario one is true, then accounting for mother-father similarity should not affect the APC of the randomly paired mothers and sons at all. However, if scenario two is true, then accounting for mother-father similarity should systematically affect the APC of the randomly paired mothers and sons. In our study, we approached this question indirectly. That is, we examined whether or not accounting for mother-father similarity in the random pairing procedure changed the reference APC to such a degree that it affected the inferences drawn. In the absence of a sound empirical basis for favoring either of the two alternative scenarios, we addressed this issue as an open research question. Throughout our study, we examined the aforementioned questions on the level of observed interest profiles, as well as on the level of model-based circumplex profiles. Because there is sound empirical evidence for the validity of the circumplex model (e.g., Nagy et al., 2010), we expected the interest similarity indices on both levels of analysis to be very similar. Such a finding would further support the validity of the circumplex model of vocational interests, because it would mean that the model-based profiles capture the essential information contained in the observed profiles.

### 3.3 Method

#### 3.3.1 *Participants and Procedure*

Data were taken from the Transformation of the Secondary School System and Academic Careers - Grade 10 (TOSCA-10) study in Germany (Trautwein et al., 2010). The full sample consisted of  $N = 3,047$  tenth graders from secondary schools. Parents were asked to complete a separate questionnaire at home. We excluded participants whose parents did not answer any items on the interest scales, leaving us with a final sample of  $N = 1,624$ .

Differences in the RIASEC scale scores of excluded and included participants were negligible across all scales ( $|\hat{d}| \leq 0.17$ , median  $|\hat{d}| = 0.08$ ). Students who remained in our sample were slightly younger ( $\hat{d} = -0.31$ ), had higher cognitive abilities ( $\hat{d} = 0.39$ ), and better grades ( $0.14 \leq \hat{d} \leq 0.27$ ). The proportion of female participants was 54%. Students' average age was  $M = 16.7$  years. Analyses were conducted on  $N = 1,231$  mother-father dyads,  $N = 853$  mother-daughter dyads,  $N = 709$  mother-son dyads,  $N = 686$  father-daughter dyads, and  $N = 601$  father-son dyads.

#### 3.3.2 *Measures*

*General Interest Structure Test (GIST)*. The GIST (Bergmann & Eder, 2005) is an instrument that is used to assess vocational interests according to Holland's RIASEC model. There is clear evidence for the structural and external validity of the instrument in Germany (Nagy et al., 2010; Volodina & Nagy, 2016). Participants were asked to rate how much they like certain activities on a 5-point Likert scale (1 = *strongly dislike* to 5 = *strongly like*). In this study, a shorter 30-item version of the GIST was used. Despite the lower item number per scale, the internal consistencies were satisfactory throughout the six scales (Cronbach's  $\alpha = .68$  to  $\alpha = .82$  in the subsamples).

#### 3.3.3 *Statistical Analyses*

*Circumplex structure*. The first step in our analyses was to investigate the structure of interests in our sample. To this end, we used the confirmatory cosine function model (CFM)

proposed by Nagy et al. (2009), in which the covariance between two RIASEC scores  $y_j$  and  $y_k$  is modeled as:

$$\text{Cov}(y_j, y_k) = \zeta_j \times [\beta_0 + \beta_1 \times \cos(\theta_j - \theta_k)] \times \zeta_k, \quad (2)$$

where  $\zeta_j$  and  $\zeta_k$  indicate scale-specific scaling parameters,  $\beta_0$  and  $\beta_1$  are the parameters of the correlation function to be estimated ( $\beta_0 + \beta_1 = 1$ ,  $\beta_0 > 0$ , and  $\beta_1 > 0$ ), and  $\theta_j$  and  $\theta_k$  are the angular positions of the scales. This model is a special case of the stochastic process model proposed by Browne (1992) and is discussed in detail in Nagy et al. (2009). In the present application, the  $\theta$  parameters were fixed to resemble a perfectly equidistant circumplex and the scaling parameters  $\zeta$  were set to be equal across all scales. Model fit was assessed using the Mplus 7.4 software (Muthén & Muthén, 1998-2014) with the TYPE=COMPLEX option to account for clustering in families. Goodness-of-fit indices were evaluated against the cut-off values recommended by Marsh, Hau, and Wen (2004).

*Calculation of model-based profiles.* In order to compute the model-based profiles, the RIASEC scales were standardized using the metric defined by the parent subsample. To account for the different sample sizes of mothers and fathers, we weighted the sample means and standard deviations accordingly. We then used ordinary least squares multiple regressions with the cosine and sine of the theoretical scale positions ( $0^\circ, 60^\circ, \dots, 300^\circ$ ) as fixed predictors to calculate the model-based profile and the SSM parameters for each individual in our sample (Gurtman, 1996). A detailed description of this procedure is presented in the online supplemental materials of this article.

*Calculation of interest similarity.* While there are several approaches to assess similarity between two psychological profiles (e.g., profile covariances or profile correlations, specific decompositions thereof [Furr, 2008], or measures of spatial profile distance [Cronbach & Gleser, 1953]), the use of profile correlations is an obvious choice when it comes to assessing similarity between vocational interest profiles. The main reason for this is that the SSM provides a model for assessing the correlation between two model-based interest profiles that is merely a function of the central parameters of the respective interest profiles: the profile

orientations. Consequently, for each dyad in our sample, we calculated the Pearson product-moment correlation between the two standardized observed profiles, as well as that between the corresponding model-based profiles. As recommended by Silver and Dunlap (1987), the correlations were then transformed to Fisher's  $z$  scores, averaged across the sample (for each dyad type), and retransformed to the  $r$ -metric afterwards.

*Evaluation of interest similarity.* In order to ensure an adequate evaluation of the statistical significance of these profile similarity indices, we relied on a so-called pseudo-couple approach (Furr, 2008; Kenny et al., 2006). This was necessary because we expected the APCs of randomly paired family members to be different from 0, due to gender-normativeness. Following this approach, a suitable reference distribution is found by creating a sufficient number (in our case, 1,000) of randomly reorganized pseudo-family datasets. Within each pseudo-family dataset, the children were randomly paired with a new mother and a new father, each from a different dyad than in the real-family dataset. Furthermore, the randomization was restricted to the extent that every daughter (or son) was matched with a random mother and a random father, who also had a daughter (or son) in the real-family dataset, to control for possible influences of the child's gender on parent-child similarity.

We then calculated the APCs for each dyad type in each of the 1,000 pseudo-family datasets, thus obtaining empirical distributions for these similarity measures. The means of these empirical distributions constitute suitable reference values that implicitly take gender-normativeness into account. For example, if randomly paired mothers and sons truly had, on average, rather dissimilar profiles, the respective empirical distribution would be centered around a negative value. Moreover, the 0.5% and 99.5% quantiles of the empirical distributions serve as the upper and lower boundaries of 99% confidence regions for these APCs. Consequently, if an APC from a real-family dyad fell outside this region, (i.e., if it was larger than the upper limit of this interval), we would conclude that the interest profiles for this specific dyad were substantially more similar than would be expected by chance.

Finally, in order to account for the similarity between the parents' interest profiles, we proceeded almost exactly as described above, while placing further constraints on the resampling process. Specifically, we split the data across different levels of mother-father profile similarity

Table 1: Correlation Matrix of RIASEC Scales in the Full Sample.

	R	I	A	S	E	C
R	(.79)					
I	.38	(.75)				
A	.08	.51	(.74)			
S	-.03	.26	.45	(.79)		
E	.19	.31	.34	.49	(.77)	
C	.29	.28	.18	.31	.51	(.77)

*Note.* Internal consistencies (Cronbach's  $\alpha$ ) of the scales in the full sample are reported in parentheses.

and repeated the resampling procedure within these intervals. For example, for mother-child similarity, the datasets were split across different levels of profile similarity between the real fathers and mothers. Consequently, the randomly assigned mothers were roughly as similar to the real fathers as were the real mothers. We thus obtained reference distributions of mother-child APCs, conditional on mother-father profile similarity. Mother-father dyads with extreme profile similarities were excluded because there were too few cases to resample in these groups ( $N = 37$ ). A formal description of this rationale is presented in the online supplemental materials. All analyses described in this section were conducted using self-written functions in R (version 3.3.1; R Core Team, 2018).

## 3.4 Results

### 3.4.1 Circumplex Structure

The first step in our analyses was to evaluate the structural validity of the circumplex model in our sample. Table 1 shows the correlation matrix of the RIASEC scales in the full sample. The intercorrelations closely resembled the typical pattern implied by the circumplex structure (e.g., Gurtman & Balakrishnan, 1998). That is, for each scale, there was a pattern of decreasing correlations mirroring the increasing distance of the scales on the circumplex. Passing the scales that are on the opposite side of the circumplex, the correlations increased again. In order to assess the fit of the model-implied correlation pattern, the cosine function model (CFM; Nagy et al., 2009) was fitted to the data. Despite the highly specific constraints of the CFM (i.e., fixed scale

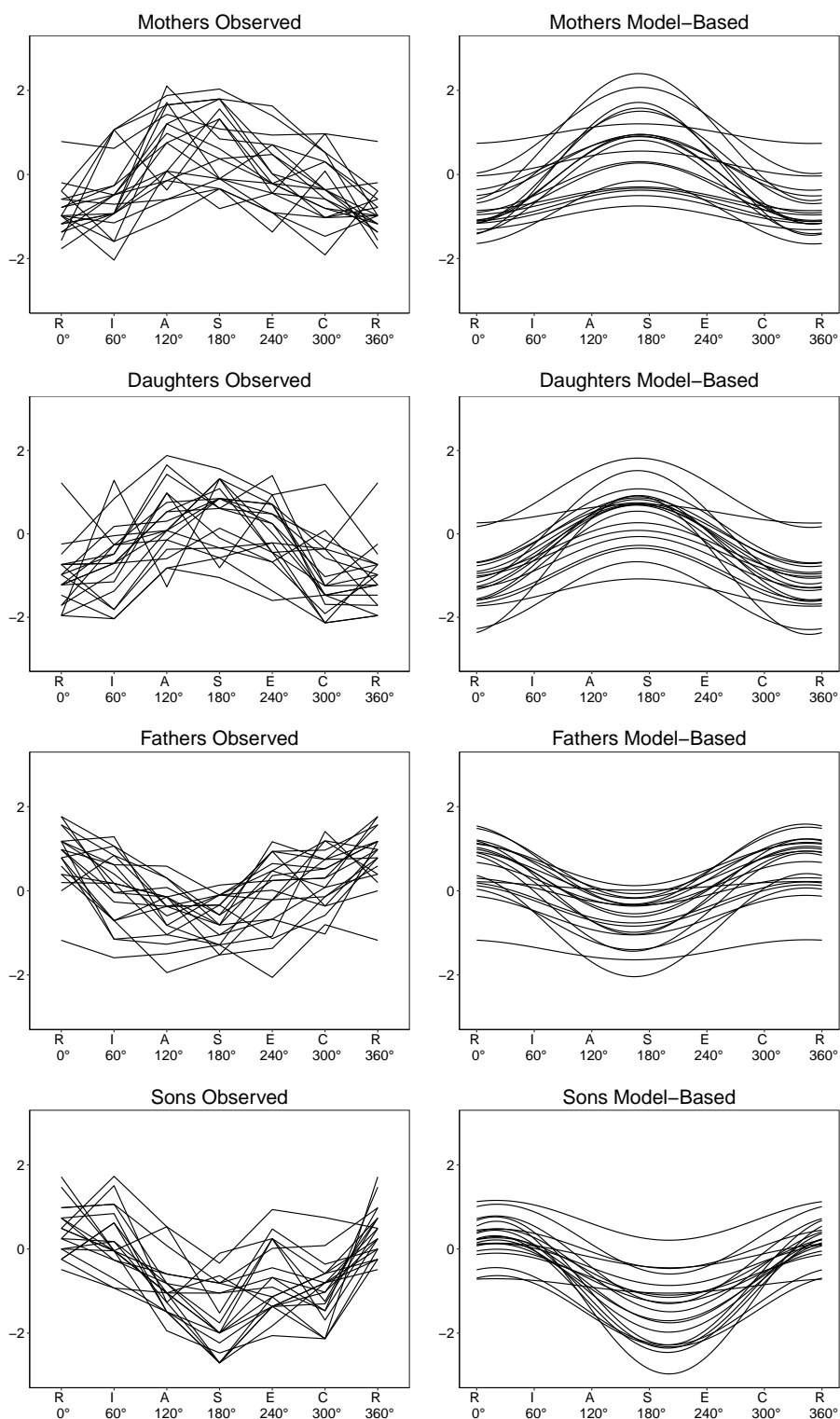


Figure 2: Line plots for prototypical mother, father, daughter and son profiles. Left side: Standardized observed profiles; Right side: Model-based profiles.

positions and equal scaling factors), model fit was satisfactory ( $\chi^2(13, N = 4,545) = 428.25$ ,  $p = .00$ ; CFI = .924; RMSEA = .084), thus supporting the validity of the postulated circumplex



structure.

As argued above, the validity of the circumplex structure has direct implications for individual interest profiles. That is, it warrants the application of the SSM to obtain model-based interest profiles. To visualize the appropriateness of this approach, Figure 2 displays the observed (left side) and the model-based (right side) profiles of 20 individuals from each group (mothers, fathers, sons, and daughters). As can be seen, the model-based profiles closely resembled the observed profiles, especially with regard to central characteristics (e.g., profile shape and scatter). Correlations between model-based and observed profiles across all participants were very high ( $\bar{r} = .79$ ). In Figure 2, we specifically chose individuals who had profile orientations close to the respective profile orientation group mean, in order to demonstrate the importance of the gender-normativeness problem. Clearly, the prototypical profiles of same-sex individuals were very much alike, while those of other-sex individuals were highly dissimilar. The descriptive statistics of the SSM parameters for each group can be found in the online supplemental materials.

### 3.4.2 *Univariate Scalewise Associations*

We first examined the bivariate correlations between corresponding observed RIASEC scores (first supercolumn of Table 2). Interest scale scores of mothers and fathers were highly correlated ( $.36 \leq r \leq .56$ ), while those of parents and children were, if at all, only weakly correlated ( $.00 \leq r \leq .25$ ). However, because this procedure corresponds to a VCA, these results do not convey information about the similarity between the interest profiles of the respective dyads. Furthermore, these bivariate correlations confound associations between theoretically meaningful profile components (e.g., profile orientation) with those attributable to less important aspects of the profile (e.g., profile elevation).

To address this problem, we display the associations between the respective SSM parameters in the second supercolumn of Table 2. For mothers and fathers, we found that a large part of the scale-level associations was attributable to the high correlation between profile mean levels ( $\tau$ ;  $r = .68$ ). Corresponding correlations between parent-child dyads were small or not significant ( $.01 \leq r \leq .19$ ). Regarding profile differentiation ( $\alpha$ ), correlations between all dyad types were

Table 2: Correlations between Observed Scale Scores and SSM Parameters

Dyad Type	Scale Scores						SSM Parameters		
	R	I	A	S	E	C	$\tau$	$\alpha$	$\overline{\Delta}_\delta$
Mother-Father	.36*	.56*	.53*	.52*	.55*	.38*	.68*	.13*	82.7°
Mother-Son	.10*	.12*	.10*	.00	.05	.08*	.01	.12*	89.1°
Mother-Daughter	.16*	.19*	.25*	.14*	.13*	.10*	.15*	.15*	59.3°
Father-Son	.21*	.22*	.14*	.09*	.02	.08	.05	.13*	71.2°
Father-Daughter	.21*	.19*	.20*	.18*	.16*	.01	.19*	.02	102.9°

Note.  $\tau$  = profile elevation;  $\alpha$  = profile differentiation;  $\overline{\Delta}_\delta$  = angular mean of difference between profile orientations. \* $p < .05$ .

small or not significant ( $.02 \leq r \leq .15$ ). Lastly, the angular means of the differences in profile orientations (scaled from  $0^\circ$  to  $180^\circ$ ) were smaller for same-sex dyads ( $59.3^\circ \leq \overline{\Delta}_\delta \leq 71.2^\circ$ ) than for other-sex dyads ( $82.7^\circ \leq \overline{\Delta}_\delta \leq 102.9^\circ$ ). Taken together, these results suggest that there are meaningful associations between interest profiles within families and emphasize the need to take the entire profile into account.

### 3.4.3 Interest Profile Similarity

The next step aimed to overcome the abovementioned limitations of VCAs by moving on to the analyses of interest profiles. The upper part of Table 3 presents the APCs for the real-family dyads, as well as the means and the limits of the interval containing 99% of the corresponding APCs from the resampling distributions for both the observed profiles (left) and the model-based profiles (right). As expected, randomly paired same-sex dyads yielded substantially positive APCs, while randomly-paired other-sex dyads yielded substantially negative APCs. Moreover, the APCs in the real-family dataset were all significantly larger than those obtained for the pseudo-families.

*Observed profiles.* For mother-father dyads, the observed APC was  $\bar{r}_{M,F} = .18$ , while random pairing yielded an APC of  $\bar{r}_{M,F}^{\text{pseudo}} = -.18$ . Although APCs of other-sex parent-child dyads found in the real-family dataset were close to zero and negative ( $\bar{r}_{M,S} = -.02$  and  $\bar{r}_{F,D} = -.07$ ), they were still significantly larger than would be expected by chance ( $\bar{r}_{M,S}^{\text{pseudo}} = -.15$  and  $\bar{r}_{F,D}^{\text{pseudo}} = -.21$ ). For same-sex dyads, APCs of pseudo-families were positive and of moderate

Table 3: Average Profile Correlations for Observed and Model-Based Profiles

Dyad Type	Observed Profiles			Model-Based Profiles		
	$\bar{r}$	$\bar{r}^{\text{pseudo}}$	99% PL	$\bar{r}$	$\bar{r}^{\text{pseudo}}$	99% PL
<i>Before accounting for mother-father profile similarity</i>						
Mother-Father	.18	-.18	[-.22, -.14]	.17	-.34	[-.43, -.26]
Mother-Son	-.02	-.15	[-.19, -.10]	.02	-.20	[-.33, -.09]
Mother-Daughter	.35	.19	[.15, .23]	.62	.45	[.36, .54]
Father-Son	.29	.11	[.06, .17]	.44	.19	[.05, .33]
Father-Daughter	-.07	-.21	[-.25, -.16]	-.32	-.50	[-.58, -.40]
<i>After accounting for mother-father profile similarity</i>						
Mother-Son	-.04	-.08	[-.16, -.02]	-.03	-.11	[-.27, .07]
Mother-Daughter	.34	.19	[.13, .25]	.60	.42	[.29, .54]
Father-Son	.30	.13	[.04, .20]	.46	.22	[.04, .37]
Father-Daughter	-.08	-.13	[-.19, -.07]	-.34	-.37	[-.48, -.25]

Note.  $\bar{r}$  = Average profile correlations for real families;  $\bar{r}^{\text{pseudo}}$  = Average profile correlation for pseudo-families. 99% PL = lower (= .005 percentile) and upper (= .995 percentile) limits of the empirical distributions for the respective APCs.

size ( $\bar{r}_{\text{M,D}}^{\text{pseudo}} = .19$  and  $\bar{r}_{\text{F,S}}^{\text{pseudo}} = .11$ ). However, APCs of real families were significantly larger ( $\bar{r}_{\text{M,D}} = .35$  and  $\bar{r}_{\text{F,S}} = .29$ ).

Taken together, our findings were fully in line with our expectations. Furthermore, they underline the need to consider gender-normativeness when evaluating the statistical significance of interest profile similarities. The largest difference between APCs of real and randomly paired dyads was found for mothers and fathers ( $\Delta\bar{r} = .36$ ). The differences between APCs of real and randomly paired parent-child dyads were smaller and of comparable size ( $.13 \leq \Delta\bar{r} \leq .18$ ).

*Model-based profiles.* The findings for the model-based interest profiles (upper right part of Table 3) were consistent with those on the level of observed profiles. The absolute values of the model-based APCs were somewhat larger than those of the observed APCs. However, this can be explained by the variance reduction that goes along with the transition from the observed to the model-based profiles (comparable to the variance reduction in latent variable modeling, where variance caused by measurement error is removed). If the covariances stay roughly the same and the variances decrease, the correlations inevitably become larger. Indeed,

when we looked at the average profile covariances, we did not find such pronounced differences.

As argued above, correlations between model-based profiles are a function of the difference between profile orientations. We thus provide the angular means of the smallest separating angles between profile orientations for all dyad types in the right most column of Table 2. The angular means of real-family dyads were significantly smaller (i.e., the profiles were significantly more similar) than the respective angular means from the resampling distributions. A graphical approach that facilitates a better understanding of the differences in profile orientations between real families and pseudo-families is presented in the online supplemental materials.

In summary, our findings further underline the validity of the circumplex model of vocational interests. Specifically, they confirm that the model-based profiles contain the essential information about the raw interest profiles. This argument is further supported by the high correlations between the observed and the model-based profile similarities (by means of profile covariances) across all dyad types ( $.85 \leq r_{\text{obs,mod}} \leq .92$ ).

#### 3.4.4 *Accounting for Parent Similarity*

The final set of analyses tackled the question of whether or not the inference about interest similarity between parents and their children was affected by the interest similarity between mothers and fathers. We argued that if parent-child similarity was caused by a dyad-specific developmental mechanism, accounting for mother-father similarity should not affect the inference about parent-child similarity (see The Present Investigation). Although such a finding would not be sufficient to prove the existence of a causal mechanism, it would be a *sine qua non* that would pave the way for subsequent research on cause and effect of parent-child interest similarity.

The lower part of Table 3 presents the results for every parent-child dyad type on the level of observed (left side) and model-based profiles (right side). APCs of same-sex parent-child dyads from real families ( $\bar{r}_{M,D} = .34$  and  $\bar{r}_{F,S} = .30$ ) were, again, significantly larger than those from pseudo-families ( $\bar{r}_{M,D}^{\text{pseudo}} = .19$  and  $\bar{r}_{F,S}^{\text{pseudo}} = .13$ ). However, APCs of other-sex parent-child dyads from real families ( $\bar{r}_{M,S} = -.04$  and  $\bar{r}_{F,D} = -.08$ ) were no longer significantly different from those obtained in pseudo-families ( $\bar{r}_{M,S}^{\text{pseudo}} = -.08$  and  $\bar{r}_{F,D}^{\text{pseudo}} = -.13$ ). Again, the results

were basically identical for the model-based profiles. Taken together, our findings indicate that only same-sex parent-child dyads are, on average, more similar to each other than would be expected by chance, when mother-father similarity is accounted for. Consequently, interest similarity between other-sex parent-child dyads appears to be traceable to the similarity between the interests of mothers and fathers.

### **3.5 Discussion**

The research presented in this article aimed to extend the understanding of intrafamily similarities in vocational interests. To this end, we identified two major methodological limitations of previous research on this topic and demonstrated the challenges they pose for analyzing profile similarity. We then combined well-established methodological means to overcome them. Specifically, we used the SSM (Gurtman & Balakrishnan, 1998) to explicitly consider the circumplex structure underlying the vocational interest scales. In doing so, we were able to assess interest profile similarity as a function of the profiles' central parameter: profile orientation. Furthermore, we used a person-centered pseudo-couple approach to adequately account for systematic differences between interests of women and men, thus taking the gender-normativeness problem into account. In sum, our findings suggest that mothers and fathers on the one hand and parents and their children on the other hand have substantially similar interest profiles. However, we also found indications that the reasons for these similarities might be different for same-sex and other-sex parent-child dyads.

#### *3.5.1 Interest Similarity between Parents*

The first major finding of our study was that interest profiles of mothers and fathers are substantially more similar than those of randomly paired women and men. Moreover, mother-father similarity was noticeably larger than parent-child similarity. Due to the cross-sectional research design, we could not disentangle whether these similarities were due to assortative mating or were a result of couples becoming more similar over time. However, several studies that analyzed couple similarity with conceptually related constructs suggest that couple similarity

is stable (Caspi, Herbener, & Ozer, 1992) and that couples are similar even before they meet (Gonzaga et al., 2010). Consequently, we suspect that mother-father interest similarity is due to active selection or social homogamy, rather than convergence. However, more research is needed to ultimately decipher these mechanisms.

### 3.5.2 *Interest Similarity between Parents and Children*

For parent-child interest similarity, the moderately sized positive correlations between corresponding RIASEC scale scores were comparable to those of parent-child personality trait similarity (Prinz et al., 2004). Interest profiles of all parent-child dyads were more similar than those of corresponding randomly paired parents and children. However, the finding that only same-sex parent-child dyads were significantly more similar to each other when mother-father similarity was accounted for suggests that the reasons for why these similarities occur might be different for same-sex and other-sex parent-child dyads.

One possible explanation could be that children's vocational interest development is substantially shaped by social learning (e.g., Lent et al., 1994) and that the same-sex parent is the primary source of identification. Support for this assumption can be found in the work of Starrels (1994), who demonstrated that adolescent children identify more strongly with their same-sex parent. Moreover, (Holtrop et al., 2018) showed that children, when asked to choose a parent whose interests they were supposed to rate, tend to select the same-sex parent rather than the other-sex parent. Thus, there is some empirical support for differences in identification with the same-sex and the other-sex parent, but further examinations of the associations between identification and interest development were beyond the scope of our study. Future research could pursue longitudinal research designs that also incorporate measures of parental identification to address this research gap.

At this point, we want to stress that the similarities reported here are average profile similarities. Consequently, we do not wish to claim that the other-sex parent could not possibly influence the development of the same-sex child's vocational interests. In our analyses, we found considerable variability in interest similarities. That is, there were families in which sons and daughters were very similar to their other-sex parent and not so much to their same-sex parent.

Future research could investigate the mechanisms underlying this variability more thoroughly by identifying moderators of parent-child interest similarity.

### 3.5.3 *Methodological Advances and Opportunities*

From a methodological point of view, our results provide additional support for the validity of the circumplex structure underlying Holland's model of vocational interests. That is, we were able to show that the model-based interest profiles, as calculated via the SSM, capture the essential information contained in the observed profiles. This conclusion is supported by the strong correspondence between observed and model-based interest profiles on the one hand and the strong concordance between the similarities calculated from observed and model-based interest profiles on the other hand.

Furthermore, adopting the perspective of circular interest profiles enabled us to identify crucial methodological challenges that severely limit the validity of previous findings on interest profile similarity. Specifically, the typical assumption that randomly pairing individuals would result in a zero correlation between the characteristics in question is erroneous in the case of vocational interest profile similarity, where, due to the pronounced gender differences (Su et al., 2009), high similarity (dissimilarity) and, thus, a high (low) APC can be expected even between randomly paired same-sex (other-sex) dyads.

Most importantly, the features outlined above are not limited to the analysis of similarity between vocational interest profiles. Instead, they are relevant whenever dyadic associations between psychological constructs that exhibit a circumplex structure, for example, interpersonal behavior (Wiggins, 1979) or affect (Russell, 1980), are examined and whenever the two subsamples that define the dyad differ systematically with regard to profile orientation. For example, Gurtman (2009) reviewed sex differences in interpersonal behavior and found systematic differences between women and men. Consequently, researchers concerned with the analysis of the similarity between profiles of interpersonal behavior should be wary of similarity (dissimilarity) that is merely due to individuals having the same (a different) gender.

### 3.5.4 *Limitations and Future Directions*

The sample used in this study was selective to the extent that it was limited to German secondary school students and their parents. Furthermore, the sample was positively selected because parents of higher achieving and more intelligent students were more likely to fill out the parent questionnaire. In order to generalize our findings, more data from families from different countries with different cultural, social, and educational backgrounds would be required. Moreover, it would be interesting to analyze parent-child interest similarity with children in different developmental phases.

Finally, our data were collected at one point in time, limiting the scope of our analyses to cross-sectional associations. Although vocational interests are considered to be relatively stable across the lifespan (Low et al., 2005), they are — just like personality traits — susceptible to change (Xu & Tracey, 2016). This is especially true for early adulthood and adolescence, where children are still in search of a (vocational) identity. Thus, to gain further insights into the mechanisms underlying interest development, it would be necessary to analyze the covariation of interest profile trajectories between parents and their children across time. Whether interest profile similarity of parents and their children becomes larger, smaller, or does not change at all from early childhood to late adolescence is an interesting question that has not been addressed this far.

### 3.5.5 *Conclusion*

Taken together, our study introduces a novel methodological approach for examining interest profile similarity. By combining the SSM (Gurtman & Balakrishnan, 1998) and the pseudo-couple technique (Kenny et al., 2006), we were able to assess interest similarity directly as the correspondence between preferred activities and to evaluate these similarities with adequate reference distributions that indirectly account for gender-normativeness and mother-father similarity. Using this approach, we were able to show that there are substantial similarities between vocational interest profiles of mothers and fathers, and between those of all parent-child dyads. Our findings suggest that interest profile similarity between same-sex parent-child dyads could



be due to specific developmental processes, while the similarity between other-sex parent-child dyads might be attributable to the similarity between the parents.

## Appendix A: Online Supplemental Materials

### *Calculation of Structural Summary Method Parameters*

In this paragraph, we explicate the computation of the model-based interest profiles by means of applying the structural summary method (SSM) to the standardized observed scale scores Gurtman and Balakrishnan (1998). Therefore, let  $i$  be the index for persons and  $j$  the index for the scales (R, I, A, etc.). Furthermore, let  $\theta_j$  be the angular position of scale  $j$  on the circumplex, with Realistic as reference scale in the three o'clock position ( $\theta_R = 0^\circ$ ). The model-based profile scores  $\hat{y}_{ij}$  are then modeled as:

$$\hat{y}_{ij} = \tau_i + \cos(\theta_j) \times PT_i + \sin(\theta_j) \times DI_i = \tau_i + \alpha_i \times \cos(\theta_j - \delta_i) \quad (\text{A1})$$

Consequently,  $\hat{y}_{ij}$  can be expressed as a function of the profile mean level ( $\tau_i$ ) and either 1) the scores on the two circumplex axes People-Things ( $PT_i$ ) and Data-Ideas ( $DI_i$ , see also the next section) weighted by the cosine and sine of the angular position of scale  $j$  on the circumplex ( $\theta_R = 0^\circ$ ,  $\theta_I = 60^\circ$ ,  $\theta_A = 120^\circ$ , etc.), or, equivalently, 2) profile differentiation ( $\alpha_i$ ) and profile orientation ( $\delta_i$ ). In either notation, the complexity of the interest profile is reduced to three person parameters. The two notations can be converted into each other using the following formulae and the respective inverse functions:

$$\delta_i = \arctan2\left(\frac{DI_i}{PT_i}\right) \times \frac{180}{\pi} \quad (\text{A2})$$

$$\alpha_i = \sqrt{PT_i^2 + DI_i^2} \quad (\text{A3})$$

In order to obtain the parameters from the standardized observed scale scores, an ordinary least squares (OLS) multiple linear regression model is fit for every person. Specifically, the vector of standardized observed scale scores  $y_{ij}$  is used as the dependent variable, while the cosine and sine of the scale positions on the circumplex ( $\theta_j$ ) are used as two fixed predictors. The intercept of this regression is equal to the profile elevation ( $\tau_i$ ), while the two regression

Table A1: Sample Descriptive Statistics of Axes Scores and SSM Parameters

	P-T		D-I		$\tau$		$\alpha$		$\delta$	
	M	SD	M	SD	M	SD	M	SD	M	SD
Mothers	-.34	.46	.09	.54	-.04	.66	.69	.39	169.8°	66.8°
Fathers	.33	.50	-.09	.55	.04	.68	.73	.36	343.8°	64.6°
Daughters	-.56	.54	.10	.59	-.28	.55	.89	.40	20.2°	47.3°
Sons	.23	.56	.10	.54	-.39	.57	.73	.37	168.6°	80.2°

*Note.* P-T = People-Things axis; D-I = Data-Ideas axis;  $\tau$  = profile elevation;  $\alpha$  = profile differentiation;  $\delta$  = profile orientation. Mean and SD of  $\delta$  correspond to angular mean and angular variance, as defined by Mardia & Jupp (2000).

weights are equal to the axes-scores ( $PT_i$  and  $DI_i$ ). These can then be transformed to profile orientation ( $\delta_i$ ) and profile differentiation ( $\alpha_i$ ), using the formulae presented above. In Table A1, we display the descriptives of the SSM parameters for each group in our sample.

Naturally, individual profiles will vary in their degree of fit to the proposed cosine function. In the SSM, the goodness-of-fit is indicated by the  $R^2$  measure of the respective OLS regression (Gurtman & Pincus, 2003). Although higher degrees of misfit (a common cutoff is  $R^2 < .70$ ) are said to result in unstable estimates of the underlying parameters (Wright et al., 2009), the extent to which model-based profiles with less optimal fit are nevertheless able to capture the essence of the observed profiles is unclear. In our study, we found that the similarities calculated from observed and model-predicted profiles still correlated highly when only dyads with model-based profiles that did not show a very good fit to the cosine function (i.e., both  $R^2 < .70$ ) were considered. This means that although a suboptimal fit to the sinusoidal form might reduce the reliability of the SSM parameters (Wright et al., 2009), they are still valid to the extent that they capture the essential profile information.

### *Dimensions Underlying the Interest Circumplex*

As an additional note to the structural model, we want to add that there is strong consent that the underlying two-dimensional structure, that is spanned by the orthogonal axes People-Things and Data-Ideas, is the core element of the interest circumplex (Prediger, 1982). The People-Things axis is spanned by the Social and Realistic scales, indicating a preference for interpersonal

Table A2: Correlations between Circumplex Dimensions

Dyad Type	People-Things	Data-Ideas
Mother-Father	0.29*	0.41*
Mother-Son	0.17*	0.19*
Mother-Daughter	0.16*	0.24*
Father-Son	0.22*	0.19*
Father-Daughter	0.20*	0.17*

\*  $p < .05$ .

versus impersonal activities. The Data-Ideas axis is orthogonal to the People-Things axis and differentiates between preferences for highly structured, data-driven tasks versus unsystematic tasks that involve theorizing, creativity, and abstraction. Consequently, the six Holland types can be interpreted as different blends of the axes' poles. Moreover, as shown in Equation A1, the SSM can be used to obtain individuals' scores on these two dimensions.

Because the analyses in our study focused on the, in our opinion, theoretically more meaningful transformations of these dimensional scores (i.e., profile differentiation  $\alpha$  and profile orientation  $\delta$ ), we did not report the associations between the intrafamily dyads' axes scores in the main manuscript. Nevertheless, for the sake of completeness, we present the respective correlations in Table A2. As can be seen, both People-Things scores as well as Data-Ideas scores were positively correlated for all dyads types. In line with our other findings, these correlations were largest for mother-father dyads and somewhat smaller, but of comparable size, for all parent-child dyads.

### *Statistical Evaluation of Profile Similarity*

The following paragraphs are intended to provide a more formal demonstration of our methodological rationale for evaluating the statistical significance of average profile correlations (APCs). Furthermore, we will elaborate on the approach we used to analyze parent-child interest similarity while accounting for the similarity between interest profiles of mothers and fathers. To this end, we will exemplarily demonstrate our approach for mother-son dyads. Of course, the rationale is identical for all other dyad types. Hereafter, mothers are denoted as  $M$

and sons as  $S$ .

The hypotheses analyzed in the first analyses were:

$H_0$ : The average profile similarity between mothers and sons within real families is equal to that of corresponding dyads from randomly paired families.

$H_1$ : The average profile similarity between mothers and sons within real families is not equal to that of the corresponding dyads from randomly paired families.

These translate into the following statistical hypotheses:

$$H_0: E(r_{M,S}) = E(r_{M,S}^{pseudo})$$

$$H_1: E(r_{M,S}) \neq E(r_{M,S}^{pseudo})$$

Using the pseudo-coupling approach, we obtained empirical distributions of the APCs across the 1000 resampling datasets for each of the five dyad types (mother-father, mother-son, etc.). The decision concerning whether or not to reject the respective  $H_0$  was based on the following rule: Determine the 0.5% and 99.5% quantiles of the empirical distributions of the average similarity measures across the 1000 pseudo-family datasets. Reject the respective  $H_0$  if the corresponding APC from the real family dataset falls outside the limits of this confidence region.

In the second set of analyses, we intended to account for the similarity between parents' interest profiles. Specifically, we considered mother-father similarity in our resampling procedure, so that the APCs from the real-family dyads were identical (and thus comparable) to those obtained in the previous analyses. Here, we additionally denote fathers as  $F$ . Consequently, the statistical hypotheses are as follows:

$$H_0: E(r_{M,S}) = E(r_{M,S}^{pseudo}) | f(\text{Cov}_{M,F})$$

$$H_1: E(r_{M,S}) \neq E(r_{M,S}^{pseudo}) | f(\text{Cov}_{M,F})$$

That is, we evaluated the average profile similarity of mothers and sons, conditional on the similarity between the interest profiles of the parents. In order to obtain an appropriate estimate for  $E(r_{M,S}^{pseudo}) | f(\text{Cov}_{M,F})$ , we approximated the continuous distribution  $f(\text{Cov}_{M,F})$  by a discrete histogram distribution. Therefore, the distribution of mother-father profile covariances was split into  $K$  bins of equal width (in our case, a bin width of 0.1). We used the profile covariances and not the profile correlations because, in the case of model-based profiles, the

latter are slightly inflated due to the variance reduction. The relative bin occupancy in bin  $k$  is written as  $\pi_k$  ( $\sum_{k=1}^K \pi_k = 1$ ).

In the next step, we calculated the mother-son APCs within each of the  $K$  bins ( $\bar{r}_{kM,S}^{pseudo}$ ). The final step was to estimate  $E(r_{M,S}^{pseudo})|f(\text{Cov}_{M,F})$  by averaging the bin-wise APCs ( $\bar{r}_{kM,S}^{pseudo}$ ) from the previous step, while using the relative bin occupancy  $\pi_k$  obtained in the first step as weights:

$$E(r_{M,S}^{pseudo})|f(\text{Cov}_{M,F}) \approx \sum_{k=1}^K \pi_k \times \bar{r}_{kM,S}^{pseudo} \quad (\text{A4})$$

This approach was repeated for each of the 1000 datasets. We thus obtained an empirical distribution for the APC of the randomly paired mother-son dyads, while taking mother-father similarity into account. Just like in the previous analyses, the respective APC from the real family dataset was considered significantly different from what would be expected by chance, if it fell outside the 99% confidence region.

### *Illustration of Differences in Profile Orientation*

A key strength of the SSM is the possibility to express profile similarity in terms of differences in profile orientations. In other words, profile similarity can be assessed by the smallest separating angle between the two person vectors in the circumplex projection. In our analyses, the angular means of the absolute separating angles (from  $0^\circ$  to  $180^\circ$ ) in the real-family data were  $\bar{\delta}_{M-F} = 82.71^\circ$  for mothers and fathers,  $\bar{\delta}_{M-D} = 59.33^\circ$  and  $\bar{\delta}_{F-S} = 71.18^\circ$  for same-sex dyads, and  $\bar{\delta}_{M-S} = 89.10^\circ$  and  $\bar{\delta}_{F-D} = 102.92^\circ$  for other-sex dyads. The corresponding angular means from the randomly paired dyads were roughly  $10^\circ$  larger for all parent-child dyads, and roughly  $20^\circ$  larger for mother-father dyads.

In order to facilitate an evaluation of the differences between the profile orientations of real and pseudo-families, Figure A1 visualizes the smoothed relative frequency distributions of separating angles for the real-family data (black lines) and across the 1000 pseudo-family datasets (gray lines). For same-sex dyads, the mass of the distributions could be expected to

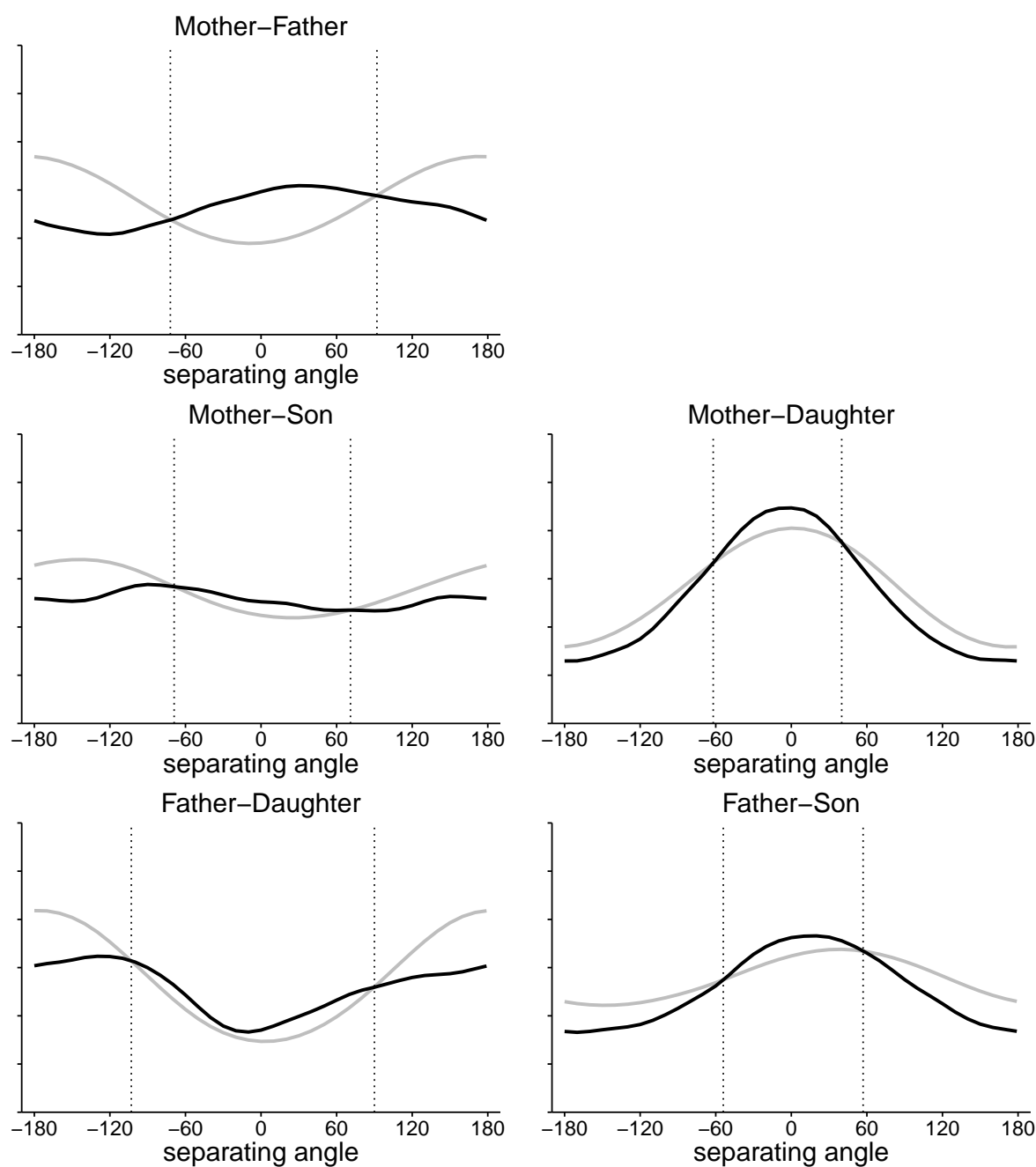


Figure A1: Smoothed distributions of separating angles for real- (black) and pseudo-families (gray).

be centered near the  $0^\circ$  position and to decrease towards the outer limits at  $-180^\circ$  and  $180^\circ$  (as indicated by the gray lines in the left panels of Figure A1). For other-sex dyads, the minima of the distributions could be expected to be located near the  $0^\circ$  position, and to increase towards the outer limits (as indicated by the gray lines in the right panels of Figure A1). In other words, members of same-sex dyads could be expected to be rather similar than dissimilar, and those of

other-sex dyads to be rather dissimilar than similar, due to gender-normativeness.

Comparing the resampling distributions to those obtained from the real-family data, there were two intersections that divided the distributions into specific sections. In between the intersections, the relative frequency of separating angles in the real-family data exceeded that obtained from the pseudo-families. That is, within (or outside) the limits of these intervals, real-family dyads were more similar (or less dissimilar) than corresponding pseudo-couples. For same-sex dyads, this area was narrower (roughly  $\pm 60^\circ$ ) than for other-sex dyads. For the latter, the intervals were wider (roughly  $\pm 70^\circ$  up to  $\pm 100^\circ$ ). This is because same-sex parent-child dyads are inevitably more similar to each other than other-sex parent-child dyads, due to gender-normativeness. Again, the differences between real-family and pseudo-family dyads were strongest for mother-father dyads.



# 4

## Study 3: The Spherical Model of Vocational Interests in Germany

Etzel, J. M., Nagy, G., & Tracey, T. J. G. (2016). The spherical model of vocational interests in Germany. *Journal of Career Assessment, 24*(4), 701–717. doi: 10.1177/1069072715616122

The aim of the present investigation is to examine key aspects regarding the validity of the spherical model of vocational interests in Germany, namely, its structural validity, its convergent validity - with an instrument assessing vocational interests according to the RIASEC (R-Realistic, I-Investigative, A-Artistic, S-Social, E-Enterprising, and C-Conventional) model-and its construct validity regarding the pattern of gender differences. To this end, the Personal Globe Inventory (PGI) was translated and completed by a sample of German university students. Results of randomization tests of hypothesized order relations provided support for the structural validity of the instrument in female and male university students. Principal components analyses with target rotations identified two particular scales as outliers. RIASEC scores derived from the PGI correlated strongly with corresponding scales of another instrument, and gender differences were in line with previous findings reported in the literature. Overall, our results provide evidence for the validity of the spherical model in German university students.

## 4.1 Introduction

Vocational interests have proven to be important characteristics of human behavior and perceptions in organizational and educational settings (e.g., Rounds & Su, 2014; Warwas et al., 2009). Findings in both fields consistently document the importance of vocational interests in predicting educational and occupational choices and demonstrate the relevance of interest congruence for educational and professional success (e.g., Etzel & Nagy, 2016; B. Lee, Lawson, & McHale, 2015; Tracey & Robbins, 2006).

Research on this topic has created a large body of theories that attempt to group the extensive range of vocational interests into meaningful interest domains. Besides Holland's (1997) famous RIASEC model, postulating six vocational personality types (R — Realistic, I — Investigative, A — Artistic, S — Social, E — Enterprising, and C — Conventional), the works of Knapp and Knapp (1974), Meir (1973), and Roe (1956) provided well-known systems for grouping vocational interests. However, recent works on the structure of vocational interests emphasize that the key aspect of their similarity structure is best described by a continuous model, while the specification of groups of vocational interest is, to a certain degree, arbitrary (Prediger, 1982; Tracey & Rounds, 1995). Today, there is ample evidence that the similarity structure of vocational interests can be described by their locations on the perimeter of a circle (i.e., a circumplex; Guttman, 1954). Interests that are located closer to each other are more similar than those that are further apart from each other (Holland, 1997). There is extensive empirical support for the structural validity of the circumplex model of vocational interests across different countries and social groups (e.g., Day & Rounds, 1998; Nagy et al., 2010; Rounds & Tracey, 1996).

Circumplex models are often described by two orthogonal axes, representing the qualities underlying the circularly ordered constructs. Regarding vocational interests, the most influential model was introduced by Prediger (1982), who specified one axis to indicate the preference for interpersonal versus impersonal tasks (People-Things), and another axis to describe the preference for internal versus external tasks (Ideas-Data). This framework allows for the integration of vocational interests with other variables (Armstrong, Day, McVay, & Rounds,

2008) and has proven to be useful for analyzing gender differences (Lippa, 1998).

Despite its long tradition and strong empirical support, the circumplex model of vocational interests has the limitation that it does not account for a person's preferred level of occupational prestige, an aspect that has repeatedly been identified as an important facet in subjective perceptions of occupations (Gottfredson, 1996). In order to integrate this aspect into the realm of vocational interests, Tracey and Rounds (1996b) introduced a spherical model of vocational interests. In this model, the interest circumplex, defined by Prediger's People-Things and Ideas-Data axes, is expanded by an orthogonal axis representing a person's preference for vocational activities or occupations at different levels of prestige. Occupational prestige is thereby understood as a broad construct, summarizing — inter alia — concepts of socioeconomic status, level of difficulty and responsibility, as well as required education and training. Our study addresses the question of whether there is empirical support for the validity of this model in Germany.

#### 4.1.1 *The Personal Globe Inventory*

The Personal Globe Inventory (PGI; Tracey, 2002) is an instrument used to assess vocational interests as conceptualized by the spherical model. It consists of eight basic scales at an intermediate prestige level (Social Facilitating, Managing, Business Detail, Data Processing, Mechanical, Nature/Outdoors, Artistic, and Helping), five higher prestige scales (Social Sciences, Science, Business Systems, Financial Analysis, and Influence), and five lower prestige scales (Quality Control, Basic Service, Personal Service, Construction/Repair, and Manual Work). Prediger's People-Things and Ideas-Data axes constitute the equator of the sphere with the eight basic interest scales distributed on its perimeter. While the Influence and Manual Work scales define the upper and lower poles of the sphere, the remaining higher and lower prestige scales are assumed to exhibit a circumplex structure at different levels of prestige.

1 displays the theoretical hemispheres as viewed from above (higher prestige scales) and below (lower prestige scales). Three different item types can be assessed with the PGI: activity preferences, activity competence beliefs, and occupational preferences. Additionally, a composite of the three item types can be derived (i.e., their average). The hypothesized spherical

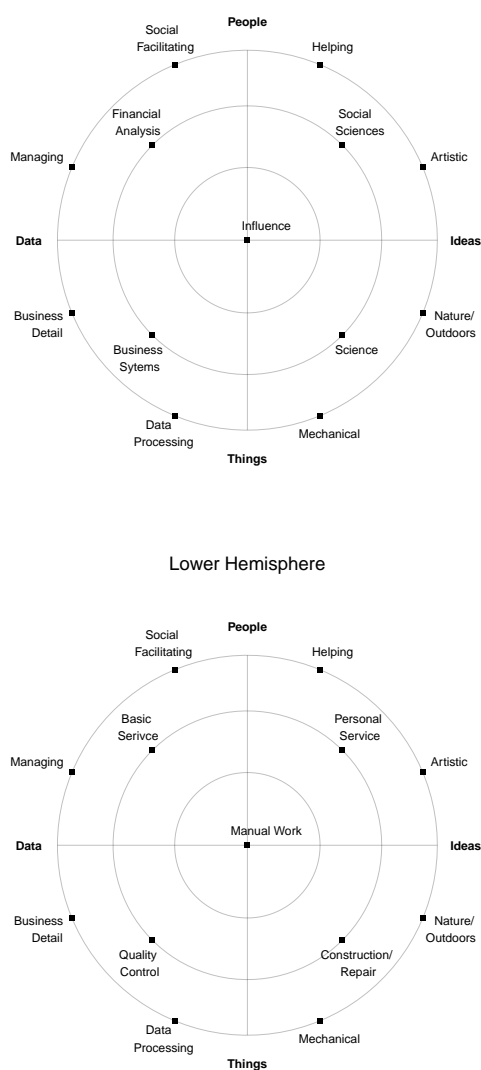


Figure 1: Spherical Model of Vocational Interests. Concentric circles (from outer to inner) are at  $0^\circ$ ,  $45^\circ$ , and  $67.5^\circ$  latitude.

structure is said to hold for all item types. Furthermore, it is possible to convert the PGI scale scores into RIASEC scores. This allows for the comparison of the PGI with other RIASEC-based interest inventories. Empirical support for the cross-cultural structural and convergent validity of the instrument has been found in English-speaking countries (Darcy, 2005; Tracey, 2002), the Balkan States (Hedrih, 2008; Šverko, 2008), China (Long et al., 2005), and the Netherlands (Holtrop et al., 2015).

However, a number of studies indicate cross-cultural and group-specific differences for the circumplex model (e.g., Hansen, Collins, Swanson, & Fouad, 1993; Leong, Austin, Sekaran, & Komarraju, 1998; Tracey & Ward, 1998) and the spherical model (Wilkins et al., 2013).

Researchers must therefore challenge the validity of the structural invariance assumption before applying an instrument in a new context, especially if it has been translated into another language. The validity of cross-cultural comparisons of interest-outcome relationships is only ensured if the invariance assumption holds to a reasonable extent. While there is support for the validity of the two-dimensional circumplex structure of vocational interests in Germany (Nagy et al., 2010), there is not yet any such evidence for the validity of the spherical model.

## **4.2 The Present Investigation**

The present research addresses the validity of the spherical model of vocational interests — as assessed by the PGI (i.e., Personal Globe Inventory) — in Germany, by analyzing a sample of  $N = 526$  university students. Following the abovementioned argumentation concerning the theoretical configuration of the 18 PGI scales, we expected to find evidence for the structural validity of the circumplex structure of the six RIASEC scales, the eight basic interest scales, the spherical structure of the 18 spherical scales, and, thus, the underlying dimensions: People-Things, Ideas-Data, and Prestige. In line with the findings of other authors, the structure was expected to be invariant across gender groups and item types (e.g., Darcy & Tracey, 2007). We employed confirmatory methods to assess global model fit as well as exploratory graphical methods to identify the PGI scales responsible for the misfit between the theoretical and the empirical interest structure.

In order to examine the convergent validity of the PGI, we analyzed its relationship to another well-established interest inventory: the General Interest-Structure-Test (GIST; Allgemeiner Interessen-Struktur-Test; Bergmann & Eder, 2005). The GIST is the state-of-the-art interest inventory in Germany for assessing vocational interests according to Holland's (1997) RIASEC model. Extensive support (Nagy et al., 2010) has been found for its structural validity. We expected to find strong associations between RIASEC scores derived from the PGI and the GIST.

Finally, we investigated gender differences in the PGI scales, thereby examining whether the pattern of gender differences corresponds to the results known from the literature. Building

upon the findings of Lippa (1998), we expected the majority of gender differences to concentrate on scales located near to the poles of the People-Things axis. On average, female participants were expected to score higher on interest domains that are located close to the People pole, whereas male participants were expected to score higher on those domains close to the Things pole. For scales located near the poles of the Data-Ideas axis, we expected to find non-significant or at least smaller gender differences. To the best of our knowledge, the relationship between gender and the Prestige axis has not yet been examined systematically. We therefore approached this issue as an open research question.

### **4.3 Method**

#### *4.3.1 Participants and Procedure*

We distributed an online questionnaire via social media platforms, specifically posting the link in groups of various majors at universities all over Germany. The instruments were embedded in a larger study containing additional measures not relevant for the present research (e.g., trait self-control). To account for the length of the instruments, we decided to implement a multiple group design with planned missing data. Participants were randomly assigned to one of three groups consisting of 1) the complete PGI (i.e., Personal Globe Inventory) and the GIST (i.e., General Interest-Structure-Test), 2) the PGI activity items, the GIST, and the personality measures, and 3) the PGI occupation items and a larger set of personality measures. Thus, all relevant instruments were assessed in at least two of the three groups.

During the survey period,  $N = 939$  people opened the link to the questionnaire. In a first step, we excluded those participants who did not reach the psychometric part of the questionnaire ( $N = 182$ ) and those who could not be identified as students ( $N = 69$ ). In addition, we excluded participants who dropped out of the survey very early ( $N = 162$ ). We defined an early dropout as someone who did not answer at least half of the first PGI instrument. The rationale behind this cutoff is coherent with the research question. Due to the order of the items, participants who did not reach the second half of the first instrument did not provide any information for the spherical scales. The final sample consisted of  $N = 526$  university students (66.54% female)

from over 50 different majors. The average age was 22.44 with a standard deviation of 3.18.

There were no significant differences between the final sample and the early dropouts with respect to gender [ $\chi^2(1, N = 685) = 1.25, p = .26$ ], number of semesters enrolled [ $t(644) = -1.20, p = .23$ ], and average school grade [ $t(675) = .866, p = .39$ ]. The age difference between our final sample and the dropouts was significant [ $t(683) = -2.57, p < .01$ ] but of negligible magnitude ( $|\Delta_M| = 0.72$ ).

### 4.3.2 Measures

*Personal Globe Inventory.* The instrument consists of 108 activity preference items, 108 activity competence belief items, and 108 occupational preferences items. Participants were asked to indicate how much they like the activities or occupations on a 7-point rating scale ranging from 1 = *very strongly dislike* to 7 = *very strongly like*. For the activity items, participants were also asked to rate their perceived competence on a 7-point rating scale ranging from 1 = *unable to do* to 7 = *very competent*. The items are organized in the same 18 scales for all item types and their composite (see Figure 1).

We translated the instrument using a translation-back translation approach: First, we translated the original items from English into German. These translations were then given to a native English-speaker working at our institute and translated back into English. The back translations were then compared with the original items and discrepancies were discussed. On this basis, we revised the instrument and created the final version. In our sample, all Cronbach's  $\alpha$  coefficients were acceptable to very good ( $\alpha = .70$  to  $\alpha = .95$ ), with two minor exceptions: the activity item types for the Personal Service subscale ( $\alpha = .61$  and  $\alpha = .65$ ).

*General Interest Structure Test (GIST).* The GIST (Bergmann & Eder, 2005) is an instrument used to assess vocational interests according to Holland's RIASEC types. The instrument has been extensively validated in Germany. It consists of 60 items describing different work activities. Participants are asked to rate how interested they are in certain activities on a 5-point scale. In our sample, internal consistencies were high throughout the six scales ( $\alpha = .84$  to  $\alpha = .91$ ). The authors provide strong evidence for the internal and convergent validity of the instrument. In addition, the circumplex structure of the GIST is well established

in Germany (Nagy et al., 2010).

### 4.3.3 *Statistical Analyses*

*Missing data.* Missing Data was handled via multiple imputations with the mice package (van Buuren & Groothuis-Oudshoorn, 2011) implemented in the R statistical software (R Core Team, 2018). Due to the large number of items, we decided to impute on the scale level. We computed the scale means prior to imputation, using all available information. This method yields results with a similar precision to that of item level imputation, while reducing computational effort (Enders, 2010). The background variables used in the imputation model were sex, age, and several school grades. Analyses of the convergence of the algorithm were inconspicuous. Using this method, we created 100 complete data sets.

*Spherical structure.* In order to analyze the structure hypothesized by the spherical model of interests, we first conducted a series of randomization tests of hypothesized order relations (Hubert & Arabie, 1987) for the RIASEC scales retrieved from the PGI, the eight-type basic interest circumplex, and the 18-type spherical model. The logic of this test (hereafter only referred to as the randomization test) is to translate the hypothesized structure into pairwise order predictions of the correlations between the scales and to compare them with the order in the sample correlation matrix. The result of this test is summarized by a correspondence index (CI) that ranges from  $-1$  to  $1$ , indicating the proportion of predictions met ( $-1$  = no predictions met,  $1$  = all predictions met).

Furthermore, it is possible to test whether or not the number of violated order relations in the sample correlation matrix is smaller than it would be if the rows and columns of the correlation matrix were randomly relabeled. We analyzed the male and female subsample separately, as well as the full sample, using the RANDALL program (Tracey, 1997). All analyses were conducted on the pooled correlation matrices, derived by averaging the correlations across the 100 imputations.

Because tests of global model fit, such as the randomization test, typically do not yield perfect congruence between the data and the hypothesized model, we additionally conducted principal components analyses (PCAs) of the full sample correlation matrices for the three



item types and their composite. The resulting component loadings allow for a more detailed examination of the relationships between the empirical data and the theoretical model. In line with (Prediger, 1998), the first component was expected to be a general response factor without substantial meaning. The second to fourth components were expected to constitute the three dimensions of the interest sphere. In order to maximize the comparability between the component loadings and the theoretical model, we standardized the vector lengths of each scale to 1. This was achieved by dividing the three component loadings  $\lambda_j$  of each scale  $j$  by the square root of the sum of squared component loadings (i.e., the vector length with respect to the three components:  $\sqrt{\lambda_{j1}^2 + \lambda_{j2}^2 + \lambda_{j3}^2}$ ). This procedure ensures that each scale is located on the surface of a unit sphere, just like the scales of the theoretical model. Finally, we performed orthogonal target rotations, using the R package "GPArotation" (Bernaards & Jennrich, 2005), thereby optimizing the correspondence between the theoretical and the empirical configuration.

The target matrix was constructed by identifying the spherical coordinates of the theoretical model (as displayed in Figure 1) and translating them into Cartesian coordinates. The Ideas pole served as the reference position for longitude ( $0^\circ$  at three o'clock). We then went in steps of  $45^\circ$  counterclockwise around the circumplex, starting with the Artistic scale at  $22.5^\circ$ , to identify the eight basic scales. For latitude, we defined the Influence scale as the upper pole ( $0^\circ$ ) and the Manual Work scale as the lower pole ( $180^\circ$ ). Accordingly, the latitude for the eight basic scales was  $90^\circ$ , because they are located at the equator of the sphere. For the lower and higher prestige scales, the first scale is located in between the Ideas and People poles ( $45^\circ$  longitude). The other scales are separated by  $90^\circ$ , moving counterclockwise. To account for the difference in Prestige, the latitudes were set to  $135^\circ$  (lower prestige) and  $45^\circ$  (higher prestige). Given the 18 pairs of spherical coordinates and setting the radius to 1, we could determine the Cartesian coordinates according to the theoretical model.

The results of the target rotated component loadings were then compared with the theoretical scale positions in two ways: First, we graphically analyzed the congruence between the empirical and the theoretical scale positions. Second, we calculated the Euclidean distances between the empirical and the theoretical scale positions in order to quantify the deviation with respect to all three dimensions. In order to define what is considered a large deviation from theory,

we specified a Euclidean distance of  $\Delta_E = 0.765$  as the cutoff criterion, which is the distance between two adjacent scales separated by the smallest possible angle in the theoretical model (i.e.,  $45^\circ$ ).

*Gender differences and convergent validity.* The convergent validity of the RIASEC scales of the PGI with the GIST RIASEC scales was examined by means of a monotrait-heteromethod correlation matrix, using the composite scores. For the analysis of gender differences, we used linear regressions of the PGI scales on a dummy coded indicator variable (1 = *male*, 2 = *female*). The regression weights were standardized in the dependent variable (i.e., *y*-standardized), thus representing gender differences in the units of the scales' standard deviations. In order to address whether or not gender was related to the Prestige axis, gender effects on PGI scales located on the same level of prestige were averaged (Figure 1) and the corresponding average effects were compared with each other. A systematic relationship would be manifested in a monotonous trend in average effects along the prestige axis (e.g., the lower the level of prestige, the larger the differences  $\Delta_E$  in favor of males would become). All of these analyses were conducted using the imputation module implemented in the *Mplus* 7.1 software (Muthén & Muthén, 1998-2014). This module combines the parameter estimates of the analyses of the 100 imputed data sets according to the rules of (Rubin, 1987) and yields appropriate estimates of their standard errors.

## 4.4 Results

### 4.4.1 Structural Validity: Randomization Tests

Table 1 presents the results of the randomization tests. In our sample, each of the 36 randomization tests was significant. For the PGI-based RIASEC model, the CIs ranged from  $CI = .76$  to  $CI = 1.00$  ( $p = .017$ ). For the eight-type model, the values ranged from  $CI = .73$  to  $CI = .90$  ( $p = .000$ ). Finally, for the 18-type spherical model, the CI values ranged from  $CI = .47$  to  $CI = .60$  ( $p = .001$ ). Overall, the activity competence item type yielded the lowest, yet significant, correspondence with the theoretical model, with a median of  $.76$ . CIs for the other item types and their composite were similar, with medians ranging from  $.85$  to  $.87$ .

Table 1: Results of the Randomization Tests of Hypothesized Order Relations

	Activity Preferences			Activity Competence Beliefs			Occupational Preferences			Composite					
	All	Female		All	Female		All	Female		All	Female		All	Female	
		Male	Female		Male	Female		Male	Female		Male	Female		Male	Female
<i>RIASEC model</i>															
Predictions made	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72
Predictions met	67	67	68	66	68	63	69	65	65	72	66	66	66	69	69
CI	.86	.86	.89	.83	.89	.76	.93	.82	.82	1.00	.83	.83	.83	.92	.92
<i>eight-type model</i>															
Predictions made	288	288	288	288	288	288	288	288	288	288	288	288	288	288	288
Predictions met	273	273	263	260	260	246	274	270	270	265	280	280	280	269	269
CI	.90	.90	.84	.82	.83	.73	.90	.89	.89	.85	.94	.94	.94	.87	.87
<i>18-type model</i>															
Predictions made	9472	9472	9472	9472	9472	9472	9472	9472	9472	9472	9472	9472	9472	9472	9472
Predictions met	7179	7109	7318	6910	6964	6859	7410	7284	7284	7424	7398	7398	7398	7510	7510
CI	.53	.51	.56	.47	.48	.47	.58	.55	.55	.58	.57	.57	.57	.60	.60

Note.  $N = 526$  (full sample),  $N = 350$  (female subsample),  $N = 176$  (male subsample). All RIASEC models:  $p = .017$ ; All eight-type models:  $p = .0004$ ; All 18-type models  $p = .001$ .

Table 2: Summary of the Principal Components Analyses

	C1	C2	C3	C4
<i>Activity Preference</i>				
Eigenvalue	5.30	3.32	2.50	1.31
VAF	0.29	0.18	0.14	0.07
$\Sigma$ VAF	0.29	0.48	0.62	0.69
<i>Activity Competence</i>				
Eigenvalue	6.52	3.15	1.81	1.13
VAF	0.36	0.18	0.10	0.06
$\Sigma$ VAF	0.36	0.54	0.64	0.70
<i>Occupational Preference</i>				
Eigenvalue	6.87	3.07	2.58	1.36
VAF	0.38	0.17	0.14	0.08
$\Sigma$ VAF	0.38	0.55	0.70	0.77
<i>Composite</i>				
Eigenvalue	5.75	3.79	2.67	1.37
VAF	0.32	0.21	0.15	0.08
$\Sigma$ VAF	0.32	0.53	0.68	0.75

*Note.*  $N = 526$  for all PCAs. C1 = General component, C2 = People-Things, C3 = Ideas-Data, C4 = Prestige; VAF = Variance accounted for.

Whereas the CIs of the RIASEC model (CI = .92 versus CI = .83) and the 18-type model (CI = .60 versus CI = .56) were slightly higher for male participants, those of the eight-type model (CI = .95 versus CI = .87) were higher for female participants. Taken together, these results provided first support for the structural validity of the model across the different gender subsamples and item types. However, the moderate CIs indicated local deviations from the theoretical model that were investigated deeper in the subsequent analyses.

#### 4.4.2 Structural Validity: Principal Components Analyses

The subsequent analyses were conducted for the gender subsamples and the full sample. As the results were congruent across gender, we only report the results for the full sample here. Separate results are available upon request. The eigenvalues and variance accounted for of the PCAs for the three item types and their composite ( $N = 526$ ) are presented in Table 2. As

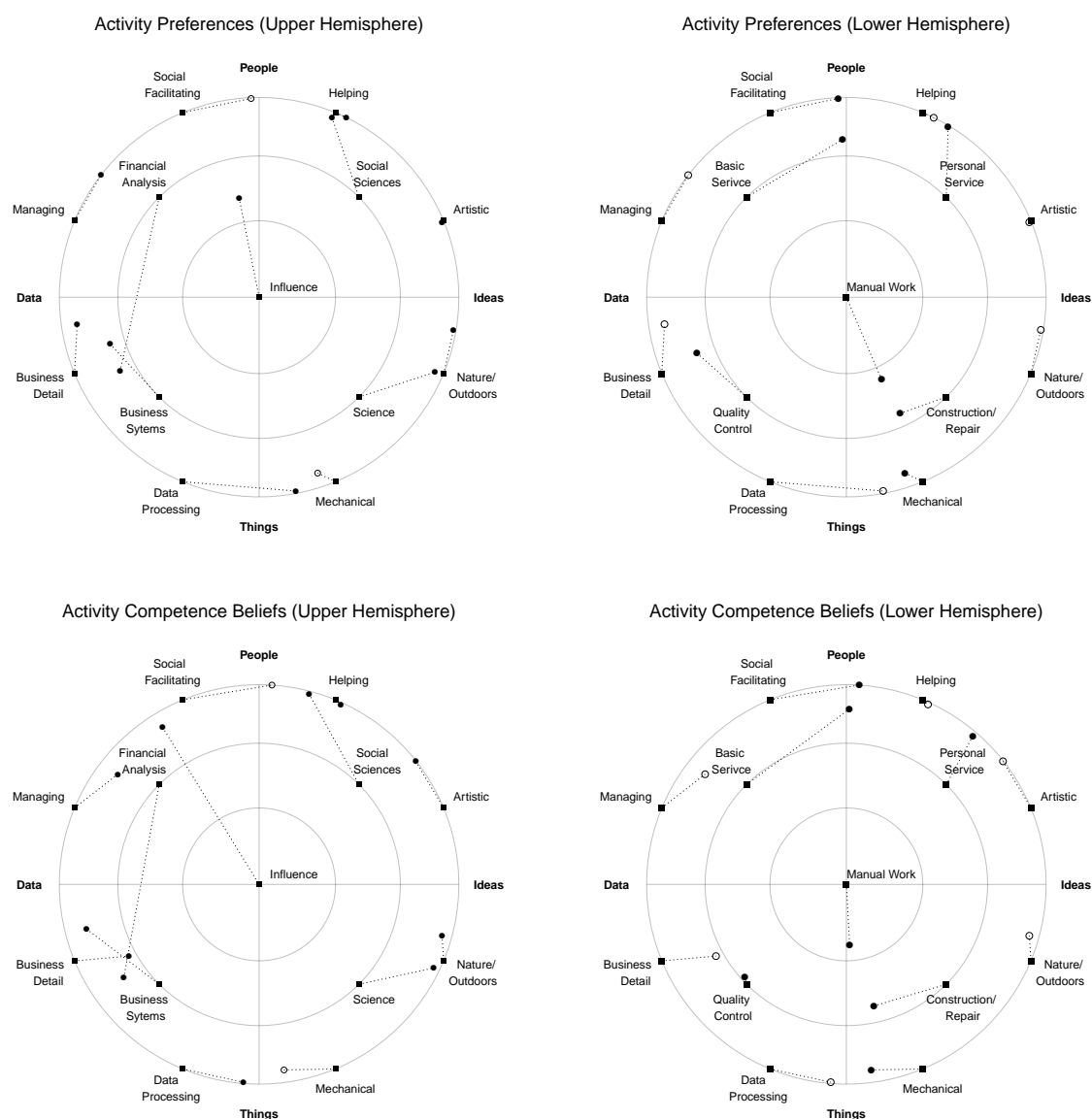


Figure 2: Theoretical versus Empirical Scale Positions: Activity Item Types. ■ = theoretical positions, • = empirical positions on displayed hemisphere, ◦ = empirical positions on opposite hemisphere.

expected, the first component represented a general component with overall positive loadings. In line with (Prediger, 1998), this general component is considered irrelevant and was hereafter ignored. Overall, the correlations between the target rotated PCA loadings and the targets were high for all three item types, yielding strong support for the validity of the three dimensions as defined by the spherical model. The agreement with the theoretical scale positions was highest for the occupational preference item and the composite ( $r = .91$  for both), followed by the activity preference items ( $r = .89$ ), and the activity competence beliefs items ( $r = .84$ ).

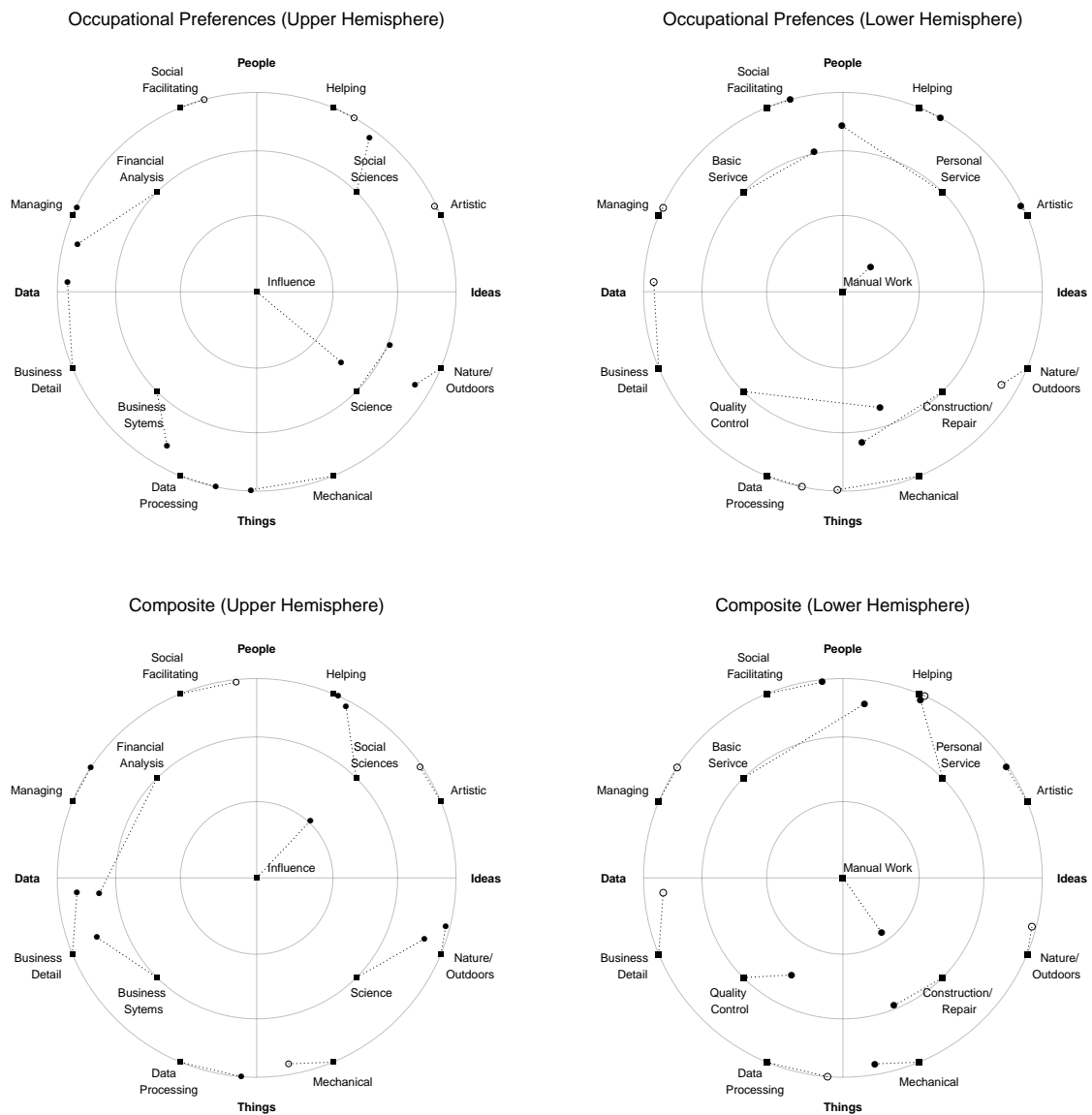


Figure 3: Theoretical versus Empirical Scale Positions: Occupational Preferences and Composite. ■ = theoretical positions, • = empirical positions on displayed hemisphere, ◦ = empirical positions on opposite hemisphere.

Figures 2 and 3 display the empirical versus the theoretical scale positions for the upper and lower hemisphere for each of the three item types and their composite. The theoretical model was not perfectly reproduced although the majority of the scales were close to their theoretical positions. In order to identify meaningful aberrations from theory, we used the Euclidean distances ( $\Delta_E$ ) between the empirical and the theoretical scale positions.

Table 3 presents the Euclidean distances for the three item types and their composite. Given our cutoff value of  $\Delta_E = 0.765$ , we only found three noticeable deviations from the theoretical

Table 3: Euclidean Distances between Theoretical Scale Positions and Target Rotated PCA Loadings

	Activity Preferences	Activity Competence Beliefs	Occupational Preferences	Composite
Social Facilitating	0.36	0.45	0.13	0.33
Managing	0.26	0.52	0.11	0.20
Business Detail	0.46	0.72	0.53	0.53
Data Processing	0.59	0.33	0.19	0.31
Mechanical	0.39	0.43	0.43	0.39
Nature/Outdoors	0.28	0.33	0.42	0.25
Artistic	0.15	0.28	0.15	0.24
Helping	0.07	0.15	0.12	0.03
Social Sciences	0.63	0.75	0.50	0.60
Influence	0.52	1.11 <sup>a</sup>	0.58	0.40
Business Systems	0.37	0.52	0.38	0.41
Quality Control	0.35	0.04	0.70	0.27
Manual Work	0.46	0.31	0.19	0.34
Personal Service	0.70	0.57	0.62	0.62
Financial Analysis	0.90 <sup>a</sup>	0.99 <sup>a</sup>	0.58	0.65
Science	0.58	0.60	0.29	0.47
Construction/Repair	0.25	0.39	0.48	0.28
Basic Service	0.57	0.68	0.41	0.75

Note. Euclidean distances in three dimensions.

<sup>a</sup>  $\Delta_E > 0.765$

model: The Influence scale for the activity competence beliefs item type shifted away from the upper pole of the sphere in the Data and People direction ( $\Delta_E = 1.11$ ). The Financial Analysis scale for the activity preferences item type shifted away from the People pole towards the Things pole ( $\Delta_E = 0.90$ ). Likewise, the Financial Analysis scale for the activity competence beliefs item type shifted from the People pole towards the Things pole ( $\Delta_E = 0.99$ ). Noticeably, not one scale exceeded our cutoff for the composite score and the occupational preference item types.

#### 4.4.3 Convergent Validity: Monotrait-Heteromethod Correlations

Although the GIST is well established in Germany, it was advisable to validate the circumplex structure in our sample. We therefore conducted a randomization test for the GIST in the full

Table 4: Monotrait-Heteromethod Correlation Matrix for the RIASEC Scales

Scale	GIST-R	GIST-I	GIST-A	GIST-S	GIST-E	GIST-C
PGI-R	<b>0.63*</b>	0.34*	-0.14	-0.24*	-0.04	0.08
PGI-I	0.42*	<b>0.66*</b>	0.17*	-0.02	-0.06	0.00
PGI-A	0.10	0.11	<b>0.79*</b>	0.24	0.10	-0.10
PGI-S	-0.06	-0.10	0.47*	<b>0.77*</b>	0.39*	0.03
PGI-E	0.08	-0.14	0.17	0.40*	<b>0.61*</b>	0.50*
PGI-C	0.45*	0.29*	-0.23*	-0.25*	0.12	<b>0.32*</b>

*Note.* R = Realistic, I = Investigative, A = Artistic, S = Social, E = Enterprising, C = Conventional; PGI = Personal Globe Inventory (Composite); GIST = General Interest Structure Test. Corresponding scales are printed in boldface.

\* $p < .001$

sample. This test yielded a CI of .74 ( $p = .017$ ), thus supporting the circumplex structure in our sample. However, this CI was lower than that of the composite PGI RIASEC model (CI = .89), indicating a better fit for the latter.

Table 4 displays the monotrait-heteromethod correlation matrix of the RIASEC scales calculated from the PGI composite scores with the RIASEC scales of the GIST. The correlation structure was very similar for all item types and across gender subsamples (correlation matrices for the other item types are available on request). The diagonal elements of the monotrait-heteromethod matrix serve as indicators for the validity of the respective scales. We found strong evidence for the convergent validity of the Realistic ( $r = .63$ ,  $p < .001$ ), Investigative ( $r = .66$ ,  $p < .001$ ), Artistic ( $r = .79$ ,  $p < .001$ ), Social ( $r = .77$ ,  $p < .001$ ) and Enterprising ( $r = .61$ ,  $p < .001$ ) scales. The only interest domain that yielded a higher correlation with a different scale than its counterpart was the PGI Conventional scale, which correlated higher with the GIST Enterprising scale ( $r = .50$ ,  $p < .001$ ) than with the GIST Conventional scale ( $r = .32$ ,  $p < .001$ ).

In order to elaborate on whether this inconsistency contests the validity of the PGI or can be attributed to the GIST, we took a closer look at the items of the Enterprising and Conventional scales of the GIST by means of a PCA. We found that those items of the GIST Conventional scale that had no significant correlations with the PGI Conventional scale defined a third component. Excluding these items from the GIST Conventional scale increased the correlation



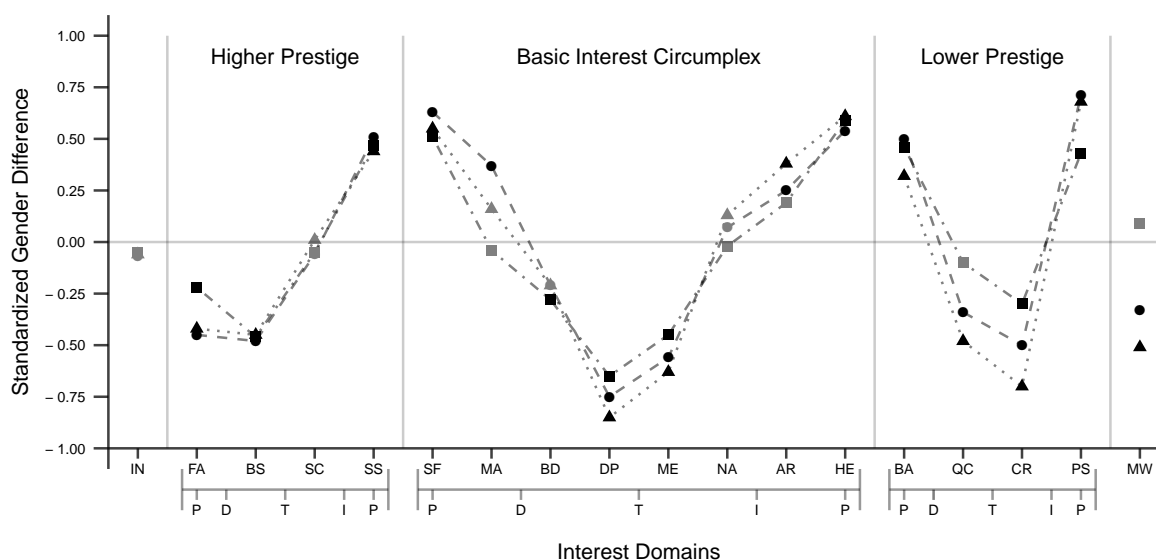


Figure 4: Standardized Gender Differences across the 18 Spherical PGI Scales. • = Activity Preferences, ▲ = Activity Competence Beliefs, ■ = Occupational Preferences; IN = Influence, FA = Financial Analysis, BS = Business Systems, SC = Science, SS = Social Sciences, SF = Social Facilitating, MA = Managing, BD = Business Detail, DP = Data Processing, ME = Mechanical, NA = Nature/Outdoors, AR = Artistic, HE = Helping, BAS = Basic Service, QC = Quality Control, CR = Construction/Repair, PS = Personal Service, MW = Manual Work, P = People, D = Data, T = Things, I = Ideas

with the PGI Conventional scale ( $r = .48, p < .001$ ), rendering the difference between the two correlations insignificant. The excluded items were rather unspecific (e.g., "Doing work that requires precision and perseverance"), thus providing reasonable evidence to attribute the source for the incongruity to the GIST rather than the PGI.

#### 4.4.4 Construct Validity: Gender Differences

Figure 4 displays the  $y$ -standardized regression coefficients of the gender mean differences for the three item types. In order not to overburden the Figure, we decided to omit the gender differences for the composite score, because they roughly correspond to the average of the presented effects. Gender was dummy coded (1 = male, 2 = female), which means that regression weights of positive sign indicate higher means in female participants. The 18 scales are presented in descending order, progressing from the upper pole (Influence), through the higher prestige scales, the eight basic scales, and the lower prestige scales, towards the lower pole (Manual Work). At each level of prestige, we started with the top left scale (see Figure

1), progressed counterclockwise from People to Data and Things to Ideas, and back again to People. The x-axis is twofold, indicating 1) each of the 18 scales, and 2) the scale positions relative to the poles of Prediger's axes.

For all three item types, the same pattern emerged: On average, female participants scored higher on scales that are closer to the People pole and male participants scored higher on scales that are closer to the Things pole on the People-Things axis. Gender differences decreased and became insignificant the closer a scale was located to either pole of the Data-Ideas axis. Across all item types, the largest negative difference was found for the Data Processing scale ( $\hat{\beta}_{\sigma_y} = -.85$  to  $-.65$ ,  $p < .001$ ). For both activity item types, the largest positive differences were found for the Personal Service scale ( $\hat{\beta}_{\sigma_y} = .68$  to  $.71$ ,  $p < .001$ ), whereas, for the occupational preference item type, the strongest positive difference was found for the Helping scale ( $\hat{\beta}_{\sigma_y} = .59$ ,  $p < .001$ ). The only result that was not in line with our expectations was the negative effect on the Financial Analysis scale for all three item types ( $\hat{\beta}_{\sigma_y} = -.45$  to  $-.22$ ,  $p < .05$ ). Note that this scale was also identified as a source of misfit from the theoretical model in the previous section, demonstrating a sizeable shift from its theoretical position (close to the People pole) towards the Things pole. In this respect, the moderate negative regression coefficients are consistent with the empirically determined position on the interest sphere.

The question of whether the Prestige axis is related to gender was approached by inspecting the average gender effects at the 5 different levels of prestige. For the occupational preference item type, no mean effect was significantly different from zero (upper pole:  $\hat{\beta}_{\sigma_y} = -.05$ ; higher prestige:  $\hat{\beta}_{\sigma_y} = -.07$ ; intermediate prestige:  $\hat{\beta}_{\sigma_y} = -.02$ ; lower prestige:  $\hat{\beta}_{\sigma_y} = .12$ ; lower pole:  $\hat{\beta}_{\sigma_y} = .09$ ). The only significant mean effects were the lower poles for the activity preference items (upper pole:  $\hat{\beta}_{\sigma_y} = -.07$ ; higher prestige:  $\hat{\beta}_{\sigma_y} = -.12$ ; intermediate prestige:  $\hat{\beta}_{\sigma_y} = .04$ ; lower prestige:  $\hat{\beta}_{\sigma_y} = .09$ ; lower pole:  $\hat{\beta}_{\sigma_y} = -.33$ ,  $p < .001$ ) and activity competence beliefs items (upper pole:  $\hat{\beta}_{\sigma_y} = -.06$ ; higher prestige:  $\hat{\beta}_{\sigma_y} = -.10$ ; intermediate prestige:  $\hat{\beta}_{\sigma_y} = .02$ ; lower prestige:  $\hat{\beta}_{\sigma_y} = -.05$ ; lower pole:  $\hat{\beta}_{\sigma_y} = -.51$ ,  $p < .001$ ). Taken together, these results indicate that gender is related to Prediger's axes but not to the Prestige axis.

## 4.5 Discussion

This study aimed to make a contribution towards the cross-cultural validation of the spherical model of vocational interests, as introduced by (Tracey & Rounds, 1996b). To this end, we translated the PGI (Tracey, 2002) into German and distributed it to a sample of university students in Germany. Results from randomization tests and PCAs with orthogonal target rotations provided strong empirical evidence for the structural validity of the model. Analyses of gender differences and associations of the PGI RIASEC scales with the GIST further supported the construct and convergent validity of the instrument. However, we observed some inconsistencies, which shall be addressed in the following paragraphs.

### 4.5.1 *Structural Validity*

We carried out randomization tests for the three item types in the male and female subsamples as well as in the full sample. Of the three item types, the activity competence belief items displayed the largest deviations from the theoretical model. This finding is in line with other studies (e.g., Long et al., 2005; Šverko, 2008). Differences between the other item types and their composite were negligible. Although there were moderate differences in fit for the RIASEC and the eight-type model between male and female participants, the differences in the spherical 18-type model were only marginal. Results of the PCAs provided further support for the validity of the dimensions that constitute the spherical model. Moreover, the target rotated component loadings allowed us to identify specific locations of deviations from the theoretical model. Across all item types, we found three sizeable deviations. For the activity preference and the activity competence belief items, the Financial Analysis scale exceeded our cutoff criterion. According to the theoretical model, this scale should be located in the People-Data quadrant of the coordinate system defined by Prediger's dimensions. In our sample, the scale shifted towards the Things pole. This scale is assumed to measure the preference for "working directly with customers on their finances" (Tracey, 2002, p. 121). A closer look at the item phrasing revealed that the direct interaction with customers is only implicitly inherent to the items. Further revision of the instrument might modify the respective items to put stronger

emphasis on the social interaction with customers.

Another noticeable deviation was the shift of the Influence scale for the activity competence belief items in the People and Data direction towards the position of the Managing scale. This finding indicates that these scales are not as distinguishable as they are supposed to be for this particular item type. Both scales consist of items that emphasize activities that imply leading or supervising groups and high-stake decision-making. Further research is needed to see whether this effect is unique for the population of university students or applies to other populations as well.

#### 4.5.2 *Gender Differences and Convergent Validity*

For the greater part, the correlations between the PGI and the GIST scales were in line with our expectations. Corresponding RIASEC scales yielded the highest correlation coefficients with one exception: The correlation between the two Conventional scales was moderately lower than the correlation between the PGI Enterprising and the GIST Conventional scale. Further analysis of the items of the GIST Enterprising and Conventional scales by means of a PCA identified the reason in the items of the GIST rather than the PGI.

Mean differences of gender across the 18 PGI scales were in line with gender differences reported by other authors (e.g., Darcy, 2005; Tracey, 2002). On average, female participants scored higher on interest scales located closer to the People pole, whereas male participants scored higher on interest scales located closer to the Things pole. These results are in line with the findings of (Lippa, 1998), who recognized that gender differences in vocational interests tend to concentrate on the People-Things axis.

Furthermore, we found evidence that this relationship is consistent across different item types and different levels of prestige, and that gender is not related to the prestige axis of the PGI. The only significant differences were found for the lower pole of the activity item types. However, this pole is indicated by only one scale, Manual Work, which was also found to have shifted slightly towards the Things pole of the Things-People axis. Closer inspection of the activity items of the Manual Work scale revealed that they can be described as rather male typed activities (e.g., "Operating a woodworking machine"), whereas the occupational

preference items were mostly neutral with respect to gender. As a consequence, this effect might be attributed to gender differences along Prediger's content axes rather than the prestige axis.

#### 4.5.3 *Limitations and Directions for Future Research*

Despite the strong support that was found for the spherical model, this study has some limitations. First, we validated the PGI only in a certain population, namely German university students. Therefore, this does not imply that the abovementioned results are generalizable across other vocational groups (e.g., high school students, employed, self-employed, and unemployed people). The analyses of the spatial representation of the spherical model were only explorative and, with the exception of the randomization tests, were not supported by statistical significance tests. Further methodical work is needed to elaborately test the spherical model by means of powerful confirmatory research methods. Finally, other correlates of the interest domains and axes should be included in future analyses in order to strengthen the convergent validity.

First insightful results concerning the role of people's preference for prestige in vocational choices have been provided by (Leung et al., 2014). Future research should aim to explore the relevance of this particular dimension in the analyses of interest congruence and outcomes such as satisfaction, tenure, and performance. Although extensive research has been conducted on this topic, many questions are left open, some of which might be answered by considering the explanatory power of the prestige dimension.



# 5

## Study 4: Evaluation of the Dimensions of the Spherical Model of Vocational Interests in the Long and Short Version of the Personal Globe Inventory

Etzel, J. & Nagy, G. (2019). Evaluation of the Dimensions of the Spherical Model of Vocational Interests in the Long and Short Version of the Personal Globe Inventory. *Journal of Vocational Behavior*, 112, 1–16. doi: 10.1016/j.jvb.2019.01.003

The present study examined three different sources of evidence for the validity of the Personal Globe Inventory (PGI; Tracey, 2002) with regard to its ability to assess the dimensions underlying the spherical model of vocational interests: People-Things, Ideas-Data, and Prestige. Specifically, we analyzed 1) evidence based on the internal structure of the eight basic interest scales, 2) convergent evidence of the PGI dimensions across different item types, and 3) evidence based on relations to plausible correlates of vocational interests, namely, gender, academic achievement, and the socioeconomic status associated with the desired profession. Moreover, we analyzed the extent to which these sources of evidence were invariant between the PGI and its associated short version—the PGI-S (Tracey, 2010). Relying on a sample of  $N = 688$  university students in Germany, we were able to show that 1) the circular order of the basic interest scales was confirmed across item types and that it was invariant across PGI versions, 2) both the relationships between corresponding dimensions across item types as well as the relationships with the validity markers were, as far as the circumplex dimensions were concerned, in line with theoretical expectations and invariant across PGI versions, and 3) there were notable differences between the respective relationships with the Prestige axes across item types and PGI versions. We conclude by weighing up the pros and cons of the two PGI versions and suggesting specific situations in which the use of either version is advised.

## 5.1 Introduction

Vocational interests are well-established antecedents of success and choice behavior in educational and organizational contexts (e.g., Nye et al., 2017; Rounds & Su, 2014; Volodina & Nagy, 2016). The majority of research on vocational interests relies on theoretical models that emphasize a circular structure of interest domains as the central characteristic of the construct domain (e.g., Holland, 1997; Tracey, 2002). Underlying this so-called circumplex structure are two orthogonal dimensions, namely, People-Things and Ideas-Data (Prediger, 1982), which depict an integrative framework to link vocational interests to external variables (Armstrong et al., 2008).

In recent years, a third dimension has been proposed that expands the two-dimensional interest space to an interest sphere: Prestige (Tracey & Rounds, 1996b). This extension to the circumplex model significantly expands the scope of vocational interests, but also poses new challenges with regard to the efficient and valid assessment of interests and the three underlying dimensions. Vocational interests, as defined in the context of the spherical model, are assessed with the Personal Globe Inventory (PGI; Tracey, 2002). Although there is some evidence for the validity of the PGI from different countries (e.g., Etzel, Nagy, & Tracey, 2016; Hedrih, 2008; Holtrop et al., 2015), the instrument has, with a few mentionable exceptions (e.g., Holtrop et al., 2015; Leung et al., 2014), seldom been used in research relating vocational interests to other variables.

There appear to be two main reasons for this lack of recognition. First, with its 18 scales and three different item types, the PGI in its full form is very comprehensive and therefore more time-consuming than alternative measures. Recognizing this issue, (Tracey, 2010) introduced an abbreviated version of the instrument, the PGI-S. In a single validation study, the author demonstrated that the PGI-S is a reliable measure. Moreover, he found convergent evidence for the instrument's validity by means of relationships with other established interest instruments as well as evidence based on the instrument's internal structure. However, there is little evidence concerning the validity of the PGI-S taken from translations of the PGI or concerning the specific differences and commonalities between the two PGI versions. Second, for both the PGI



and the PGI-S, there is a lack of empirical evidence for the validity based on relations with other variables that are systematically associated with vocational interests.

In this study, we aimed to find further support for the validity of the PGI and the PGI-S by analyzing three sources of validity evidence that directly relate to the three dimensions and by examining the extent to which the analyzed relationships were invariant between PGI versions. First, we examined evidence based on the internal structure of the PGI's eight basic interest scales that define the equator of the interest sphere. Second, we analyzed convergent evidence of the three PGI dimensions across item types. Finally, we investigated evidence based on relations between the PGI dimensions and plausible correlates of vocational interests, namely, gender, academic achievement, and the socioeconomic status (SES) of the participants' desired professions.

In the following sections, we first introduce the spherical model of vocational interests and elaborate on the meaning and conceptualization of its three underlying dimensions before introducing the instruments used to assess them (i.e., PGI and PGI-S). We then continue by reviewing the theoretical arguments for the postulated associations between the three underlying dimensions and the aforementioned validity markers.

### 5.1.1 *Models of Vocational Interests*

*Holland's model of vocational interests.* The majority of research on vocational interests refers to interests as defined by Holland's (1997) model of vocational personalities and work environments. Therein, interests are defined as relatively stable preferences for broad activity domains. Holland postulated six distinct interest types, according to which individuals and environments can be categorized: Realistic, Investigative, Artistic, Social, Enterprising, and Conventional (RIASEC). One of the core assumptions of this model is the calculus hypothesis, which states that the six interest types can be represented on the perimeter of a circumplex (see also the left most panel of Figure 1). Thereby, the proximity of the interest types indicates a structural pattern of psychological similarity. Specifically, the distances between the interest types on the circumplex are inversely proportional to their similarity. For example, Investigative and Realistic are more similar than Investigative and Conventional, because they occupy adjacent

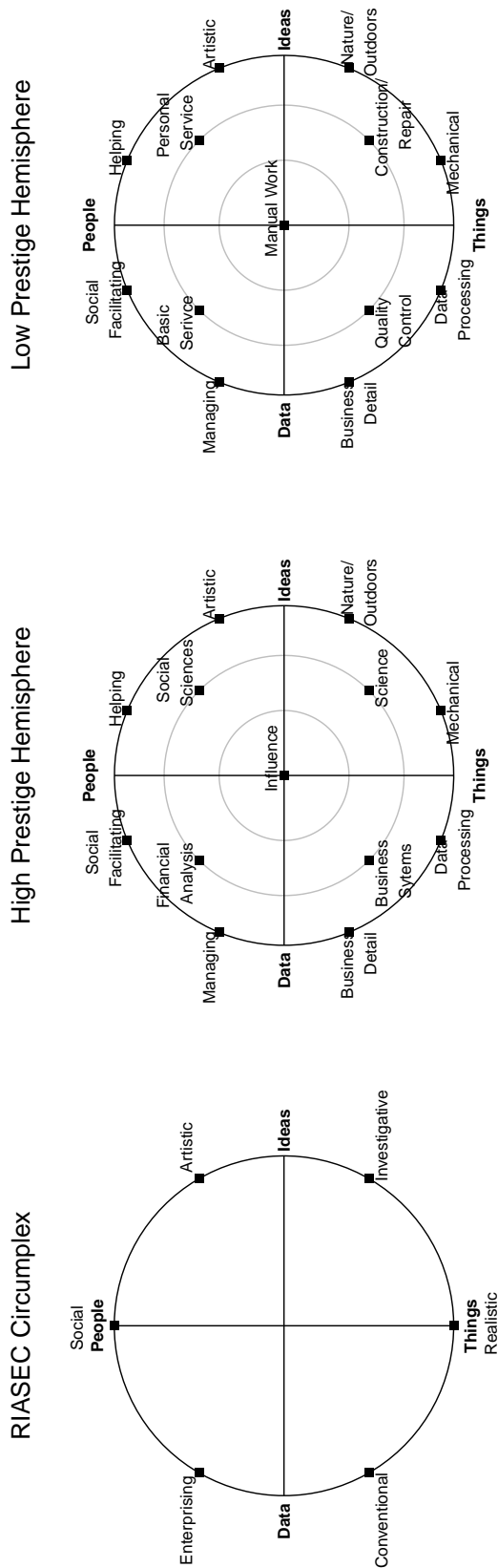


Figure 1: Traditional RIASEC model and spherical model of vocational interests

positions on the circumplex. Investigative and Enterprising are maximally different, because they are on opposing sides of the circumplex.

Underlying the circular order of the interest types are two dimensions: People-Things and Ideas-Data. The People-Things dimension distinguishes preferences for working with people from preferences for working with tools and machines, while the Ideas-Data dimension distinguishes preferences for unsystematic and creative tasks from preferences for structured and rigid tasks (Prediger, 1982). The left most panel of Figure 1 displays the RIASEC circumplex, with its underlying dimensions as coordinate axes. There is sound empirical evidence for the validity of these underlying dimensions and their relevance for research on vocational interests. For example, the People-Things dimension is often considered as the central construct to explain gender differences in vocational interests (Lippa, 1998; Su et al., 2009). Furthermore, the Ideas-Data dimension has been found to be related to verbal abilities (Ackerman & Heggstad, 1997).

Consequently, the two dimensions are often viewed as a constituting and organizing element of the interest circumplex (Armstrong et al., 2008), while the six RIASEC types can be seen as different blends of the dimensions' poles. As such, they are just one possible categorization of vocational interests among many others (Tracey & Rounds, 1995). The strong emphasis on the circumplex and its underlying dimensions naturally leads to the question of how to assess these dimensions with sufficient reliability, validity, and efficiency. A possible way to foster the assessment of the circumplex dimensions could be the use of a more differentiated interest conceptualization (e.g., one with more than six indicator scales).

*Spherical model and Personal Globe Inventory.* In recent years, alternatives to the RIASEC categorization have emerged that, while maintaining many of the core principles of the RIASEC model, extend it in meaningful ways. One of the most recent advancements is the spherical model of vocational interests (Tracey & Rounds, 1996b). This model extends the traditional RIASEC model by 1) using an alternative, more differentiated categorization of eight basic interest types to constitute the circumplex, and 2) introducing a third dimension that is orthogonal to the basic interest circumplex: Prestige. Within the framework of the spherical model, prestige is defined broadly as indicating preferences for or competence beliefs in activities with different levels of complexity, responsibility, and associated socioeconomic

status (Tracey & Rounds, 1996b).

Tracey (2002) introduced an instrument to assess vocational interests in the sense of the spherical model: the Personal Globe Inventory (PGI). The PGI comprises 18 interest types: eight scales for the basic interest circumplex (Social Facilitating, Managing, Business Detail, Data Processing, Mechanical, Nature/Outdoors, Artistic, and Helping) constituting the equator of the interest sphere, five scales for the High Prestige hemisphere (Social Sciences, Science, Influence, Financial Analysis, and Business Systems), and five scales for the Low Prestige hemisphere (Personal Service, Manual Work, Basic Service, Construction/Repair, and Quality Control). The middle and right panel of Figure 1 display the ordering of the scales on the sphere as viewed from above (High Prestige hemisphere) or below (Low Prestige hemisphere). A detailed description of the 18 interest types can be found in the original monograph (Tracey, 2002).

Each scale is measured with six items, resulting in a total of 108 items. Furthermore, there are three different item types that can be used to measure different, yet strongly interrelated, conceptualizations of the spherical model. The first two item types are intended to measure preferences for and competence self-beliefs in particular activities. Participants are asked to rate how much they like these activities (activity preferences) or how good they think they are at performing these activities (activity competence beliefs). The third item type assesses participants' preferences for certain occupations by means of their liking of different occupational titles (occupational preferences). Consequently, in its full form, the instrument consists of  $3 \times 108 = 324$  items.

To this day, the PGI has been translated into several languages (e.g., Hedrih, 2008; Holtrop et al., 2015). Analyses with each of these translations have provided evidence for the convergent validity of the PGI scales with other well-established interest inventories based on the RIASEC taxonomy (e.g., Etzel et al., 2016). However, evidence for the validity of the instrument is limited. First, evidence based on the PGI's internal structure has only been analyzed by means of the randomization test of hypothesized order relations (RTOR; Hubert & Arabie, 1987). As argued by Nagy et al. (2010), the RTOR is not well suited to detect nuanced differences between alternative covariance structures due to its weak power. The authors suggested using

more elaborate confirmatory methods to analyze the postulated circumplex structure, which we elaborate on in the Methods section. Second, there is little evidence concerning the validity of the PGI dimensions in relation to plausible correlates of vocational interests.

### 5.1.2 *The Spherical Model in Applied Research*

Although the spherical model is a promising extension of the traditional RIASEC model, applications of the PGI in research on vocational interests are still relatively rare. A few mentionable examples are the works of Holtrop et al. (2015), who analyzed the relationships between the PGI and personality traits, and Leung et al. (2014), who showed that Prestige can distinguish choice behavior for different educational pathways. There appear to be two main reasons for why the PGI is currently underused in applied research on vocational interests. First, although there is reasonable evidence for some sources of validity (i.e., evidence based on internal structure as well as convergent and discriminant evidence), the question of how the PGI's underlying dimensions relate to typical correlates of vocational interests has rarely been addressed. Second, the PGI is an extensive measure, consisting of 324 items in its full form, which could tempt researchers to rely on shorter instruments, which are, however, often based on the traditional RIASEC model.

In an attempt to remedy these issues, Tracey (2010) developed a short version of the PGI—the PGI-S. Using a data-driven approach, the author identified the four best marker items for the basic interest scales, as well as four items for the High and Low Prestige poles, respectively. In doing so, the number of items was effectively reduced to  $2 \times 40 = 80$  (40 for each of the two activity item types). Clearly, the PGI-S focuses on the assessment of the basic interest circumplex dimensions: People-Things and Ideas-Data. The Prestige dimension is assessed by combining two marker scales for High and Low Prestige. The PGI-S has been investigated in the United States (Tracey, 2010), in China (Zhang et al., 2013), and in Turkey (Vardarli et al., 2017). However, these studies were primarily concerned with validity evidence based on the instrument's internal structure and with convergent evidence, while the question of how the dimensional scores from the PGI-S relate to plausible correlates of vocational interests was not addressed in depth. In this regard, the evidence for the validity of the PGI and PGI-S is limited

and further research on their relationships with external variables is called for.

### 5.1.3 *Correlates of the Interest Sphere Dimensions*

In the following sections we introduce variables that constitute plausible validity markers of the dimensions of the PGI and PGI-S. Specifically, we discuss how the dimensions of the spherical model can be expected to relate to gender, academic achievement, and the SES of the desired profession. To this end, we draw on arguments brought forward in the framework of the Social Cognitive Career Theory (SCCT; Lent et al., 1994). The core assumption of the SCCT is that interests are formed by self-efficacy and outcome expectations. Interests in specific kinds of activities are then said to increase the probability to select and perform particular tasks in the future, which leads to attainments in particular task domains. Based on these experiences, individuals eventually revise their self-efficacy and outcome expectations and, thus, update their interests accordingly.

*Gender.* There is sound empirical evidence for the existence of systematic gender differences in vocational interests and educational choices across all age groups. Specifically, research has shown that women typically score higher on scales close to People, while men usually score higher on scales close to Things (Lippa, 1998; Su et al., 2009). In the framework of the SCCT, this finding is typically attributed to gender role socialization processes. For example, when boys and girls are exposed to different learning opportunities in critical phases of their career development and have particular outcome experiences while performing different activities, they inevitably develop distinguishable self-efficacy and outcome expectations and, consequently, distinguishable interests (Lent et al., 1994). Because of the overwhelming empirical evidence for and the striking magnitude of these gender differences (effect sizes larger than  $d = 1.20$ ; see Su et al., 2009), gender can be considered a strong marker for the validity of the People-Things dimension.

*Academic achievement.* According to the SCCT, individuals' current self-efficacy beliefs, outcome expectations, and interests in specific content domains affect their intentions to pursue and practice congruent activities. This practice leads to positive or negative experiences, depending on whether or not the individual is capable of mastering the respective activities.

Based on these experiences, individuals eventually reevaluate their self-efficacy beliefs and outcome expectations in the respective content domain, which, in turn, leads to a reassessment of corresponding interests (Lent et al., 1994).

Following this rationale, it can be reasoned that interests in specific domains, mediated by the sustained practice of corresponding activities, foster the acquisition and development of domain-specific abilities. In the long run, these reciprocal processes can be expected to result in a positive relationship between interests in specific domains and corresponding abilities, because successfully mastering specific activities positively reinforces interests in such activities, while the experience of failure in activities from other domains decreases interests in the latter. Consequently, given the strong link between abilities and academic achievement (e.g. Nagy, 2006; Rohde & Thompson, 2007), it is reasonable to assume that interests in specific content domains are positively associated with markers of academic achievement in corresponding subjects of study and negatively associated with academic achievement in subjects from oppositional content domains.

Similar arguments have been put forward by Ackerman and Heggestad (1997), as well as Pässler, Hell, and Beinicke (2015), who both found that, across multiple independent studies, cognitive abilities from different domains were associated with particular vocational interest types. Specifically, math and spatial abilities were found to be positively correlated with Realistic and Investigative interests, while verbal abilities were correlated with Artistic interests. Likewise, Volodina and Nagy (2016) were able to show that school grades from different subjects were systematically related to the six RIASEC types. For example, they found math and physics grades to be positively related to Realistic and Investigative interests and negatively related to Artistic and Social interests, and vice versa for German grades. Moreover, the correlations of these variables with the RIASEC types displayed a pattern that corresponded to the circular ordering of the scales. As argued by Nagy (2006), this means that these correlations can be projected onto the circumplex and, thus, can be directly related to the two underlying dimensions (People-Things and Ideas-Data). In an application of this approach, the author found math achievement to be related to Things, and English ability to be related to Ideas.

While the aforementioned studies provide evidence for associations between the circumplex

dimensions and academic achievement in specific domains, there is, to the best of our knowledge, not yet any comparable evidence for relations between the Prestige dimension and academic achievement. However, because the Prestige dimension indicates preferences for more complex and challenging tasks, Prestige can be expected to be positively associated with academic achievement in general. This is because, according to the SCCT, individuals with preferences for such tasks are more likely to practice respective activities and, based on whether they experience success or failure, update their interests in such tasks accordingly. Socioeconomic Status of the Desired Profession. Until now, we have introduced correlates of vocational interests that can be expected to be systematically associated with the two circumplex dimensions. There are only few comparable studies concerned with associations between the Prestige dimension and other variables. Tracey (2002) found that college students scored higher on High Prestige scales than high school students, and vice versa for Low Prestige scales. Furthermore, Sodano and Tracey (2008) found positive associations between the activity items' position on the Prestige dimension and students' content ratings regarding the level of prestige, effort, skill, and competition associated with those activities.

However, what is still missing is more proximal evidence of the Prestige dimension's eligibility to assess preferences for activities with different levels of Prestige. For example, if the Prestige dimension truly measures what it's supposed to measure, people scoring high on the Prestige dimension should aspire to more prestigious professions than those scoring low. One of the very few empirical examinations concerning the importance of the Prestige dimension is found in the work of Leung et al. (2014), who demonstrated that the Prestige dimension discriminated between students who chose a business oriented educational pathway and those who chose a path in arts and humanities.

## **5.2 The Present Investigation**

This article aimed to answer three distinct questions regarding different sources of evidence for the validity of the PGI dimensions, namely, evidence based on internal structure, convergent evidence, and evidence based on relations to other variables. Unless stated otherwise,



the hypotheses introduced below apply to all three item types (activity preferences, activity competence beliefs, and occupational preferences).

### 5.2.1 *Evidence Based on Internal Structure*

The first part of our study was aimed to evaluate the extent to which the eight basic interest scales conformed to a circumplex structure. In the literature, there is a distinction between perfect circumplexes with equidistant scale positions and quasi-circumplexes that allow deviations from the very strict equidistance assumption (e.g., Holland & Gottfredson, 1992). Since sample correlation matrices hardly ever concur with the strict pattern implied by an equidistant circumplex (Nagy, 2006; Nagy et al., 2010), we expected the basic interest scales to display the theoretically postulated circular order, but did not expect them to be equidistant.

**Hypothesis 1:** The eight basic interest scales will exhibit a quasi-circumplex structure.

### 5.2.2 *Convergent Evidence*

The second part of our study was concerned with the interrelations between corresponding PGI dimensions assessed with different item types. For example, the People-Things scores assessed with the activity preferences items should be positively related to the People-Things scores assessed with the activity competence beliefs items, as well as with those of the occupational preferences items. The same should be true for the other two dimensions. Based on the results of former validation studies (e.g., Hedrih, 2008; Tracey, 2002), we expected all of these relationships to be positive and of considerable magnitude.

**Hypothesis 2:** Corresponding PGI dimensions obtained from different item types will be positively associated.

### 5.2.3 *Evidence Based on Relations to Other Variables*

Finally, we analyzed the relationships between the three PGI dimensions and the validity markers presented in the previous sections. First, based on the overwhelming empirical support for the existence of gender differences along the People-Things dimension (Su et al., 2009), we expected male participants to score higher on Things and female participants to score higher on People.

**Hypothesis 3a:** Female participants will score higher on People and male participants will score higher on Things.

Second, based on the various findings concerning the relationships between intellectual abilities, achievement, and vocational interests (e.g., Ackerman & Heggestad, 1997; Pässler et al., 2015; Volodina & Nagy, 2016), we expected academic achievement to be differentially related to the two circumplex dimensions. Specifically, we anticipated achievement in school subjects that require verbal and artistic skills (i.e., German and art) to be related to Ideas and People and achievement in subjects that require scientific and mathematical abilities (i.e., math, physics, chemistry, and biology) to be related to Things.

**Hypothesis 3b:** Achievement in school subjects that require verbal or artistic skills (German and art) will be positively associated with Ideas and People.

**Hypothesis 3c:** Achievement in school subjects that require scientific or mathematical skills (math, physics, chemistry, and biology) will be positively associated with Things.

Due to the fact that the relationships between academic achievement markers and the Prestige dimension have never been analyzed before, we can only carefully speculate about possible links between these constructs. A plausible assumption could be that individuals with better grades are more likely to develop interests and competence beliefs in complex and demanding activities, thus resulting in positive relationships between Prestige and academic achievement in general. However, due to the lack of a resilient empirical and theoretical foundation, we addressed this as an open research question.

Lastly, we addressed the relationships between the three dimensions of the spherical model and the SES of the desired profession. As argued above, we expected that people with higher preferences for prestigious activities and occupations would aspire to occupations of higher SES. Consequently, if Prestige was independent of the content dimensions (i.e., People-Things and Ideas-Data), which it should be if the structure of interests is spherical, the socioeconomic status associated with the participants' desired profession should be positively associated with the Prestige dimension, but unrelated to the two circumplex dimensions.

**Hypothesis 3d:** The socioeconomic status associated with the desired profession will be positively associated with Prestige and unrelated to People-Things and Ideas-Data.

#### 5.2.4 *Invariance of the PGI and PGI-S Dimensions*

If the PGI-S is indeed a valid short version of the PGI, all of the above hypotheses should hold for both PGI versions. Consequently, we also analyzed the extent to which the postulated relationships were invariant between PGI versions. Because the PGI-S strongly focuses on the assessment of the basic interest circumplex, we expected the fit to the circumplex model, the convergence of the circumplex dimensions across item types, as well as the relationships between the external variables and the circumplex dimensions (People-Things and Ideas-Data) to be invariant across PGI versions. However, it is not self-evident that the same has to hold for the respective relationships concerning Prestige. This is because of the relatively broad definition of Prestige, which is supposed to cover preferences for tasks on different levels of status, difficulty, responsibility, and level of training (Tracey & Rounds, 1996b). Because the PGI-S measures Prestige with only eight items (compared to 60 in the PGI), it is questionable whether or not PGI-S Prestige can sufficiently cover the construct domain of Prestige. Accordingly, we tested the invariance of the postulated relationships for hypotheses **H2-H3d** separately for the circumplex dimensions and the Prestige dimension.

### 5.3 Method

#### 5.3.1 *Participants and Procedure*

In their validation study of the PGI, Etzel et al. (2016) used a random group online sample of university students in Germany acquired via Facebook. In two groups, a German translation of the PGI (for details on the translation process see Etzel et al., 2016) was presented in its full form (i.e., the long version for all three item types). In the third group, only the occupational interest items were assessed with the PGI, while activity preferences and activity competence beliefs were assessed with the PGI-S. In the present study, we relied on the PGI data from the same sample, but we also included data from the PGI-S as well as data from external variables that had never been analyzed before.

After excluding participants who quit the questionnaire before reaching the PGI items and those who could not be identified as students (e.g., due to missing information on occupational

status and major), we were left with  $N = 240$  participants for the PGI-S and  $N = 448$  participants for the PGI group. The two groups did not differ with regard to distribution of gender ( $\chi^2[1, N = 685] = 0.06, p = .80$ ; PGI group: 66% female, PGI-S group: 65% female), average age ( $t[683] = 0.17, p = .87$ ; PGI group:  $M = 22.29$ , PGI-S group:  $M = 22.25$ ), or distribution of RIASEC codes of the majors ( $\chi^2[5, N = 577] = 6.39, p = .27$ ). Hence, the two groups can be considered equivalent with regard to demographic composition.

### 5.3.2 Instruments

*Vocational interests.* Vocational interests were assessed using the German translations of the PGI and the PGI-S (Etzel et al., 2016). Participants were asked to rate how much they liked certain activities and occupations on a 7-Point Likert scale (1 = *Strongly dislike*, 7 = *Strongly like*). For the activity competence beliefs items, participants were asked to judge their competence in these activities (1 = *Unable to do*, 7 = *Very competent*).

The original versions of the instruments have been found to be reliable (PGI:  $.69 \leq \alpha \leq .96$ ; PGI-S:  $.71 \leq \alpha \leq .92$ ). Furthermore, there is evidence for their validity based on internal structure as well as on convergence with other interest instruments (Tracey, 2002, 2010). As mentioned above, the PGI consists of 18 scales, each measured by six items. The PGI-S consists of 10 scales, each measured by four items. While the PGI comprises three different item types, namely, activity preferences, activity competence beliefs, and occupational preferences, the PGI-S only comprises the two activity item types. A complete account of the sample correlations of the PGI and PGI-S scales and the external variables is given in the online supplemental material to this article.

*Academic achievement.* Academic achievement was measured via the participants' self-reported grades from their university entrance qualification in six different school subjects: German, art, math, biology, chemistry, and physics. Grades were scaled such that 1 indicated the worst possible grade (insufficient) and 6 indicated the best possible grade (very good). As argued by Kuncel, Crede, and Thomas (2005), the validity of self-reported grades is moderated by actual ability. However, because our sample comprised university students, we can safely assume that our participants were on the higher end of the ability spectrum, where the use of

self-reported grades is less problematic.

*Socioeconomic status of desired profession.* Participants were asked to indicate what kind of profession they would like to work in via an open-ended question. The occupations were then coded by two independent raters according to the International Standard Classification of Occupations (ISCO-08 International Labour Office, 2012). Coder agreement was very high (Cohen's  $\kappa = .85$ ). The ISCO-08 codes were further recoded to the respective scores of the International Socio-economic Index of Occupational Status classification system (ISEI; Ganzeboom, De Graaf, & Treiman, 1992), which is an empirically constructed measure of the SES of occupations (Ganzeboom & Treiman, 1996). The recoding was done using the syntaxes provided by the authors (Ganzeboom & Treimann, 2010). Due to the high correlations between the ISEI scores obtained from the two coders ( $r = .94$ ), we used the average of these scores in our analyses.

### 5.3.3 Statistical Analyses

*Circumplex structure.* In order to examine the circumplex structure of the eight basic interest scales (**H1**), we followed the approach suggested by Nagy et al. (2010), who proposed the use of a confirmatory factor analysis specification of Browne's (1992) circular stochastic process with a Fourier series (CSPF; see also Nagy et al., 2009). This model has several advantages compared to the commonly used RTOR. First, in the CSPF, the fit of the circumplex structure can be judged by means of familiar goodness-of-fit indices, as used in structural equation modeling (SEM). Second, the CSPF is a very flexible model that enables researchers to test specific hypotheses about the circumplex structure (e.g., testing whether or not the circumplex is perfectly equidistant). Finally, the CSPF can be extended to include multiple groups in order to test the invariance of the circumplex structure between groups.

Within the framework of this model, the correlation between two circumplex variables  $j$  and  $k$  is modeled as:

$$\rho_{j,k} = \zeta_j \left\{ \beta_0 + \sum_{m=1}^M \beta_m \times \cos [m \times (\theta_j - \theta_k)] \right\} \zeta_k, \quad (1)$$

where  $M$  is the number of components in the Fourier series,  $\zeta_j$  and  $\zeta_k$  are the communalities of variables  $j$  and  $k$ ,  $\beta_0, \beta_1, \dots, \beta_m$  are the parameters that define the shape of the correlation function (in order to ensure a correlation metric, the  $\beta$ -parameters are constrained to be positive and  $\beta_0 = 1 - \sum_{m=1}^M \beta_m$ ), and the  $\theta$ -parameters specify the angular locations of the respective scales on the circumplex measured in radians ( $0 \leq \theta \leq 2\pi$ ). Consequently, by using the CSPF, it is possible to parameterize the central aspects of the structural model and to test specific hypotheses about them. In our application, we estimated a quasi-circumplex by freely estimating all angular locations ( $\theta_j$ ) but one. This is because, in order to identify the model, one scale must serve as a reference scale (in our case: Mechanical) with a fixed angular location of  $0^\circ$ . A more detailed documentation of this approach can be found in Nagy et al. (in press).

In our application, we fitted multigroup CSPFs for the activity item types and a single-group CSPF for the occupational preferences item type. For the multigroup models, first, a reference model was estimated so that the respective parameters were allowed to vary freely across groups. By imposing equality constraints on the defining parameters of the circumplex (i.e., the  $\beta$ -parameters that pertain to the correlation function as well as the  $\theta$ -parameters that pertain to the angular locations of the scales), we tested whether or not the circumplex structure differed between the PGI and the PGI-S.

Traditionally, these hypotheses are evaluated by means of likelihood ratio ( $\Delta\chi^2$ ) tests. Thereby, a nonsignificant  $\Delta\chi^2$  test statistic indicates that the respective null hypothesis of no differences in fit cannot be rejected. A caveat of this test is its high sensitivity to detecting even the smallest deviations between competing models, especially when sample size is large. Statistical models are, in general, only simplified approximations of reality, which is why it is questionable whether or not small but statistically significant differences are of practical relevance. In order to address this issue, G. W. Cheung and Rensvold (2002) suggested using the difference between the models' comparative fit indices (CFI; Bentler, 1990) as an alternative means to judge model invariance. According to the authors, a difference of  $|\Delta\text{CFI}| < 0.01$  can be considered to indicate invariance. The overall goodness-of-fit of the CSPF models was evaluated in reference to common cutoff criteria for three of the most prominent goodness-of-fit indices [good fit: CFI > .95, root mean square error of approximation (RMSEA) < .05,

standardized root mean square residuals (SRMR) < .08; acceptable fit: CFI > .90, RMSEA < .08; but see also Marsh et al., 2004].

*Examination of item context effects in the PGI-S.* Preliminary to analyzing the central hypotheses, we addressed the issue of potential item context effects in the PGI-S. This step is particularly important as the PGI-S comprises a subset of PGI items. Hence, the context in which the items are presented differs between the PGI and PGI-S, to the extent that different items are presented immediately before and after the items that are part of both the PGI and the PGI-S. Therefore, we tested whether or not these different item contexts affected central item characteristics.

To this end, we created a pseudo PGI-S version (PGI-S\*) by calculating the scale and axes scores for participants who actually answered the full PGI, but using only the items that comprised the respective PGI-S scales. Using multigroup SEMs, we then tested whether or not the PGI-S and PGI-S\* were invariant with regard to means, standard deviations, intercorrelations, and relationships with the validity markers. In sum, we found no significant differences between the PGI-S and PGI-S\* in any of the analyzed relationships, which indicates that the items were not affected by the context in which they were presented (detailed results of these analyses may be requested from the corresponding author).

*Convergent evidence and relations to other variables.* In order to analyze the relationships between the PGI dimensions of different item types (2), the relationships between the dimension scores and the validity markers (**H3a-H3d**), and the invariance of these relationships across PGI versions, we used SEMs that incorporated two separate variables for each dimension. The first variable contained the dimension scores obtained from the PGI, while the second variable contained the corresponding scores obtained from the PGI-S, as well as the respective data from the PGI-S\*. In order to test the invariance of the respective estimates between the PGI and PGI-S, the parameters in question were set to be equal and the degree of misfit introduced by this constraint was evaluated by means of  $\Delta\chi^2$  tests (Preacher, 2006). Because we found no indication of item context effects, any noninvariant relationships between the PGI and PGI-S would be solely attributable to differences in the specific item compositions of the long and short version. The major benefit of using this particular approach is that it maximizes the power

of the tests in question, because it uses all the available information to estimate the respective parameters.

All analyses were conducted using the *lavaan* package (version 0.6-1; Rosseel, 2012) in R (R Core Team, 2018), with the exception of the CSPF analyses of the circumplex structure, which were conducted using *Mplus 7.4* (Muthén & Muthén, 1998-2014). The invariance tests between PGI and PGI-S were conducted separately for the two circumplex dimensions and the Prestige dimension. Furthermore, each analysis was conducted separately for all available item types. The majority of missing data in our study was due to the planned missing data design (81%). Another 6% of missingness was due to item nonresponse, and 13% of missingness was due to participants not reaching the end of the questionnaire. Missing data were handled by means of full information maximum likelihood (FIML) estimation, which has been shown to be superior to traditional methods of handling missing data, such as listwise deletion (Schafer & Graham, 2002). FIML estimation was justified, because 1) the amount of not-reached items did not affect the distribution of PGI scores, 2) the amount of item nonresponse was negligible, and 3) the majority of missing data was planned and could, therefore, be considered to be missing completely at random (Graham, Taylor, Olchowski, & Cumsille, 2006).

## 5.4 Results

The following sections follow a strict rationale that aims to ease the presentation of the results pertaining to the analyses introduced above. Specifically, the three subsections of this section correspond to the three sources of validity evidence under investigation. Within each subsection, we first present the results pertaining to the PGI before contrasting these results to the corresponding results pertaining to the PGI-S. Furthermore, whenever suitable, we first present the results pertaining to the two circumplex dimensions (People-Things and Ideas-Data) before presenting the results pertaining to the Prestige dimension.

### 5.4.1 *Internal Consistency*

Prior to the examination of our central hypotheses, we analyzed the reliability of the dimensions



Table 1: Descriptive Statistics and Internal Consistencies ( $\alpha$ ) of PGI and PGI-S Scales and Correlates

	AP				ACB				OP						
	PGI		PGI-S		PGI		PGI-S		PGI		PGI				
	M	SD	$\alpha$	M	SD	$\alpha$	M	SD	$\alpha$	M	SD	$\alpha$			
<i>PGI Scales</i>															
Social Facilitating	3.99	1.23	.76	3.80	1.27	.71	4.40	1.16	.71	4.27	1.21	.68	3.70	1.09	.72
Managing	3.85	1.09	.71	3.83	1.23	.71	4.29	1.13	.70	3.99	1.27	.73	3.32	1.22	.86
Business Detail	2.92	1.25	.84	2.74	1.31	.81	3.06	1.31	.84	2.99	1.31	.79	2.56	1.25	.91
Data Processing	2.66	1.28	.81	2.63	1.29	.71	2.24	1.19	.79	2.20	1.17	.72	2.44	1.35	.93
Mechanical	2.49	1.27	.85	2.56	1.34	.78	1.99	1.08	.83	2.23	1.31	.78	2.53	1.33	.89
Nature/Outdoors	3.69	1.21	.71	4.06	1.31	.66	3.34	1.11	.71	3.94	1.25	.68	3.71	1.51	.89
Artistic	3.80	1.55	.84	3.66	1.62	.79	2.92	1.26	.80	2.70	1.38	.78	3.51	1.60	.90
Helping	4.94	1.15	.73	4.34	1.45	.73	4.63	1.14	.73	4.05	1.35	.62	4.25	1.59	.93
High Prestige	8.23	2.33	.85	3.95	1.27	.55	7.30	2.30	.88	3.72	1.17	.59	8.39	2.30	.88
Low Prestige	6.18	2.22	.87	2.75	1.22	.71	6.52	2.25	.89	3.13	1.38	.70	5.71	2.06	.91
People-Things	3.92	3.42	.89	3.00	3.52	.85	4.80	3.09	.88	3.52	3.27	.82	2.98	3.90	.95
Ideas-Data	1.00	3.07	.86	1.29	3.48	.84	-1.05	2.53	.81	-0.35	2.79	.78	1.49	3.66	.94
Prestige	2.07	2.58	.82	1.21	1.60	.55	0.79	2.20	.83	0.60	1.57	.54	2.66	2.27	.85
<i>Correlates</i>															
Gender	1.70	0.48	—	—	—	—	—	—	—	—	—	—	—	—	—
German	4.90	0.86	—	—	—	—	—	—	—	—	—	—	—	—	—
Art	5.16	0.82	—	—	—	—	—	—	—	—	—	—	—	—	—
Math	4.54	1.17	—	—	—	—	—	—	—	—	—	—	—	—	—
Physics	4.41	1.06	—	—	—	—	—	—	—	—	—	—	—	—	—
Chemistry	4.48	1.12	—	—	—	—	—	—	—	—	—	—	—	—	—
Biology	4.89	0.94	—	—	—	—	—	—	—	—	—	—	—	—	—
ISEI	73.88	14.09	—	—	—	—	—	—	—	—	—	—	—	—	—

Note.  $\alpha$  = Cronbach's coefficient  $\alpha$ . AP = Activity preferences; ACB = Activity competence beliefs; OP = Occupational preferences; gender was coded as 1 = male, 2 = female.

and subscales across PGI versions and item types. The internal consistency estimates (Cronbach's  $\alpha$ ) of all subscales and dimensions are presented in Table 1. According to Nunnally (1978),  $\alpha$  should be at least .70 for basic research purposes and at least .90 for individual diagnostics. Across all item types, we found the PGI scales and dimensions to exceed the  $\alpha = .70$  threshold. As expected, the internal consistencies of the PGI scales and dimensions were, on average, larger than those of the corresponding PGI-S scales and dimensions, due to the higher item count (PGI:  $.79 \leq \bar{\alpha} \leq .88$ ; PGI-S:  $.71 \leq \bar{\alpha} \leq .72$ ).

For the PGI-S subscales, six out of the 20  $\alpha$  values fell below the .70 threshold. However, only three of these subscales yielded  $\alpha$  values that were significantly lower than .70, as indicated by the fact that .70 was not included in the respective bootstrapped 95% confidence interval (Helping for the activity competence beliefs item type, and High Prestige for both activity item types). However, the low subscale reliabilities did not affect the reliabilities of the PGI-S circumplex dimensions, which yielded good internal consistencies ( $.78 \leq \alpha \leq .85$ ) that were comparable to those of the PGI ( $.81 \leq \alpha \leq .95$ ). The internal consistencies of PGI Prestige were good ( $.82 \leq \alpha \leq .85$ ), but those of PGI-S Prestige were critically low ( $.54 \leq \alpha \leq .55$ ).

#### 5.4.2 *Fit to the Structural Model*

The first step in the analyses of the basic interest scales' fit to the circumplex model was to examine how many components in the Fourier series would suffice to adequately estimate the correlation functions. To this end, Browne (1992) recommended using fewer components than the number of indicators divided by two, which led to a maximum number of three components in our case. Consequently, we fitted the CSPF for each subsample using  $M = 3$ ,  $M = 2$ , and  $M = 1$  components in the Fourier series. In doing so, we found  $M = 2$  components to be adequate for estimating the CSPF for activity preferences and occupational preferences, and  $M = 3$  components to be adequate for activity competence beliefs.

Table 2 displays the goodness-of-fit indices and model comparison statistics of the multi-group CSPFs for the activity item types (M1a-M2b), as well as those of the single-group CSFP for the occupational preferences item type (M3). The reference models for the activity item types (M1a and M2a) fitted the data excellently, as did the models in which the parameters responsible

Table 2: Goodness-of-fit Indices and Model Comparisons for the CSPF for all Item Types

Model	Goodness-of-Fit Indices						Model Comparisons			
	$\chi^2$	df	<i>p</i>	CFI	RMSEA	SRMR	$\Delta\chi^2$	$\Delta$ df	<i>p</i>	$\Delta$ CFI
<i>Activity preferences</i>										
M1a	42.04	22	.01	.988	.052	[.027, .076]	.034			
M1b	51.86	31	.01	.988	.045	[.022, .066]	.042	9	.37	.000
<i>Activity competence beliefs</i>										
M2a	53.11	20	.00	.981	.070	[.048, .094]	.041			
M2b	75.79	30	.00	.974	.068	[.049, .087]	.050	10	.01	-.007
<i>Activity competence beliefs</i>										
M3	46.20	11	.00	.975	.099	[.071, .129]	.055			

Note. Model comparisons were possible for activity preferences and activity competence beliefs item types. Model a) is always the unconstrained model, where the  $\theta$ - and  $\beta$ -parameters were estimated freely for each PGI version. Model b) is always the constrained model, where these parameters were set to be equal between PGI versions. For occupational preferences (M3), a single-group CSPF was estimated.

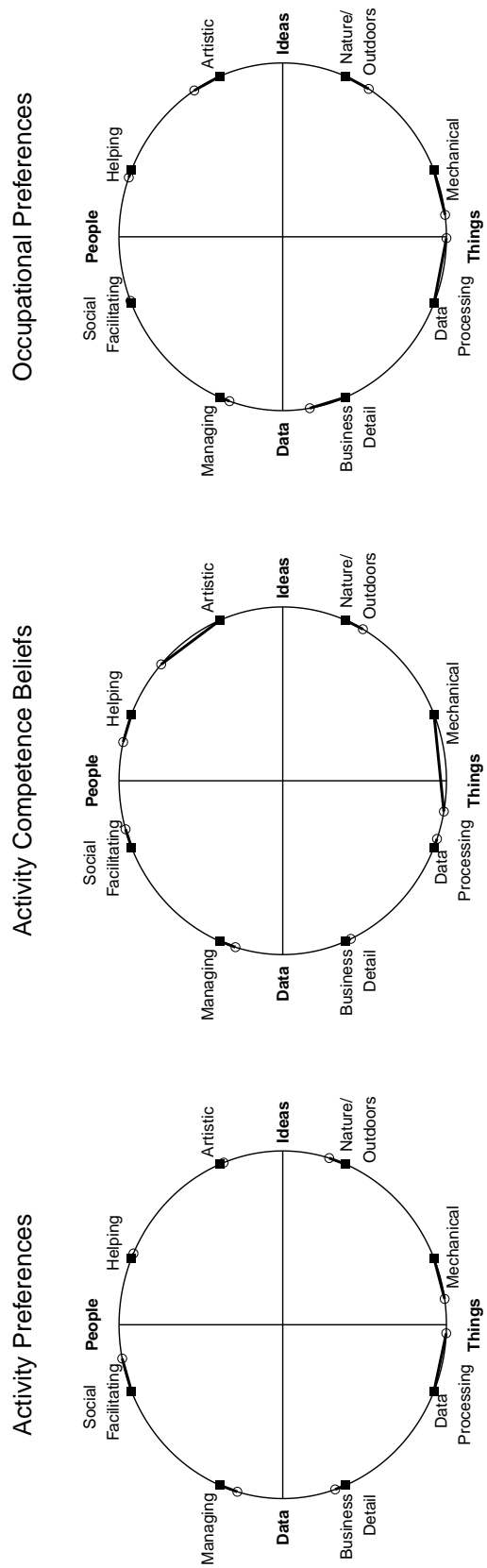


Figure 2: Comparison of theoretically postulated (■) and empirically estimated (○) scale positions from the restricted CSPF models. The empirically estimated scale positions were rotated such that the mean deviation from the theoretically postulated scale positions was minimized.

for the shape of the correlation functions ( $\beta$ ) and those identifying the scales' positions on the circumplex ( $\theta$ ) were set to be equal between the PGI and the PGI-S (M1b and M2b). For the activity preferences item type, the fit of the constrained model was not significantly worse with respect to the  $\Delta\chi^2$  test as well as the  $\Delta\text{CFI}$  criterion. For the activity competence beliefs item type, the  $\Delta\chi^2$  test indicated a significant decrease in fit for the constrained model. However, the  $\Delta\text{CFI}$  criterion did not indicate a meaningful difference between the models ( $\Delta\text{CFI} = -.007$ ). Finally, the fit of the single-group CSPF to the PGI occupational preferences data was very good according to the CFI and the SRMR, but only acceptable according to the RMSEA. The most plausible source of this minor inconsistency was the very small unique variance of the Social Facilitating subscale (Browne, MacCallum, Kim, Andersen, & Glaser, 2002).

In sum, our findings strongly support **H1**. As can be seen in Figure 2, the scales did not conform to a perfectly equidistant circumplex, as was expected. In order to quantify the scale positions' average deviation from the theoretically postulated positions, we used the  $A^*$  coefficient (Fisher, Heise, Bohrnstedt, & Lucke, 1985), a circular analog of the common Pearson product-moment correlation. In our sample, fit was close to unity for the activity ( $A^* = .96$ ) and occupational ( $A^* = .94$ ) preferences item types, and somewhat lower but still very high for the activity competence beliefs item type ( $A^* = .81$ ).

### 5.4.3 *Convergent Evidence*

Table 3 summarizes the correlations between corresponding dimension scores from different item types in four super columns, containing (from left to right) 1) the correlations between corresponding PGI dimensions, 2) the correlations between corresponding PGI-S dimensions, 3) the invariance tests for these correlations between the PGI and PGI-S circumplex dimensions, and 4) the corresponding invariance tests for PGI and PGI-S Prestige. Note that, for the PGI-S, the relationships between the activity item type dimensions and the occupational preferences dimensions are in fact relationships between the PGI-S activity item type dimensions and the PGI occupational preferences dimensions.

First, in line with our expectations, we found the correlations of corresponding PGI circumplex dimensions (People-Things and Ideas-Data) to be very high for all three comparisons

Table 3: Relationships Between PGI Dimensions and Correlates with Corresponding Invariance Tests between PGI and PGI-S

	PGI			PGI-S			Test P-T & I-D		Test PRE	
	P-T	I-D	PRE	P-T	I-D	PRE	$\chi^2_2$	$p$	$\chi^2_1$	$p$
AP with ACB	.85***	.75***	.75***	.84***	.77***	.63***	3.71	.16	27.25	.00
AP with OP	.78***	.83***	.43***	.77***	.81***	.32***	1.78	.41	8.68	.00
ACB with OP	.75***	.66***	.28***	.74***	.64***	.21***	1.66	.43	2.66	.10

*Note.* P-T = People-Things, I-D = Ideas-Data, PRE = Prestige; AP = Activity preferences, ACB = Activity competence beliefs, OP = Occupational preferences.

\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$ .

(.66  $\leq r \leq$  .85, all  $p < .001$ ). Concerning the Prestige dimension, the convergent correlation was also high for the comparison of the activity item types ( $r = .75$ ,  $p < .001$ ). However, the respective correlations between the activity item types and the occupational preferences item type were notably smaller (activity preferences with occupational preferences:  $r = .43$ ,  $p < .001$ ; activity competence beliefs with occupational preferences:  $r = .28$ ,  $p < .001$ ).

For the PGI-S circumplex dimensions, the results were basically identical (.64  $\leq r \leq$  .84, all  $p < .001$ ). Moreover, these correlations were not significantly different from the corresponding correlations obtained in the PGI, as indicated by the nonsignificant  $\chi^2$ -difference tests (third super column of Table 3). The correlations between the Prestige dimensions from different item types were, again, high for the comparison of activity item types ( $r = .63$ ,  $p < .001$ ), and notably smaller for the comparison of activity item types and occupational preferences (activity preferences with occupational preferences:  $r = .32$ ,  $p < .001$ ; activity competence beliefs with occupational preferences:  $r = .21$ ,  $p < .001$ ).

In addition, convergent correlations between the PGI-S Prestige axes were systematically smaller than the corresponding correlations between the PGI Prestige axes, and significantly so for two out of three comparisons. The fact that the convergent correlations of activity competence beliefs Prestige and occupational preferences Prestige did not differ significantly between the PGI and PGI-S could be due to the fact that the respective correlations were rather small in the first place (.21  $\leq r \leq$  .28; all  $p < .001$ ).

Taken together, our findings partially support **H2** and provide first insights into the com-

monalities and differences between the dimensions of the spherical model, as assessed with different item types and PGI versions. While the circumplex dimensions of different item types were strongly related for both the PGI and PGI-S, the interrelations of activity Prestige and occupational Prestige, as well as those of PGI Prestige and PGI-S Prestige, were rather ambivalent, to the extent that they appeared to capture related, yet somewhat distinguishable aspects of Prestige.

#### 5.4.4 *Evidence Based on Relations to Other Variables*

In this section, we present the results of our analyses concerning the relationships of the PGI and PGI-S dimensions with the external validity markers. We first present the results pertaining to the relationships between the two PGI circumplex dimensions (People-Things and Ideas-Data) and the validity markers before we progress to the corresponding relationships between the PGI Prestige dimension and the validity markers. We conclude by contrasting the corresponding relationships between the PGI and the PGI-S, again, first for the two circumplex dimensions and then for the Prestige dimension. A summary of these results can be found in Table 4. Just like Table 3, it consists of four super columns containing (from left to right) 1) the correlations of the PGI dimensions and the validity markers, 2) the respective correlations of the PGI-S dimensions and the validity markers, 3) the invariance tests for these relationships between the PGI and PGI-S circumplex dimensions (People-Things and Ideas-Data), and 4) the corresponding invariance tests for PGI and PGI-S Prestige. In addition, Figures 3 and 4 illustrate the respective relationships with the two circumplex axes (Figure 3) and the Prestige axis (Figure 4) for all three item types and both PGI versions.

*PGI circumplex dimensions.* First, we found the expected positive relationship between gender (*male* = 1, *female* = 2) and the People-Things axes (**H3a**) across all three item types ( $.35 \leq r \leq .43$ , all  $p < .001$ ), indicating that, on average, female participants scored higher on People and male participants scored higher on Things. Additionally, for the activity item types, gender was positively correlated with Ideas-Data.

As expected, better grades in German and art were positively related to People and Ideas (**H3b**) for the activity item types ( $.13 \leq r \leq .24$ , all  $p < .01$ ). For occupational preferences,

Table 4: Relationships Between PGI Dimensions and Correlates with Corresponding Invariance Tests between PGI and PGI-S

	PGI			PGI-S			PGI = PGI-S			Test Circumplex		Test Prestige	
	P-T	I-D	PRE	P-T	I-D	PRE	P-T	I-D	PRE	$\chi^2_2$	$p$	$\chi^2_1$	$p$
<i>Activity preferences</i>													
Sex	.41***	.11**	.01	.45***	.11**	-.02	.42***	.13**	-.00	12.28	.00	1.26	.26
German	.20***	.14***	.21***	.18***	.09*	.27***	.20***	.11**	.25***	19.15	.00	3.65	.06
Art	.19***	.18***	.00	.19***	.19***	.09	.19***	.19***	.06	0.95	.62	6.40	.01
Math	-.14***	-.02	.02	-.14***	-.05	-.04	-.13**	-.04	-.02	2.92	.23	3.46	.06
Physics	-.30***	-.07	-.02	-.30***	-.06	-.07	-.30***	-.06	-.05	0.16	.92	2.71	.10
Chemistry	-.21***	-.01	.04	-.21***	-.02	.01	-.21***	-.02	.02	0.50	.78	0.72	.40
Biology	-.11*	.10*	.14**	-.12**	.09*	.06	-.11**	.09*	.09*	1.42	.49	5.93	.01
ISEI	.06	.06	.21***	.07	.03	.13**	.08	.04	.16***	5.59	.06	7.83	.01
<i>Activity competence beliefs</i>													
Sex	.43***	.18***	.11**	.48***	.20***	.08	.45***	.19***	.10*	28.15	.00	0.91	.34
German	.16***	.13**	.27***	.14***	.05	.28***	.16***	.07	.28***	32.07	.00	0.14	.71
Art	.24***	.22***	.03	.22***	.22***	.15**	.22***	.22***	.12*	2.02	.36	9.54	.00
Math	-.21***	-.04	.09	-.21***	-.06	.04	-.21***	-.05	.06	0.83	.66	1.73	.19
Physics	-.31***	-.14**	.05	-.32***	-.10*	-.00	-.32***	-.11*	.01	5.24	.07	1.58	.21
Chemistry	-.21***	-.01	.04	-.23***	-.01	.01	-.22***	-.01	.02	1.98	.37	0.83	.36
Biology	-.13**	.07	.13*	-.15***	.08	.08	-.15***	.08	.10*	2.70	.26	1.49	.22
ISEI	.08	.10*	.26***	.07	.06	.18***	.09*	.08	.21***	6.79	.03	6.25	.01

Note. P-T = People-Things, I-D = Ideas-Data, PRE = Prestige. Gender was coded as 1 = male, 2 = female.

\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$ .



German grade was positively associated with People ( $r = .15, p < .01$ ), while the art grade did not yield any significant relationship with either circumplex dimension. Grades in the natural sciences and math were positively associated with Things (**H3c**), as indicated by the negative correlations with the People-Things axes ( $-.31 \leq r \leq -.11$ , all  $p < .05$ ). The only exception was the correlation between biology grade and People-Things for occupational preferences, which was not significantly different from zero. The correlations between grades in math and the natural sciences and the Ideas-Data axes were, for the most part, not significantly different from zero. The few exceptions were the correlations of Ideas-Data with biology grade for activity preferences ( $r = .10, p < .05$ ) and occupational preferences ( $r = .10, p < .05$ ), as well as the correlation with physics grade for activity competence beliefs ( $r = -.14, p < .01$ ).

Lastly, the ISEI of the desired profession was not related to either PGI circumplex dimension, with the exception of a negligibly small correlation with Ideas-Data for activity competence beliefs ( $r = .10, p < .05$ ). These findings were also in line with our expectations, since the sphericity of the model implies that the High and Low Prestige poles can be expected to be unrelated to the circumplex dimensions (i.e., People-Things and Ideas-Data; **H3d**).

*PGI Prestige dimension.* Turning our attention to the respective relationships between the validity markers and the PGI Prestige axes, we first found gender to be unrelated to Prestige for the activity and occupational preferences item types, and only weakly related to activity competence beliefs Prestige ( $r = .11, p < .01$ ). This means that, while male and female students were, on average, equally likely to prefer High Prestige activities and occupations, female students perceived themselves to be slightly more competent in High Prestige activities than male students.

Concerning the relationships with academic achievement, we found the German grade to be positively associated with Prestige for the activity item types (activity preferences:  $r = .21, p < .001$ ; activity competence beliefs:  $r = .27, p < .001$ ), but not for the occupational preferences item type. Furthermore, our analyses yielded small positive correlations between Prestige and biology grade for the activity item types. Remarkably, occupational preferences Prestige was positively related to grades in all natural science domains (physics:  $r = .23$ , chemistry:  $r = .31$ , biology:  $r = .32$ , all  $p < .001$ ).

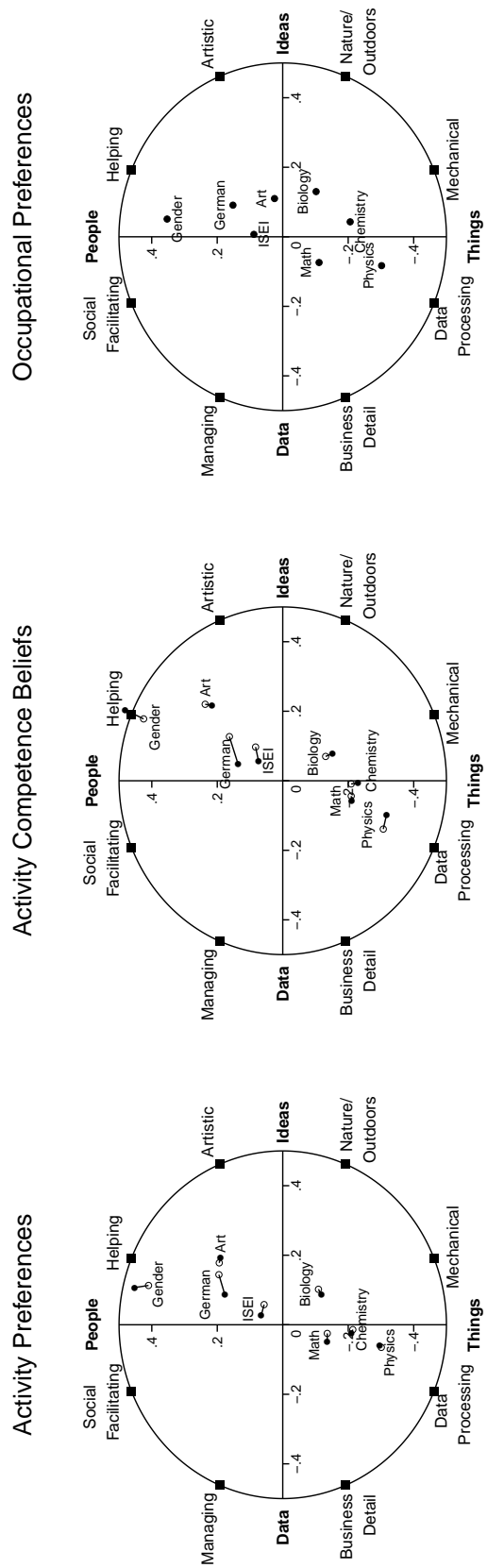


Figure 3: Correlations between the validity markers with the People-Things and Ideas-Data dimension scores of the PGI (○) and PGI-S (●) projected onto the basic interest circumplex. Gender was coded as 1 = *male* and 2 = *female*.

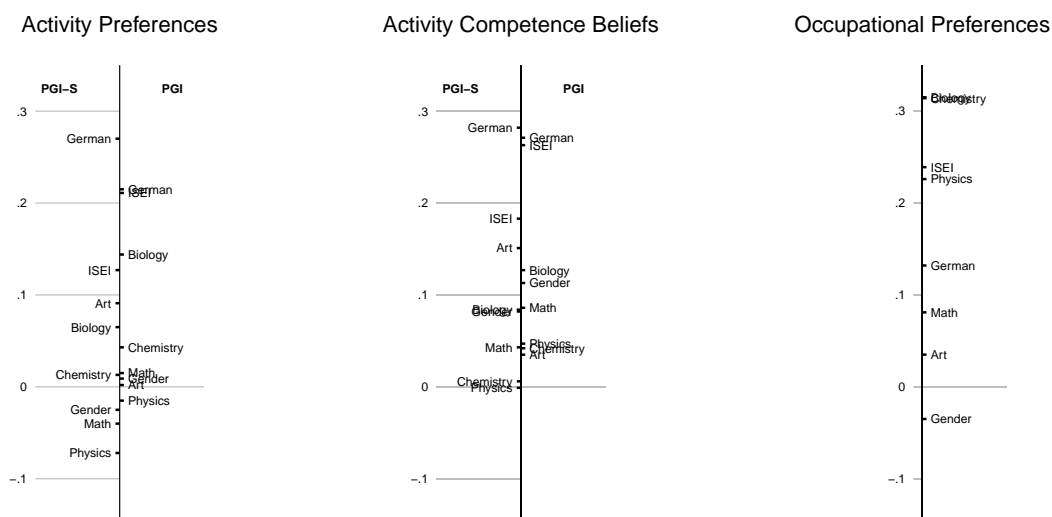


Figure 4: Correlations between the validity markers and the Prestige dimension scores from the PGI and PGI-S. Gender was coded as 1 = *male* and 2 = *female*.

Finally, the correlations of PGI Prestige with the central validity marker, the ISEI score of the participants' desired professions, was positive and of moderate size for all three item types ( $.21 \leq r \leq .26$ , all  $p < .001$ ). Hence, in line with our expectations, people with higher scores on the Prestige dimensions were more likely to aspire to professions associated with higher levels of SES (**H3d**).

#### 5.4.5 Comparison of PGI and PGI-S

*Circumplex dimensions.* As can be seen in Figure 3, the relationship patterns of the PGI circumplex axes and the PGI-S circumplex axes with all validity markers were very similar. Specifically, for the activity preferences item type, we found only two significant differences between the two PGI versions. First, the associations between gender and the circumplex dimensions, especially People-Things, were marginally larger in the PGI-S than they were in the PGI ( $|\Delta r| = .04$ ). Second, the PGI circumplex dimensions were more strongly associated with German grade than those of the PGI-S ( $|\Delta r| = .02$  for People-Things,  $|\Delta r| = .05$  for Ideas-Data). However, the magnitudes of these differences were very small and can be considered to be of little practical relevance.

For the activity competence beliefs item type, we found three significantly different re-

relationships between the PGI and PGI-S. First, the point-biserial correlation with gender was marginally larger in the PGI-S ( $|\Delta r| = .05$  for People-Things,  $|\Delta r| = .02$  for Ideas-Data). Second, the correlation with German grade was slightly larger in the PGI ( $|\Delta r| = .02$  for People-Things,  $|\Delta r| = .08$  for Ideas-Data). Lastly, the correlation with the ISEI of the desired profession was slightly larger in the PGI ( $|\Delta r| = .01$  for People-Things,  $|\Delta r| = .04$  for Ideas-Data). However, since these relationships were close to zero in the first place, these differences, too, should have little to no practical impact.

*Prestige dimension.* For the respective relationships between the validity markers and Prestige, we found three significant differences for activity preferences. First, the correlation of Prestige with art grade was higher for PGI-S Prestige ( $|\Delta r| = .09$ ). However, both correlations were not significantly different from zero. Second, PGI Prestige yielded a higher correlation with biology grade than PGI-S Prestige ( $|\Delta r| = .08$ ). Most importantly, PGI prestige was more strongly correlated with the central validity marker, namely, the ISEI of the desired profession, than PGI-S Prestige ( $|\Delta r| = .08$ ). For activity competence beliefs, PGI-S Prestige also yielded a higher correlation with art grade ( $|\Delta r| = .12$ ) and a lower correlation with the ISEI of the desired profession ( $|\Delta r| = .08$ ).

To summarize the central findings of our analyses, we found the relationships between the validity markers and the circumplex axes to be largely in line with our expectations (**H3a–H3d**) and highly similar across item types and PGI versions. However, the respective analyses of the relationships with the Prestige axes revealed two possible sources of discordance. First, while Prestige, as assessed with the activity items, was predominantly related to verbal achievement, occupational preferences Prestige was primarily associated with achievement in the natural sciences. Second, for all PGI item types, the ISEI score of the desired occupation yielded the expected moderate positive correlations, while these relationships were significantly weaker in the PGI-S.

## 5.5 Discussion

The aim of the present study was twofold. First, we aimed to investigate three different sources

of evidence for the validity of the dimensions of the spherical model of vocational interests as assessed with the PGI: People-Things, Ideas-Data, and Prestige. Second, we aimed to find further support for the validity of the PGI-S, by examining the extent to which these sources of evidence were invariant between the two PGI versions. In sum, our analyses yielded highly similar results when the two circumplex dimensions were concerned. Across item types and PGI versions, we found that the correlation pattern of the basic interest scales conformed to a quasi-circumplex structure (**H1**), that the circumplex dimensions measured with different item types showed a high convergence (**H2**), and that the relationships of the circumplex dimensions with gender (**H3a**), academic achievement (**H3b** and **H3c**), and the SES associated with the desired profession (**H3d**) were largely in line with our expectations.

Unfortunately, the same could not be confirmed for the Prestige dimension. While we found that Prestige, as measured with all item types or either PGI version, was positively associated with our central validity marker the ISEI score associated with the participants' desired profession, we also found some inconsistencies. Specifically, we found that the reliability of PGI-S Prestige was insufficient, that the convergent validity evidence of Prestige was the lowest for all three dimensions, and that the relationships of Prestige and the academic achievement markers varied between item types and PGI versions. In the next section, we discuss possible reasons and solutions for the identified incongruities, before contrasting the pros and cons of the two PGI versions. We then conclude by summarizing the practical implications of our findings and discussing possible limitations of our study that might serve as a starting point for future research.

### 5.5.1 *Reliability of the PGI-S Subscales and Dimensions*

Our analyses revealed that the reliabilities of some PGI-S subscales were not optimal. This problem primarily concerned the High Prestige subscale and, consequently, the Prestige dimension of the PGI-S. The reliability estimates of all other subscales were roughly the size that could be expected due to the lower item count. Most importantly, the internal consistencies of the circumplex dimensions were high regardless of PGI version or item type. Our findings thus stand in contrast to those of Tracey (2010), who did not report similar problems concerning the

reliability of the PGI-S Prestige subscales.

In our opinion, the most plausible explanation for the low reliability of the German PGI-S High Prestige scales is the specific item selection. Recall that Tracey (2010) used item response theory methods to empirically determine the four best marker items from the original 30 High Prestige items in a US sample. Because we used the same items from the German translation of the PGI, we cannot rule out that these four items were either not optimally translated or were just not perfectly suitable indicators of High Prestige in our population. Future research could pursue a similar data-driven item selection approach to identify a better set of items to measure the PGI-S High Prestige dimension. Furthermore, using more than just four items to assess High Prestige might be necessary in order to cover the broadly defined Prestige construct more sufficiently.

### 5.5.2 *Differential Relationships of PGI and PGI-S*

**Prestige with Validity Markers** While the relationships between our external validity markers and the two circumplex dimensions, as assessed with all item types, were neatly in line with theoretical expectations and largely invariant between PGI versions, our findings concerning the relationships between these validity markers and Prestige were more heterogeneous. We would like to further elucidate the two most striking incongruities.

First, while the relationships between PGI Prestige, as assessed with the two activity item types, and the academic achievement markers were largely invariant, the pattern of relationships for occupational preferences Prestige was notably different. Specifically, activity Prestige was positively related to verbal achievement and was not or was only weakly associated with achievement in other content domains. Conversely, occupational preferences Prestige was positively related to achievement in the natural sciences (i.e., physics, biology, and chemistry). Second, although Prestige was found to be positively related with the ISEI of the participants' desired profession across item types and PGI versions, these relationships were significantly lower for PGI-S Prestige than for PGI Prestige.

The most plausible explanation for these differences is, in our opinion, again, the specific item content and the selection of the respective measures. Concerning the differences between

the PGI item types, it is important to recall that the activity items are phrased as common work activities, such as "Give lectures to large groups", while the occupational preferences items are simply occupational titles, such as "Biologist" or "Chemist". While the activity descriptions are rather concrete and tangible, the occupational titles are subject to the participants' ideas about the respective occupations. Moreover, students with different occupational aspirations might have concrete ideas about which specific occupations they are interested in, while they do not necessarily associate specific activities with these occupations. These disparities might in turn lead to different conceptualizations of Prestige preferences, depending on which item type is used. This could also explain the relatively low correlations between corresponding PGI and PGI-S Prestige dimensions from all item types.

Concerning the differential relationships of PGI and PGI-S Prestige with the validity markers, one possible explanation could be that the relationship between the ISEI and Prestige in the PGI-S was underestimated due to the unreliability of the PGI-S Prestige dimension. If this was the case, the relationship patterns of PGI and PGI-S Prestige would be similar, but of different magnitude. Specifically, the relationships of the validity markers and PGI-S Prestige would decrease towards zero. However, the fact that PGI-S Prestige correlated higher with verbal achievement suggests that this is not the most plausible explanation. A more substantial explanation, which could also explain the predominant relationship between Prestige and verbal abilities, is that the Prestige construct in the PGI-S is more narrowly defined, compared to Prestige in the PGI. A closer look at the content of the items that comprise the Low Prestige and High Prestige subscales of the PGI-S shows that they differ strongly with regard to the degree of verbal skills required to successfully complete them.

While the High Prestige subscale contains activities such as "Provide financial counseling", "Defend people in court", and "Give lectures to large groups", the Low Prestige subscale contains tasks such as "Wash clothes" and "Inspect automobiles". Consequently, the focus of the Prestige dimension in the PGI-S is strongly confounded with the requirement of verbal and communication skills. In contrast, the Prestige dimension in the PGI is subdivided into and assessed with ten subscales, which naturally leads to a broader, more differentiated assessment of Prestige. Arguably, this more general conception of Prestige is better suited to cover the

construct as intended by the authors (Tracey, 2002; Tracey & Rounds, 1996b).

### 5.5.3 *Comparison of the PGI and PGI-S and Practical Implications*

In our opinion, the full PGI has two clear advantages. First, it includes the occupational preferences item type. Detailed information about which specific occupations a client or participant prefers could be especially interesting for career counselors. Second, our findings indicate that the PGI is better suited to assess Prestige, because 1) PGI Prestige was more reliable than PGI-S Prestige, 2) validity evidence based on the relation with the socioeconomic status of the desired profession was stronger for PGI Prestige than for PGI-S Prestige, and 3) occupational preferences Prestige appears to contain additional information about Prestige that is not captured by Prestige as assessed with the activity item types. Therefore, if an analysis of the Prestige dimension is of central interest to the researcher or counselor, the use of the PGI is advised.

However, these advantages come with a price: the extensive amount of time that is required to complete the entire instrument. Since time is a crucial variable in planning research designs, especially in the context of large-scale assessments, researchers might be deterred from using the PGI in its full form. This leads directly to the major advantage of the PGI-S: its efficiency. Based on our findings, we conclude that, when an efficient analysis of relationships with the circumplex dimensions is central to the problem at hand, and questions about occupational Prestige are of less interest, the use of the PGI-S is advised. In career counseling contexts, the PGI-S could be used cautiously as a time-efficient screening instrument. Thereby, counselors should rely less on the specific results on the subscale level, and instead focus on the counselees' scores on the two circumplex dimensions.

### 5.5.4 *Limitations and Future Directions*

Lastly, we want to mention some limitations of our research that need to be addressed in subsequent research. First, our sample comprised university students and therefore rather high-achieving individuals with higher vocational aspirations. This limits the range of the analyses pertaining to the relationships of Prestige and the SES of the desired profession. In



order to generalize our findings, further research with samples from other relevant populations such as individuals in vocational training settings, in the workplace, and individuals who are unemployed is required. Moreover, it would be interesting to analyze the relationships between the Prestige dimension and the SES of the actual occupations held by the individuals some years later. Because our analyses were limited to the German translation of the instruments, the extent to which these findings can be transferred to other translations of the PGI (e.g., Holtrop et al., 2015) could be addressed in future research.

The associations between the three dimensions and academic achievement reported in this study were only correlative. In order to disentangle the specific causal relationships between interests and academic achievement, more research is needed that also considers potential moderators or mediators of these relationships (e.g., self-concept; see, for example, Grigg et al., 2018). Furthermore, both the vocational interests and academic achievement were assessed using self-report measures, which could lead to covariance inflation. Future research could strive to analyze the relationships between the interest sphere dimensions and objective measures of performance and abilities.

Finally, we see two potential ways to improve the German PGI-S. First, it seems desirable to revise the PGI-S Prestige dimension, potentially by including a few more items in order to more fully cover the scope of the construct or by selecting better marker items for the Prestige dimension. Second, since the occupational preferences items appeared to contain information beyond that of the activity item types, the development of a corresponding short version for the occupational preferences item type could broaden the possibilities of vocational interest measurement and could enable researchers to adapt their measurement tools to their specific desiderata.

## **Appendix A: Online Supplemental Materials**

### *General Information*

This supplement contains an overview of the planned missing data design as well as the pairwise complete correlations of all observed variables in our study. Due to the fact that we obtained scores for 11 scales (i.e., scores for the eight basic interest scales as well as for the three dimensions) observed in 5 different questionnaire versions (PGI - Activity preferences, PGI - Activity competence beliefs, PGI - Occupational preferences, PGI-S - Activity preferences, PGI-S - Activity competence beliefs) and, furthermore, eight external variables (Gender, ISEI of the desired occupation, and school grades in German, Art, Math, Physics, Chemistry, and Biology), our study contained a total of 63 observed variables. For the sake of lucidity, we partitioned the  $63 \times 63$  correlation matrix into 17 submatrices. Tables A3 through A8 present the correlations within instruments. Tables A9 through A14 present the cross-version correlations. Finally, tables A15 through A19 present the correlations between the different PGI versions and the external validity markers.

Because we employed a multimatrix design, the net sample sizes for the correlations reported here are somewhat smaller than the sample sizes of the models presented in the article, which always relied on the total available information. Specifically, the models in our study inferred missing data by means of full information maximum likelihood estimation. Therefore, discrepancies may occur between the correlation estimates in these tables and the corresponding estimates reported in the main article. When in doubt, the reader should ultimately rely on the parameter estimates reported in the main article.

Table A1: List of Abbreviations

Abbreviation	Full Name
SF	Social Facilitating
MA	Managing
BD	Business Detail
DP	Data Processing
ME	Mechanical
NO	Nature / Outdoors
AR	Artistic
HE	Helping
PT	People-Things
ID	Ideas-Data
PRE	Prestige
ISEI	International Socio-economic Index of Occupational Status

Table A2: Overview of the Variable Distribution in the Planned Missing Data Design

	PGI		PGI		PGI-S		PGI-S	
	Activity	Competence Beliefs	Activity	Occupational Preferences	Activity	Preferences	Activity	Competence Beliefs
Group 1	✓	✓	✓	✓	✗	✗	✗	✓
Group 2	✓	✓	✗	✗	✗	✗	✗	✓
Group 3	✗	✗	✓	✓	✓	✓	✓	✓

Table A3: PGI - Activity Preferences

	SF	MA	BD	DP	ME	NO	AR	HE	PT	ID	PRE
SF	—										
MA	.54***	—									
BD	.20***	.60***	—								
DP	-.11*	.14**	.38***	—							
ME	-.05	.18***	.34***	.70***	—						
NO	.13**	.03	.06	.32***	.43***	—					
AR	.25***	-.02	-.12*	.07	.09	.37***	—				
HE	.60***	.23***	.00	-.11*	-.01	.27***	.35***	—			
PT	.63***	.17***	-.29***	-.74***	-.66***	-.20***	.28***	.60***	—		
ID	-.11*	-.59***	-.63***	-.08	.05	.54***	.67***	.26***	.11*	—	
PRE	.05	.13*	.27***	-.02	-.25***	-.05	-.01	.14*	.14*	-.18**	—

Note. Number of Observations: 315-433.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A4: PGI - Activity Competence Beliefs

	SF	MA	BD	DP	ME	NO	AR	HE	PT	ID	PRE
SF	—										
MA	.48***	—									
BD	.23***	.60***	—								
DP	.02	.24***	.54***	—							
ME	.00	.30***	.48***	.69***	—						
NO	.16**	.13**	.23***	.32***	.42***	—					
AR	.40***	.15**	.02	.03	.04	.29***	—				
HE	.61***	.30***	.15**	-.06	.00	.30***	.43***	—			
PT	.62***	.13*	-.33***	-.68***	-.64***	-.19***	.40***	.61***	—		
ID	-.09	-.59***	-.63***	-.28***	-.13*	.40***	.52***	.22***	.22***	—	
PRE	.08	.19***	.27***	.01	-.23***	.04	.04	.23***	.15**	-.18**	—

Note. Number of Observations: 314-433.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A5: PGI - Occupational Preferences

	SF	MA	BD	DP	ME	NO	AR	HE	PT	ID	PRE
SF	—										
MA	.66***	—									
BD	.36***	.73***	—								
DP	.02	.17**	.32***	—							
ME	-.03	.08	.26***	.88***	—						
NO	-.01	-.15**	-.08	.40***	.48***	—					
AR	.25***	-.09	-.13*	.13*	.10	.29***	—				
HE	.56***	.07	-.09	-.15**	-.18**	.07	.40***	—			
PT	.56***	.16**	-.16**	-.70***	-.75***	-.37***	.26***	.70***	—		
ID	-.24***	-.70***	-.69***	.02	.12*	.60***	.62***	.29***	.02	—	
PRE	-.22***	-.17**	.05	.08	.13*	.27***	-.02	-.08	-.22***	.15**	—

Note. Number of Observations: 318-331.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A6: PGI-S - Activity Preferences

	SF	MA	BD	DP	ME	NO	AR	HE	PT	ID	PRE
SF	—										
MA	.37***	—									
BD	.19**	.66***	—								
DP	-.09	.30***	.52***	—							
ME	.10	.20**	.33***	.68***	—						
NO	.04	-.02	-.02	.16*	.16*	—					
AR	.28***	-.06	-.11	.04	.17*	.26***	—				
HE	.48***	.05	-.08	-.15*	-.01	.21**	.34***	—			
PT	.58***	.00	-.33***	-.71***	-.57***	-.11	.29***	.65***	—		
ID	-.10	-.65***	-.69***	-.26***	-.02	.52***	.62***	.34***	.24***	—	
PRE	.10	.13	-.04	-.08	-.33***	-.06	-.03	.15*	.26***	-.09	—

Note. Number of Observations: 228–236.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A7: PGI-S - Activity Competence Beliefs

	SF	MA	BD	DP	ME	NO	AR	HE	PT	ID	PRE
SF	1.00										
MA	.53***	—									
BD	.14*	.66***	—								
DP	.02	.39***	.54***	—							
ME	.14*	.37***	.46***	.65***	—						
NO	.16*	.23***	.19**	.23***	.22***	—					
AR	.29***	.12	.03	.06	.12	.25***	—				
HE	.50***	.26***	.03	-.16*	-.06	.26***	.21**	—			
PT	.56***	.05	-.36***	-.68***	-.58***	-.09	.26***	.66***	—		
ID	-.15*	-.60***	-.65***	-.37***	-.18**	.37***	.50***	.20**	.25***	—	
PRE	.08	.09	.02	-.18**	-.31***	-.05	-.09	.05	.22***	-.14*	—

Note. Number of Observations: 227–235.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A8: Validity Markers

	Gender	German	Art	Math	Physics	Chemistry	Biology	ISEI
Gender	—							
German	.18***	—						
Art	.32***	.25***	—					
Math	.03	.15***	-.03	—				
Physics	.08*	.22***	.14**	.40***	—			
Chemistry	.00	.14**	.07	.46***	.53***	—		
Biology	-.09	.13**	.10	.54***	.36***	.54***	—	
ISEI	.20***	.10*	.13**	.06	.12**	.05	.02	—

Note. Number of Observations: 382–685. Gender was coded as 1 = male, 2 = female.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A9: Rows: PGI - Activity Preferences, Columns: PGI - Activity Competence Beliefs

	SF	MA	BD	DP	ME	NO	AR	HE	PT	ID	PRE
SF	.72	.28***	.07	-.12*	-.11*	.10*	.31***	.53***	.57***	.05	.11
MA	.45***	.68	.45***	.11*	.14**	.05	.07	.26***	.19***	-.44***	.18**
BD	.17***	.42***	.72	.36***	.30***	.09	-.06	.06	-.23***	-.54***	.25***
DP	-.06	.13**	.35***	.74	.54***	.22***	-.04	-.17***	-.60***	-.22***	-.09
ME	-.04	.18***	.34***	.51***	.73	.29***	-.01	-.04	-.50***	-.11*	-.31***
NO	.05	-.02	.08	.20***	.29***	.70	.23**	.15**	-.16**	.38***	-.08
AR	.23***	.01	-.07	-.01	.01	.19***	.74	.25***	.27***	.46***	-.05
HE	.48***	.11*	.00	-.10*	-.07	.21***	.35***	.78	.53***	.28***	.15**
PT	.49***	.03	-.31***	-.60***	-.55***	-.13**	.35***	.53***	.84	.26***	.20***
ID	-.09	-.42***	-.43***	-.12*	-.03	.31***	.44***	.12*	.10*	.74	-.23***
PRE	.04	.18**	.25***	.06	-.18**	-.06	-.02	.12*	.08	-.24***	.73

Note. Number of Observations: 314-433.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A10: Rows: PGI - Activity Preferences, Columns: PGI - Occupational Preferences

	SF	MA	BD	DP	ME	NO	AR	HE	PT	ID	PRE
SF	.42	.30***	.12	-.18*	-.25**	-.28**	.04	.33***	.44***	-.22*	-.27**
MA	.50***	.68	.45***	-.16	-.24**	-.40***	-.18*	.11	.35***	-.63***	-.16
BD	.27**	.64***	.70	.10	.03	-.18*	-.23**	-.06	-.02	-.64***	.08
DP	-.03	.17	.33***	.68	.61***	.39***	.19*	-.19*	-.55***	.03	.29**
ME	.03	.19*	.25**	.72***	.71	.40***	.11	-.14	-.56***	.03	.03
NO	-.11	-.18*	-.11	.33***	.36***	.57	.21*	.06	-.29***	.43***	.31***
AR	.22*	-.01	-.11	.03	.01	.08	.73	.22*	.25**	.39***	-.04
HE	.33***	.05	-.14	-.06	-.08	.01	.21*	.68	.44***	.20*	-.10
PT	.31***	.01	-.24**	-.61***	-.62***	-.44***	.08	.47***	.77	-.02	-.30***
ID	-.20*	-.54***	-.53***	.17	.24**	.47***	.56***	.16	-.09	.82	.10
PRE	.16	.18*	.31***	-.31***	-.38***	-.25**	.00	.32***	.40***	-.23**	.45

Note. Number of Observations: 122-128.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A11: Rows: PGI - Activity Competence Beliefs, Columns: PGI - Occupational Preferences

	SF	MA	BD	DP	ME	NO	AR	HE	PT	ID	PRE
SF	.64	.42***	.16	-.08	-.11	-.27**	.15	.40***	.47***	-.23*	-.21*
MA	.47***	.55	.29***	-.10	-.10	-.27**	-.07	.11	.29**	-.43***	-.02
BD	.20*	.38***	.50	.12	.09	-.10	-.07	-.08	-.07	-.39***	.20*
DP	.02	.16	.35***	.49	.44***	.19*	.14	-.14	-.38***	-.06	.34***
ME	.08	.19*	.23**	.51***	.50	.28**	.02	-.13	-.40***	-.05	.13
NO	-.04	-.15	-.04	.18*	.26**	.39	.07	.07	-.19*	.27**	.36***
AR	.32***	.03	-.06	-.05	-.09	-.11	.56	.26**	.35***	.21*	-.03
HE	.46***	.12	-.08	-.14	-.14	-.13	.07	.61	.50***	.02	-.02
PT	.44***	.11	-.21*	-.47***	-.47***	-.38***	.10	.49***	.72	-.03	-.32***
ID	-.17	-.51***	-.48***	.00	.05	.30***	.33***	.20*	.02	.63	.03
PRE	.16	.12	.24**	-.39***	-.43***	-.23**	-.04	.25**	.41***	-.20*	.38

Note. Number of Observations: 121-128.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A12: Rows: PGI - Occupational Preferences, Columns: PGI-S - Activity Preference

	SF	MA	BD	DP	ME	NO	AR	HE	PT	ID	PRE
SF	.64	.45***	.33***	.01	.04	-.01	.18**	.46***	.42***	-.20**	.16*
MA	.45***	.71	.59***	.23***	.20**	-.12	-.04	.04	.04	-.57***	.05
BD	.19**	.51***	.76	.46***	.32***	-.09	-.16*	-.11	-.30***	-.60***	-.02
DP	-.01	.07	.25***	.63	.74***	.12	.14*	-.13	-.54***	.00	-.31***
ME	-.09	-.01	.18**	.55***	.69	.23***	.13	-.10	-.54***	.10	-.38***
NO	-.02	-.20**	-.05	.18*	.27***	.70	.25***	.09	-.20**	.47***	-.23**
AR	.26***	-.19**	-.21**	.04	.08	.17*	.67	.30***	.26***	.51***	.10
HE	.52***	.03	-.04	-.20**	-.13	.09	.29***	.69	.60***	.21**	.26***
PT	.46***	.13	-.11	-.49***	-.53***	-.16*	.14*	.50***	.78	.01	.41***
ID	-.11	-.60***	-.57***	-.18*	-.06	.43***	.45***	.24***	.15*	.81	-.05
PRE	-.23**	-.09	.02	.25***	.03	.45***	-.06	-.10	-.30***	.14	.24

Note. Number of Observations: 194–203.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A13: Rows: PGI - Occupational Preferences, Columns: PGI-S - Activity Competence Beliefs

	SF	MA	BD	DP	ME	NO	AR	HE	PT	ID	PRE
SF	.48	.42***	.24***	-.03	.02	-.01	.12	.41***	.39***	-.22**	.13
MA	.35***	.58	.47***	.19**	.24***	-.09	.01	.10	.05	-.50***	.06
BD	.12	.40***	.58	.41***	.32***	-.08	-.10	-.04	-.26***	-.53***	-.05
DP	-.05	.11	.30***	.60	.66***	.10	.09	-.20**	-.56***	-.10	-.32***
ME	-.10	.06	.27***	.55***	.63	.24***	.08	-.13	-.55***	.00	-.36***
NO	-.04	-.05	.05	.16*	.19**	.58	.15*	-.02	-.22**	.31***	-.22**
AR	.19**	-.10	-.15*	-.02	-.02	.07	.52	.13	.22**	.35***	.07
HE	.30***	.05	-.08	-.25***	-.20**	.05	.18**	.55	.52***	.16*	.16*
PT	.34***	.08	-.19**	-.51***	-.52***	-.17*	.11	.46***	.74	.05	.37***
ID	-.11	-.42***	-.41***	-.17*	-.15*	.33***	.30***	.08	.11	.65	-.06
PRE	-.18*	.00	.13	.21**	.00	.37***	-.08	-.13	-.28***	.04	.13

Note. Number of Observations: 193–203.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A14: Rows: PGI-S - Activity Preferences, Columns: PGI-S - Activity Competence Beliefs

	SF	MA	BD	DP	ME	NO	AR	HE	PT	ID	PRE
SF	.64	.28***	.06	-.11	.09	.05	.22***	.41***	.45***	-.03	.15*
MA	.31***	.69	.51***	.23***	.22***	-.01	-.01	.09	.00	-.55***	.17**
BD	.11	.50***	.73	.43***	.33***	-.01	-.04	-.07	-.30***	-.59***	.00
DP	-.07	.27***	.50***	.81	.55***	.13	.01	-.24***	-.65***	-.35***	-.12
ME	.07	.24***	.36***	.58***	.80	.16*	.09	-.06	-.51***	-.13*	-.27***
NO	.00	.03	.02	.09	.06	.73	.15*	.14*	-.09	.38***	-.07
AR	.24***	-.01	-.07	.00	.05	.22***	.74	.23***	.26***	.48***	-.04
HE	.37***	.08	-.03	-.19**	-.09	.21**	.16*	.83	.55***	.24***	.11
PT	.43***	-.05	-.35***	-.64***	-.49***	-.08	.21**	.60***	.86	.29***	.25***
ID	-.05	-.43***	-.48***	-.25***	-.14*	.39***	.39***	.24***	.23***	.79	-.12
PRE	.13	.12	.01	-.14*	-.35***	-.11	-.09	.11	.27***	-.18**	.70

Note. Number of Observations: 227–235.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .



Table A15: Rows: PGI - Activity Preferences, Columns: Validity Markers

	Gender	German	Art	Math	Physics	Chemistry	Biology	ISEI
SF	.31	.09	.20***	-.01	.01	-.09	-.14*	-.01
MA	.11*	-.06	.05	-.02	-.04	-.02	-.01	-.09
BD	-.13**	-.07	-.03	.15**	.09	.19**	.19***	-.09
DP	-.35***	-.16**	-.11	.14	.12*	.19**	.18**	.00
ME	-.28***	-.19***	-.10	.11*	.08	.15**	.18**	-.16**
NO	.06	.01	.09	.12*	.36***	.20	.04	.03
AR	.14**	.21***	.32***	-.04	.03	-.04	-.12	.05
HE	.28***	.11*	.16**	.05	.06	-.05	-.08	.08
PT	.46***	.21***	.24***	-.13*	-.10	-.22***	-.25***	.09
ID	.09	.15**	.18**	.00	.13*	-.02	-.09	.10
PRE	-.05	.21***	.02	-.02	.16**	.02	.00	.21***

Note. Number of Observations: 216–433. Gender was coded as 1 = male, 2 = female.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A16: Rows: PGI - Activity Competence Beliefs, Columns: Validity Markers

	Gender	German	Art	Math	Physics	Chemistry	Biology	ISEI
SF	.26	.14**	.21***	-.05	.02	-.06	-.09	.02
MA	.02	.04	.00	-.05	.00	.01	.00	-.06
BD	-.16**	.03	-.01	.17***	.14**	.14*	.24***	-.10
DP	-.42***	-.07	-.11	.19	.11*	.15*	.18**	-.03
ME	-.31***	-.11*	-.07	.13**	.10	.16**	.21***	-.18***
NO	.06	.05	.05	.22***	.37***	.33	.09	.03
AR	.18***	.21***	.35***	-.10*	-.07	-.09	-.13	.09
HE	.30***	.14**	.17**	-.03	.03	-.05	-.11	.06
PT	.48***	.16**	.23***	-.21***	-.13*	-.22***	-.26***	.12*
ID	.18***	.09	.20***	-.01	.06	.00	-.13*	.11*
PRE	.07	.26***	.07	.06	.14*	.05	.10	.26***

Note. Number of Observations: 215–434. Gender was coded as 1 = male, 2 = female.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A17: Rows: PGI - Occupational Preferences, Columns: Validity Markers

	Gender	German	Art	Math	Physics	Chemistry	Biology	ISEI
SF	.21	-.02	.01	-.08	-.08	-.11	-.10	-.06
MA	-.02	-.09	-.04	.00	-.05	.00	-.02	-.12*
BD	-.13*	-.04	-.07	.11	.00	.09	.19**	-.03
DP	-.34***	-.15**	.03	.03	-.01	.14*	.26***	-.15*
ME	-.23***	-.14*	.04	.08	.05	.20**	.25***	-.11
NO	-.06	-.09	.00	.02	.26***	.15	.05	-.01
AR	.00	.17**	.16*	-.13*	.03	-.01	-.06	-.09
HE	.25***	.10	.04	-.05	-.06	-.08	-.16*	.04
PT	.35***	.16**	.03	-.11	-.11	-.21**	-.29***	.05
ID	.05	.10	.11	-.07	.13*	.04	-.07	.02
PRE	-.04	.14*	.03	.08	.30***	.31***	.22**	.21***

Note. Number of Observations: 204–330. Gender was coded as 1 = male, 2 = female.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A18: Rows: PGI-S - Activity Preferences, Columns: Validity Markers

	Gender	German	Art	Math	Physics	Chemistry	Biology	ISEI
SF	.13	.02	.02	-.11	-.08	-.13	-.20*	.00
MA	.02	-.02	.04	-.02	.06	.01	-.10	.04
BD	-.09	-.03	.00	.08	.09	.10	.11	.03
DP	-.31***	-.08	-.07	.10	.10	.19*	.30***	-.04
ME	-.34***	-.11	.00	.04	.03	.03	.22**	-.08
NO	.09	-.02	.07	.04	.28***	.21	.07	.10
AR	.17**	.10	.32***	-.20**	-.06	-.06	-.03	-.12
HE	.22***	.13*	.09	-.03	-.03	-.06	-.18*	-.05
PT	.40***	.15*	.11	-.15*	-.14*	-.20*	-.39***	-.01
ID	.15*	.08	.19*	-.09	.02	-.02	-.01	-.04
PRE	.05	.27***	.04	.00	.02	.04	-.15	.09

Note. Number of Observations: 144–234. Gender was coded as 1 = male, 2 = female.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Table A19: Rows: PGI-S - Activity Competence Beliefs, Columns: Validity Markers

	Gender	German	Art	Math	Physics	Chemistry	Biology	ISEI
SF	.15	.00	.09	-.20**	-.19**	-.16	-.24**	-.08
MA	-.01	-.02	.05	-.01	-.01	.00	-.13	-.06
BD	-.15*	-.01	.00	.18**	.05	.15	.16*	-.08
DP	-.30***	-.17*	-.12	.13	.05	.18*	.28***	-.12
ME	-.37***	-.12	-.03	.00	.01	-.04	.13	-.12
NO	.13*	.05	.13	.07	.24***	.16	.04	.08
AR	.19**	.07	.41***	-.22***	.00	-.04	-.14	-.13
HE	.27***	.12	.19*	-.04	-.04	-.05	-.22**	-.07
PT	.43***	.14*	.22**	-.20**	-.16*	-.18*	-.41***	.00
ID	.22***	.11	.27***	-.14*	.11	-.05	-.10	.04
PRE	.12	.30***	.08	.06	.06	.00	-.13	.15*

Note. Number of Observations: 143–233. Gender was coded as 1 = male, 2 = female.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .



# 6

## Discussion

The present dissertation was concerned with advancing the analysis and measurement of vocational interest profiles. The first part of the dissertation aimed to identify challenges and potential fallacies in the analysis of vocational interest similarity within individuals over time (i.e., stability and change of interests) as well as between individuals in meaningful groups (i.e., interest similarity within families) and to overcome them by means of innovative methodological approaches towards analyzing these similarities from a profile-centered perspective. In the second part of the dissertation, the goal was to present a thorough evaluation of the validity of a German translation of the Personal Globe Inventory (PGI) and its associated short form, the Personal Globe Inventory - Short (PGI-S). Thereby, a strong emphasis was placed on finding evidence for the structural validity of the underlying spherical model and the circumplex submodels that define the equator of the sphere, on finding evidence for the validity of the underlying dimensions based on their relationships with plausible external correlates, and, finally, on examining the extent to which the respective validity evidence was comparable between the PGI and the PGI-S. In doing so, the specific pros and cons of either version were expected to be identified.

In the following sections, first, a short summary of the central findings of each of the four empirical studies that make up this dissertation is presented (Section 6.1). Next, the theoretical implications of these findings and their contributions to the current state of knowledge are discussed (Section 6.2). Additionally, some of the limitations of these findings are considered

and potential future directions are illustrated. The subsequent section is concerned with the methodological implications of the particular challenges that had to be overcome in order to arrive at these conclusions and the analytical strategies that were pursued as a means to this end (Section 6.3). The final section aims to contemplate some limitations of these methods and points towards possible research desiderata that might take up on these results and further advance the ideas that have been presented herein (Section 6.4).

## **6.1 Summary of the Findings from the Empirical Substudies**

### *6.1.1 Study 2*

In Study 2, it was shown that trainees' vocational interest profiles (or, more precisely, the shapes of their interest profiles) are, on average, relatively stable over the entire course of vocational education and training (VET). In all but one of the VET groups, stability was found to be higher in later stages of training (T2 → T3) than in earlier stages (T1 → T2). Concurrent with this finding, it was found that the congruence between trainees' interests and the characteristics of their respective VET environment (P-E congruence) increased over the course of training in three out of the five VET groups. However, these increases in P-E congruence were rather small compared to the observed selection effects that were manifested in an already high average P-E congruence at the beginning of training.

Profile stability, P-E congruence, and changes in P-E congruence over time were found to display considerable interindividual variability, both between and within groups. Moreover, the interindividual differences in these parameters were found to be largely stable over the entire course of training, too. In other words, trainees with rather stable interest profiles at the beginning of training were likely to also have stable interest profiles in later phases of training and vice versa for trainees with less stable interest profiles. Likewise, trainees whose interest profiles showed a good fit with the environmental characteristics at the beginning of training tended to also have a high P-E congruence in later stages of training and vice versa for trainees with lower levels of P-E congruence.

Finally, it was shown that P-E congruence was consistently related to satisfaction with the

VET course, both within and across time and both at the group level and at the individual level. Specifically, sizeable correlations were found between P-E congruence for all VET groups on all measurement occasions. Moreover, changes in P-E congruence were accompanied by corresponding changes in satisfaction with VET. At the group level, this was evidenced by the fact that those groups that demonstrated an increase in average P-E congruence were found to show a less steep decrease in average satisfaction. At the individual level, changes in P-E congruence were found to be correlated with changes in satisfaction, especially in the earlier stages of training (T1 → T2).

In conclusion, it was learned that vocational interest profiles and interest congruence are relatively stable over the entire course of VET. However, young adults differ substantially with regard to their degree of interest stability. In contrast to the rather inconclusive findings of previous meta-analyses on the congruence-satisfaction relationship, it was found that the congruence between trainees' vocational interest profiles and commensurate environmental reference profiles was considerably related to their satisfaction with VET. Finally, the results suggest that this congruence is primarily established through occupational selection processes, whereas occupational socialization effects appear to play a subordinate role. The fact that environmental experiences in the first stages of young adults' professional life seem to contribute little to the development of their vocational interests raises the question of which factors contribute. A potential source of this development, namely, socialization effects of family environments, was examined in Study 3.

### 6.1.2 *Study 3*

Study 3 demonstrated that vocational interest profiles of family members were substantially more similar to each other (again, with regard to shape) than those of corresponding randomly paired dyads. The largest differences between average profile correlations (APCs) of randomly paired and real-family dyads were found for mothers and fathers. The respective findings for all parent-child dyads were substantially smaller and were all of comparable size. In a subsequent set of analyses, the similarity of vocational interest profiles of parent-child dyads was evaluated once more but this time while simultaneously considering the similarity between the parents'

interests. These analyses revealed that, when the similarity between parents' interest profiles was accounted for, only the APCs of same-sex parent-child dyads were significantly more similar than those of corresponding randomly paired parent-child dyads.

A particularly preeminent finding was that it was possible to fully reproduce all of the aforementioned relationship patterns on the level of model-based circumplex profiles. Specifically, both mother-father and all parent-child dyads yielded significantly larger APCs (this time calculated as the profile correlations between model-based profiles) than the corresponding randomly paired dyads. Again, when mother-father similarity was accounted for, only the model-based profiles of same-sex dyads were found to be significantly more similar than the corresponding randomly paired dyads.

In sum, it was learned that there are considerable indications for the existence of sizeable intrafamily similarities in vocational interest profiles. These similarities might arise as a result of partner selection (in the case of mother-father similarity) and intrafamily socialization processes or genetic influences (in the case of parent-child similarity). The results further provide new support for the validity of the circumplex model of vocational interests. However, more research is clearly needed on the question of how exactly these similarities come about. Because the results of both Study 2 and Study 3 relied on the same instrument to assess vocational interests (i.e., the GIST), it remains to be seen whether or not these findings can be generalized to other inventories that assess vocational interests on the basis of alternative theoretical models.

### 6.1.3 *Study 4*

The findings of Study 4 first revealed that the PGI scales were reliable and valid, as indicated by their acceptable to very good internal consistency estimates and their very good fit to the different underlying structural models. Specifically, across all item types (activity preferences, activity competence beliefs, occupational preferences, and a composite score) and submodels (18-type spherical model, 8-type circumplex, and the traditional RIASEC circumplex), the randomization test of hypothesized order relations (RTOR; Hubert & Arabie, 1987) indicated a significant fit of the respective correlation patterns to the underlying structural assumptions for both male and female participants. Furthermore, the PGI RIASEC scales were found to be



highly correlated with corresponding scales of an alternative instrument, the General Interest-Structure-Test (GIST; Bergmann & Eder, 2005), which is the most widely used instrument to assess vocational interests in German-speaking countries. Lastly, it was found that male participants scored higher on scales close to the Things pole of the People-Things dimension and female participants scored higher on scales close to the People pole of the People-Things dimension. No or only negligible gender differences were found on scales close to either pole of the Ideas-Data dimension.

Taken together, the PGI appears to assess the basic interest circumplex that is defined by the People-Things and Ideas-Data dimensions not only with sufficient reliability and validity but also in great accordance with the interest circumplex as assessed with other established interest inventories (i.e., the GIST). Therefore, it can be expected that the findings of Study 2 and Study 3 could be replicated with the PGI. Moreover, the use of the PGI could also extend these findings by considering yet another dimension of the vocational interest construct space that has not yet been considered in examining these questions to the present day, namely, Prestige. Although the findings of Study 4 provided strong support for the PGI's construct validity and its convergent validity, not much was revealed about its validity based on relationships to other variables (except gender). Furthermore, the PGI is a relatively extensive instrument that might be impracticable in many applied settings. These issues were addressed in the final study of this dissertation.

#### 6.1.4 *Study 5*

The findings of Study 5 suggest that the PGI-S, too, is a reliable, valid, and exceptionally efficient instrument to assess vocational interests, at least with regard to the two circumplex dimensions (People-Things and Ideas-Data). The eight basic interest scales, which the PGI-S predominantly focuses on, were found to be somewhat less reliable than the corresponding PGI scales but were still in the range of what would be expected due to the reduced item count. On the level of the two circumplex dimensions, reliabilities between the two instruments were comparably high. Furthermore, it was found that the PGI-S' eight basic interest scales adhered to the postulated circumplex structure. For the first time, the circumplex structures of the PGI and PGI-S scales

were evaluated with a more elaborate confirmatory model for testing circumplex structures: the *circular stochastic process model with a Fourier series* (CSPF; Browne, 1992). In doing so, it was also possible to test and confirm that both the PGI and PGI-S data exhibited a very good fit to the presumed circumplex structure and that the central parameters of the models (those pertaining to the angular locations of the scales around the perimeter of the circumplex) were virtually invariant between the two PGI versions.

This validity evidence, which was based on the relations of the two circumplex dimensions with other variables, was largely in line with theoretical expectations and also invariant between PGI versions. Specifically, it was found that the People-Things dimension of the PGI-S displayed the expected gender differences, to the extent that female participants were more likely to score high on the People dimension and male participants were more likely to score high on the Things dimension. German and art grades were found to be related to the Ideas dimension and mathematics and science grades were related to the Things dimension. The findings regarding the Prestige dimension, on the other hand, were somewhat ambivalent. First, it was found that the PGI-S Prestige dimension was not as reliable as the PGI Prestige dimension. Moreover, there were significant, yet small, differences between the relationship of Prestige and the academic achievement markers obtained with either instrument. Finally, the most consistent finding was that the Prestige dimensions from either item type and either PGI version were significantly and positively related to the socioeconomic status of the participants' desired profession, although to different extents.

These findings led to the conclusion that the PGI is also valid with regard to its relationships to the external variables considered in this study. The PGI-S, on the other hand, is a reliable and valid alternative to the long form of the PGI, especially in situations where the use of the former is not feasible. However, the validity of the PGI-S—in its current form—appears to be limited to the two circumplex dimensions (People-Things and Ideas-Data). Regarding the Prestige dimension of the German PGI-S, further revisions seem required in order to tap the instrument's full potential by validly assessing all of the extensions that the spherical model of vocational interests provides.

## 6.2 Theoretical Implications

### 6.2.1 *Stability of Vocational Interests and P-E Congruence*

The present dissertation provides new insights into the stability of vocational interests and their congruence with characteristics of the work environment over the course of young adults' VET. Overall, the respective findings were largely in line with those of previous studies that unequivocally demonstrated the relatively high stability of vocational interests across the life span (Hoff et al., 2018; Low et al., 2005; Schultz et al., 2017; Tracey & Robbins, 2005; Tracey et al., 2005; Xu & Tracey, 2016). However, the analyses presented in Study 2 extend previous findings by contributing to the understanding of interindividual differences in intraindividual interest profile stability and to that of systematic changes in interest profiles in reaction to environmental experiences.

The relationship patterns that emerged on the group level revealed that, although there were significant differences in stability and P-E congruence between groups, there was, on average, little systematic variability in vocational interests over time. Specifically, significant increases in average P-E fit were only found in three of the five groups and were almost negligible compared to the large selection effects. Empirical evidence for the latter was significantly extended by considering the possibility of normative profile components that could potentially lead to an over- or underestimation of these effects. These findings suggest that individuals establish a congruence between their interests and the demands and opportunities of particular work environments primarily through occupational selection, whereas occupational socialization merely plays an ancillary role. In sum, the predominance of occupational selection effects further emphasizes the already widely acknowledged importance of career counseling and the goal of helping young adults to find a career path that suits their particular character as best as possible.

However, the fact that there was substantial interindividual variability in profile stability, P-E congruence, and changes in P-E congruence over the course of training indicates that things seem to be a little bit more complicated than the group-level perspective might suggest. In particular, far from being at random, these interindividual differences in intraindividual profile

development were moderately associated with corresponding changes in trainees' satisfaction with their VET course. In contrast to the rather ambiguous meta-analytical findings of previous investigations on the congruence-satisfaction relationship (Assouline & Meir, 1987; Tokar & Subich, 1997; Tranberg et al., 1993; Tsabari et al., 2005), it can be firmly concluded that this particular finding presents strong support for the validity of the long presumed relationship between P-E congruence and satisfaction (Holland, 1997). Furthermore, it emphasizes Tinsley's (2000) criticism of previous attempts to operationalize P-E congruence based on potentially incommensurable dimensions of the person and the environment. In this regard, the method to assess interest congruence proposed in this study (i.e., correlating the individual interest profiles with an appropriate, time invariant, reference profile) appears to be a promising approach whose applicability should be further investigated.

A primary task of future endeavors that aim pick up on these findings could be to identify both group- and individual-level predictors of these interindividual differences in interest profile stability and change. A potential starting point for further investigations could be to analyze these relationships while simultaneously considering personality traits and (general or domain-specific) cognitive abilities, as advocated by several authors (Ackerman, 1996; Ackerman & Heggestad, 1997; Lubinski, 2000; Lubinski & Benbow, 2000). For example, based on the assumptions of the social cognitive career theory (SCCT; Lent et al., 1994), it could be argued that interests can be expected to change in reaction to updated self-efficacy beliefs that depend on the success or failure to acquire the professional skills and knowledge required to persist in a particular work environment. Moreover, it can be expected that different personality trait constellations would further moderate these changes because these characteristics are likely to have an effect on how individuals cope with experiences of success or failure. Although profile shape can readily be considered to be the most important profile component, future studies should also consider the stability and change of, as well as the interrelationships between, the other profile components (profile scatter and profile elevation) in order to obtain a more complete picture of the underlying processes of profile stability and change.

### 6.2.2 *Similarity of Vocational Interests within Families*

Another important contribution of the present dissertation is the finding of substantial interest profile similarities between mothers and fathers and between parent-child dyads. Concerning the former, the results suggest that vocational interests are an important construct to consider in research on couple similarity, which has, to this day, primarily focused on other psychological constructs, such as personality traits (e.g., Luo & Klohnen, 2005) or leisure interests (e.g., Gonzaga et al., 2010). Although these results suggest *that* these similarities exist, the question of *how* these similarities come about remains open. Future research on this topic could therefore focus on examining the role of different mechanisms of couple similarity in order to analyze whether this similarity is due to active mate selection, or whether it is an indirect byproduct of social homogamy or mating market operation, a matter of couples becoming more similar over time, or any combination of these mechanisms (Luo, 2017). Thereby, a longitudinal perspective could help to disentangle these different possibilities.

With regard to parent-child similarity, the fact that only same-sex parent-child dyads were considerably more similar to each other than corresponding randomly paired parent-child dyads (when mother-father similarity was accounted for) suggests that the same-sex parent plays a greater role in children's vocational interest development. Thereby, it is important to consider that these similarities were found over and above the similarity that was due to gender-normative profile components. In other words, same-sex parent-child dyads were even more similar to each other than typical members of their respective sex, and other-sex parent-child dyads were just as dissimilar as typical members from different sexes. Similar to the findings on interest profile stability and change discussed in the previous section, there was considerable variability in intradyadic similarity. This finding further advises a more thorough investigation of potential predictors and moderators of these similarities. Again, the application of longitudinal research designs appears to be inevitable in order to appropriately disambiguate the complex causal relationships that lead to these similarities.

### 6.2.3 *Vocational Interests and External Variables*

Over the course of this dissertation, several relationships between vocational interests and external criteria were analyzed. Besides the associations between interest congruence and satisfaction already discussed (Section 6.2.1), a particular focus was put on the analysis of the relationships between the dimensions underlying the spherical model of vocational interests and plausible external variables that could be expected to be related to these dimensions. To this end, Studies 4 and 5 investigated, among other things, the relationships between vocational interests and gender, academic achievement, and the socioeconomic status of the participants' desired profession.

*Gender.* The evidence for considerable gender differences in vocational interests has been thoroughly reviewed and discussed (Lippa, 1998; Su et al., 2009). Due to the consistency of these differences, gender was used as a central validity criterion for the People-Things dimension and considered to be a crucial factor in the analysis of interest similarities within families. Unsurprisingly, the results concerning the relationship of vocational interest profiles and gender obtained in the course of this dissertation were unequivocally in line with previous findings. However, there were also some novel insights pertaining to the relationship between the Prestige dimension and gender. First, despite the fact that the structural assumptions of the spherical model imply a decrease in differentiation at higher and lower levels of prestige (compared to the intermediate prestige level at the equator of the sphere), corresponding gender differences were also found on the high and low prestige scales. This particular finding emphasizes the stability and consistency of gender differences across all levels of prestige. Second, there were no or only negligible differences in gender along the Prestige dimension across item types and PGI versions. The only significant, yet small, association between Prestige and gender was found for the activity competence beliefs item type of the PGI-S. The absence of substantial gender differences in Prestige further highlights the outstanding importance of the People-Things dimension for explaining gender differences in vocational interests.

*Academic Achievement.* The relationships between the circumplex dimensions (People-Things and Ideas-Data) and academic achievement (as indicated by domain-specific school

grades) were in line with theoretical expectations and with previous empirical results on these associations (Volodina & Nagy, 2016). Moreover, they were in agreement with corresponding findings regarding the relationship of vocational interest profiles and domain-specific abilities and literacy (Ackerman & Heggestad, 1997; Nagy, 2006; Warwas et al., 2009). Hence, they contribute further to the ever-growing body of empirical evidence that supports some of the central assumptions of the SCCT (Lent et al., 1994), which assumes a reciprocal feedback mechanism of performance attainments, self-efficacy beliefs, and interests.

While it was speculated that interest in higher prestige activities and occupations would be associated with better grades regardless of subject, the respective results were somewhat ambivalent. Specifically, for the activity item types, Prestige was most strongly related to the German grade. This finding could perhaps be explained by the fact that the higher prestige activity items often involved activities that required higher verbal skills. For example, “Defending people in court” is an activity that clearly requires verbal eloquence and high oratory skills. For the occupational preferences item type, however, the strongest relationships were found between Prestige and grades in subjects concerned with the natural sciences. These findings suggest that both occupational preference Prestige and activity preference Prestige measure related, yet somewhat distinguishable aspects of the relatively broadly defined occupational prestige construct. They are, hence, in line with the arguments brought forward by Prediger (1996), who (in reference to Osipow, 1979) challenged the conceptualization of the occupational preference Prestige dimension and, instead, considered it to reflect different levels of occupational aspiration. Clearly, more research is needed on the potential differences between these two conceptions of Prestige.

*Socioeconomic Status of Desired Professions.* One of the most consistent findings regarding the relationships of the Prestige dimension with external variables was found for what was considered to be the central validity criterion for this dimension: the socioeconomic status (SES) associated with the participants’ desired profession. Specifically, because the Prestige dimension is said to capture preferences for different levels of status—inter alia—it was expected that students with higher vocational aspirations (as reflected by the SES of their desired profession) would score higher on the Prestige dimension. Although the respective effect sizes

differed to some extent, the expected association was found in all PGI versions and across all item types. The comparable magnitude of the effect sizes of this relationship across all PGI item types extenuates some of the criticism that has been put forward regarding the meaning of the Prestige dimension (Prediger, 1996). However, future research should try to analyze the relationships between the Prestige dimension and multiple, more distal criteria. A good starting point could be to disentangle the rather broad notion of occupational prestige (Tracey & Rounds, 1996b) and to find appropriate measures for assessing the degree to which participants' actual professions reflect the particular concepts considered to be included in the Prestige dimension (see also Sodano & Tracey, 2008).

*Summary and outlook.* The research presented in this dissertation expands the vocational interest literature in several meaningful ways. The results presented in the empirical substudies provide strong evidence for the relatively high stability of vocational interest profiles over the course of VET. Moreover, they illustrate the existence and importance of substantial selection effects that guide young adults' behavior towards fitting work environments (namely, VET courses). This, in turn, is associated with their satisfaction with VET. The particular experiences these young adults have in the first stages of their vocational career appear to have relatively little effect on the average trainee's vocational interest congruence, as evidenced by the absence of clear occupational socialization effects. However, there appear to be substantial interindividual differences with regard to the stability of vocational interests and interest congruence. The findings further suggest that the family context is likely to play an important role in children's vocational interest development and that vocational interests are a significant aspect of couple similarity. It was found that the PGI and PGI-S present reliable and, in many respects, valid alternatives to traditional interest inventories in German speaking countries, which are largely compatible with the latter but extend them in meaningful ways (i.e., by introducing the Prestige dimension and by relying on a more differentiated classification system). Based on these findings, it can be expected that analyses of the central applied research questions of this dissertation with the PGI or PGI-S would lead to very similar conclusions.

These findings entail several interesting follow-up questions that should be addressed in future research. First, based on the fact that vocational interests have been found to be relatively



stable in middle and late adulthood, the question emerges of when and how these interests form. To address these issues, it appears necessary to employ longitudinal studies to track interest development from early childhood to adolescence. The findings presented herein suggest that such endeavors should certainly consider effects of the family environment in order to expand our understanding of interest development. A particular challenge of analyzing such questions pertains to the assessment of vocational interests in younger children, who are often considered to have insufficient knowledge of the world of work. This could render traditional interest inventories infeasible. Second, due to the substantial interindividual differences in interest profile stability, more research is needed to identify antecedents and moderators of profile stability and interest-congruence stability. Moreover, it remains to be seen whether some people just need longer to find out what they would like to do or whether they never really figure it out. If so, what would the consequences of this struggle be and how could psychologists help to guide these individuals? Lastly, it is necessary to further examine the meaning of occupational prestige for these questions. For example, it would be interesting to study whether or not the findings of Study 2 and Study 3 could be replicated with the PGI and what particular role the Prestige dimension plays in intrafamily interest similarity and interest stability and change. However, prior to such endeavors, it appears mandatory to invest more time and research in the valid assessment of this particular aspect of the vocational interest construct.

### **6.3 Methodological and Practical Implications**

The theoretical implications of the empirical investigations that make up this dissertation, which were discussed in the previous sections, provide interesting new insights into questions about many different topics of vocational interest research. However, they all have one thing in common: They were only revealed because the respective research questions were approached from a profile-centered perspective that allowed the simultaneous consideration of multivariate interest configurations in the analysis of the stability of vocational interest profiles over time, the agreement between individuals' interest configurations and a commensurate environmental

reference profile, the similarity between vocational interest profiles of dyad members, and their relationships to external variables. Moreover, the presented approaches do not merely display purely descriptive summaries of intraindividual measures of profile stability or intradyadic profile similarity. Instead, they depict different elaborate strategies to aggregate these individual level estimates and to make appropriate statistical inferences about their underlying population distributions. These approaches thus picked up on previous research that emphasized the importance of integrating the traditional variable-centered perspective and the more holistic intraindividual perspective (Asendorpf, 2006; Nagy, 2006). Furthermore, they extended these endeavors by identifying the particular challenges that these analyses pose for the examination of the similarity between vocational interest profiles and by proposing innovative analytical strategies to overcome these challenges.

### 6.3.1 *A Case for the Profile-Centered Perspective*

Although the particular research questions addressed in this dissertation have touched on very different topics of vocational interest research, namely, the stability of vocational interest profiles over time, the agreement between individuals' interest configurations and a commensurate environmental reference profile, the similarity between the vocational interest profiles of dyad members, and the relationships of vocational interest profiles to external variables, they are interconnected by the fact that they all take a profile-centered perspective towards finding answers to them. Throughout this dissertation, it was shown that this perspective is not only advantageous but is also indispensable for the appropriate recognition of the core element of the vocational interest construct: the relative configuration of individuals' likes and dislikes.

The findings of the four empirical studies presented in this dissertation, as well as the theoretical arguments and illustrative examples explicated in the introductory chapter, emphasize that analyses conducted from a profile-centered perspective can yield very different results compared to analysis from the traditional variable-centered perspective that do not account for intraindividual interest configurations but rather consider relationships between isolated interest domains. This is not to say that either perspective is ultimately superior to the other. Rather, it should be clear that the specific research questions at hand have specific requirements and

thereby determine the theoretical and analytical perspective taken towards analyzing them.

The necessity to consider the intraindividual interest configuration of vocational interests is strongly interwoven with the structural assumptions underlying the interest domains. The strongest case for this argument can be found in the works of Tracey and Rounds (1995), who clearly demonstrated the arbitrariness of the particular interest domains used to infer the underlying circumplex structure. If this assumption is accepted, it is hard to find convincing theoretical arguments that would advise disjointed analyses of single interest domains, however they may be classified. Ultimately, this means that the specific classification system is arbitrary, as long as similar activity domains are grouped together. The important part is that respective analyses should consider the entire information available instead of relying on only some of these more or less arbitrary categories.

To further strengthen this argument, consider the following hypothetical example: A particular work environment is characterized by demands and opportunities for activities that can be allocated to the Social domain. Two individuals have completed the same interest inventory (based on a 5-point Likert scale) and both have achieved a scale score of  $S = 3$  on the Social subscale<sup>1</sup>. Will these individuals fit equally well to the proposed environment? Are they equally likely to choose this particular environment from the large number of potential work environments? Will they both have the same attitudes towards this environment and put in the same amount of effort to complete the demanded work tasks? The arguments presented in this dissertation warrant that the unanimous answer should be: We cannot say, unless we know their scores on the other interest domains. If  $S = 3$  was the highest score in the profile, we would expect the respective individual to persist quite well in the proposed environment. If, however,  $S = 3$  was the lowest score in the profile, we would expect the opposite. In any analyses from the traditional variable-centered perspective, these individuals would, however, be treated exactly alike, regardless of their scores on the other scales, because they achieved the same score on the Social scale<sup>2</sup>.

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<sup>1</sup>For the sake of the argument, it is assumed that these individuals are comparable with regard to other important criteria, such as gender, age, educational background, personality structure, general and domain-specific cognitive abilities, etc.

<sup>2</sup>Except for, of course, potential interaction effects that might or might not be specified between the Social

The greater challenge that the investigations of applied research questions from the profile-centered perspective entail concerns the fact that they require analysts to find a balance between two particular levels of analysis. First, in order to consider the intraindividual or intradyadic agreement between the interest profiles of two individuals (or the same individual over time), appropriate means must be employed to assess this agreement. As argued in Section 1.5.2, it is of greatest importance to consider the fact that different similarity measures capture different aspects of profile agreement and that the choice of a particular similarity measure should always be guided by the goal to meet the specific requirements defined by the research question at hand. Second, once appropriate measures have been chosen and once individual- or dyad-level similarity has been calculated for each analysis unit, the task is to appropriately aggregate these similarity indices in order to make it possible to make inferences about the underlying population distributions of these similarities and to test specific hypotheses about them. Some of the challenges that arise from this perspective have been identified and addressed in this dissertation. The aim of the following sections is to critically reflect on the various methodological advances presented to overcome these challenges.

### 6.3.2 *Aggregating Individual-Level Estimates of Profile Agreement*

The first methodological challenge of the profile-centered perspective towards analyzing relationships between vocational interest profiles that was identified in this dissertation arises from the fact that the interindividual and intraindividual perspectives have, to this day, largely been recognized and treated as two separate and mostly incompatible approaches. On the one hand, variable-centered approaches typically blend out intraindividual peculiarities and aim to identify general relationships between two or more variables across all individuals in a presumably homogenous population. In doing so, these methods arrive at conclusions about the associations between variables for the typical or average member of the population but do not consider the agreement between intraindividual configurations of multivariate sets of variables. On the other hand, the strictly intraindividual perspective is concerned with the agreement of

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domain and the other interest domains. Nevertheless, there are good arguments against relying solely on such interaction effects because their number grows exponentially with the number of included variables, which quickly leads to unduly complex designs that require vast amounts of data and tend to become unstable (Asendorpf, 2015).

multivariate sets of variables within persons but blends out interindividual differences in these intraindividual similarities and, thus, severely limits the generalizability of the obtained results. An integrative perspective that combines the advantages of both approaches would, hence, require individual-level parameters of profile agreement to be estimated, for example, by means of profile correlations, and these individual level estimates to then be aggregated in order to analyze properties of the underlying population distributions of and interindividual differences in these intraindividual profile agreements.

To this end, the research presented in Study 2 of this dissertation proposed a meta-analytical strategy towards aggregating individual-level effect sizes of profile agreement with the help of multivariate random-effects meta-analysis (MREMA) models (M. W. Cheung, 2013). This strategy was motivated by the obvious similarity of the problems at hand and those encountered in conventional meta-analyses. Specifically, whereas meta-analyses aim to aggregate effect sizes obtained from multiple independent studies and to infer from them to a theoretical underlying population of a potentially infinite number of such studies, the profile-centered approach presented in Study 2 aimed to aggregate individual-level effect sizes (i.e., effect sizes indicating intraindividual profile stability or the agreement between individuals' interest profiles and environmental reference profiles) obtained from independent individuals and to infer from them to an underlying population of a potentially infinite number of such individuals.

From a methodological point of view, this approach has been shown to have many advantages over alternative strategies that are usually applied in such analyses. In most cases, these alternatives amount to a mere calculation of an average of these effect sizes or to their use as dependent or independent variables in traditional statistical methods (e.g., correlation, regression, or ANOVA). First, the meta-analytical approach considers the sampling variability of the individual-level effect sizes and, hence, ensures a more appropriate estimation of the respective aggregated effect sizes. This issue has seldom, if ever, been considered in previous research on profile similarity, but is commonly highlighted in other research fields (e.g., Bauer, Preacher, & Gil, 2006). Second, the particular use of the MREMA model makes it possible to simultaneously aggregate multiple effect sizes from the same source while considering the statistical dependencies between them. This is especially helpful in longitudinal analyses where

the same person might yield several indicators of profile agreement, for example, between her or his interest profiles measured at several points in time and a commensurate environmental profile. Third, the specification of the MREMA model as a random-effects model in the structural equation modeling (SEM) framework (M. W. Cheung, 2013) makes it possible to estimate and straightforwardly test interesting hypotheses about averages of and interindividual variability in these effect sizes. Moreover, the SEM specification allows for arbitrary extensions of these models<sup>3</sup>, for example, by further including covariates or by extending the models to the multigroup case. Fourth, the SEM specification allows for a flexible and straightforward handling of missing effect sizes via full information maximum likelihood (FIML) estimation. Finally, the meta-analytical aggregation approach makes it possible to simultaneously consider relationships between effect sizes and between effect sizes and covariates on both the group level and the individual level. Again, this is primarily due to the high flexibility of the SEM specification, which, for example, allows for the estimation and statistical evaluation of correlations between the random-effects variables pertaining to dependent effect sizes from the same source.

Taken together, the meta-analytical aggregation strategy appears to be a promising approach towards integrating the intraindividual and interindividual perspectives. This approach makes it possible to investigate basically any research question that necessitates the simultaneous consideration of entire multivariate trait configurations but, at the same time, aims to make general statements about the relationships of these intraindividual measures of profile stability, similarity, or agreement with a reference profile. In contrast to the rather simplistic approach of just using these individual-level effect sizes as dependent or independent variables that is taken in traditional statistical analysis methods, the meta-analytical aggregation stands out by its ability to appropriately consider the sampling variability of these individual-level estimates.

### 6.3.3 *Accounting for Normative Profile Components*

The second methodological challenge identified in this dissertation pertained to appropriately

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<sup>3</sup>However, the specific implementation of these models with the help of definition or constraint variables in common statistical software solutions (e.g., *Mplus*) will probably limit the complexity of these extensions to some extent.

evaluating the statistical significance of average profile similarities, as assessed via average profile correlations (APCs), of dyads that comprise members of two distinct groups that differ with regard to their normative or “prototypical” profile components (e.g., Furr, 2008). As demonstrated in Study 3, this circumstance will most likely be reflected by the fact that randomly paired members from either group will, on average, be positively or negatively correlated, based on the similarity of the normative profile components. Consequently, the traditional approach of testing whether or not such an APC is significantly different from zero will, in most instances, be inappropriate. Whereas Furr (2008) advised researchers to approach this issue using a decomposition strategy in order to separate normative profile components from distinctive profile components to analyze the similarity between either of these profiles, the research presented in this dissertation demonstrates the benefits of tackling this issue from a different perspective, namely, by means of resampling techniques.

The apparent benefit of the resampling approach is that it does not “partial out” specific parts of the interest profile and, thus, contains the original meaning of the resulting similarity indices, which makes it much easier to communicate the results obtained. Instead, the resampling approach aims to adjust the statistical inference about the average profile similarity by relying on an empirically derived sampling distribution of APCs under the assumption of the null hypothesis that the dyad members are randomly assigned to each other. The APC from the real dyads is then evaluated against this resampling distribution and its statistical significance is inferred from the likelihood of obtaining such an APC (or a more extreme one), given the resampling distribution.

Besides retaining the original meaning of the similarity index used, the resampling approach has several more advantages. First, the resulting resampling distributions implicitly consider profile normativeness. If members of two similar (or dissimilar) groups are randomly paired with one another, the resulting APC will be, in all likelihood, positive (or negative). Consequently, when this procedure is repeated many times, the resulting resampling distribution of the APCs is likely to be centered around a positive (or negative) value. The validity of these assumptions was clearly demonstrated in Study 3. Second, the resampling algorithm can easily be adjusted to also consider other potential covariates and conditions. For example, it was shown that further

adjustments can be made to consider the similarity between mothers and fathers in the evaluation of the statistical significance of parent-child profile similarity. Although this particular issue is not detailed in Study 3, it can be shown that other, at first glance more obvious, approaches towards adjusting for mother-father similarity (for instance, with the help of partial correlations) are not applicable<sup>4</sup>. The adjustment of the resampling approach thus made it possible to analyze specific research questions that could not have been analyzed by means of traditional methods.

Taken together, the resampling or pseudo-coupling approach appears to be a powerful method to account for profile normativeness in the analysis of average profile similarities. The flexibility of the method makes it possible to impose additional constraints on the resampling algorithm in order to account for potential confounding factors. Although the method was demonstrated using the example of vocational interest profile similarity between family members as assessed via profile correlations, it is not limited to this construct or the specific measure of similarity. For example, this method could straightforwardly be applied to an analysis of the similarity in interpersonal behavior profiles, personality trait profiles, or self-concept profiles. Because the resampling approach is nonparametric (i.e., no assumptions are made about the underlying sampling distribution of the profile similarity indices), it is especially suitable for analyzing the statistical significance of profile similarity measures that are often not normally distributed (e.g., Cronbach & Gleser, 1953) and that, therefore, often violate the distributional assumptions of traditional methods.

#### 6.3.4 *Structural Validity and Relations to External Variables*

The third methodological challenge addressed in this dissertation was the analysis of the validity of the spherical structure underlying the 18 PGI scales and the structural validity of the circumplex that is formed by its eight basic interest scales. Thereby, it was attempted to validate these structural models with regard to both internal (i.e., structural validity) and external (i.e., relationships to other variables) validity criteria (similar to the approach suggested by Mcardle

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<sup>4</sup>Specifically, the partial correlation is not applicable because the three profile correlations in a mother-father-child triad are not independent. On the level of model-based interest profiles, it was shown that the partial correlation between any two interest profiles, with the third profile being “partialed out”, will always amount to either 1 or -1.



& Prescott, 1992). The simultaneous consideration of both validity aspects ensures that one does not fall prey to extracting meaningless patterns from covariance structures that have no relevance for the relationships of the construct in question with relevant external criteria. To this end, the results obtained extend the findings of Nagy (2006), who demonstrated the benefits of such an integrative approach in order to find evidence for the validity of the circumplex structure of the RIASEC domains in Germany.

Concerning the evaluation of the structural validity of both the spherical model and the basic interest circumplex, as assessed with the PGI and PGI-S, this dissertation presented two extensions to well established methodological approaches taken as a means to this end. First, in Study 4, it was shown that principal components analyses with subsequent target rotations of the loading matrix can be used to explore potential reasons for imperfect results of confirmatory tests, such as the RTOR. Specifically, the Cartesian coordinates of the theoretically postulated scale positions on the unit sphere can be used to define the target matrix for the rotation algorithm. This then makes it possible to identify particular scales that deviated noticeably from their theoretically postulated positions. Omnibus tests like the RTOR, on the other hand, do not allow for such deeper investigations of the structural composition. Second, by extending the CSPF (Browne, 1992) to the multigroup case, it was possible to test the invariance of central model parameters pertaining to the circumplex structures from different instruments (namely, the PGI and the PGI-S). Using this approach, it was demonstrated that the essential parameters of the instruments' circumplex structures are invariant and, hence, that they indeed measure the same construct. Although there are comparative versions of the RTOR with the help of which such hypothesis can also be tested, the multigroup CSPF is much more flexible. Whereas the comparative RTOR is basically a test of the equality of the order relations across two correlation matrices, the multigroup CSPF allows for a direct test of the differences between theoretically meaningful model parameters, such as the components of the correlation function and the scales' angular position on the circumplex.

Regarding the analyses of interest profiles and external criteria, the particular approach employed in Study 5 was to reduce the profile information by transforming the scale scores to the respective dimension scores (People-Things, Ideas-Data, and Prestige). By so doing, it

was possible to investigate the validity of the profiles retrieved from the instruments in question by considering the relationships between these dimension scores and theoretically meaningful external criteria. This particular approach further emphasizes the close relationship between the structural validity of the instrument, in the sense of the scales' fit to the underlying structural models, and the validity of individual-level interest profiles. In this regard, the findings of Study 5 provide strong evidence not only for the validity of the particular scales that make up the underlying model but also for the validity of the interest profiles that can be derived from these scales.

#### **6.4 Limitations and Future Directions**

In order to conclude this dissertation, these final paragraphs aim to address some limitations of the research presented herein and to present prospects for potential future endeavors. Because the limitations and future directions pertaining to the specific research questions that were addressed in the context of this dissertation have already been addressed in the respective sections of this discussion (Section 6.2), the focus is on the particular strengths and weaknesses of the analytical methods employed to reach these conclusions.

First, the methods used in order to analyze the similarity of vocational interest profiles between individuals and within individuals over time were two-step approaches. That is, data were analyzed in two subsequent analysis steps. However, the particular data situations in these analyses can also be contextualized as a multilevel problem with nested data structures (e.g., Curran, 2003; Mehta & Neale, 2005). For example, concerning the analyses of vocational interest profile stability, there are interest profiles comprising scores on interest domains or items (Level-1 unit), which are nested within individuals (Level-2 unit). Likewise, regarding the analysis of intradyadic profile similarities, the data can be considered to be organized in the form of interest profiles comprising scores on particular interest domains or items (Level-1 unit), nested within dyads (Level-2 unit). This then makes it possible to analyze these data by means of multilevel analysis techniques. In fact, some researchers have already proposed the use of such techniques in order to analyze personality trait configurations from a person-

centered perspective (e.g., Asendorpf, 2006). However, it can be expected that the traditional multilevel modeling techniques have to be adjusted in order to make it possible to derive suitable indicators of profile stability. Specifically, it can be expected that the assumptions of traditional multilevel models will typically not hold in these particular data situations (e.g., the assumption of homogenous residual variances for all Level-1 units; a potential way to address this issue in order to make these models applicable for the analysis of interindividual differences in within-person variability can be found in Hoffman, 2007). Nevertheless, given the prominence and widespread application of multilevel modeling techniques, this possibility seems worthy of deeper consideration.

Second, the analyses presented in this dissertation were limited to the use of one particular similarity measure that only considered the similarity of one specific profile component, namely, profile shape: the profile correlation. Although this measure was argued to be the most appropriate to assess the similarity between vocational interest profiles, it does not necessarily have to be the most appropriate measure in other situations. For example, when analyzing the similarity between the profiles of subtests of a test to assess general cognitive ability, it can be expected that profile elevation will, in this case, play a much more important role than it does in the analysis of interest profile similarity. Therefore, an alternative similarity measure that also captures the similarity between profile elevations might be more appropriate in such situations. Consequently, future research could aim to investigate the extent to which the proposed analysis strategies can be applied to analyses based on other similarity indices. The flexibility of the proposed methods can be expected to enable straightforward transferability.

Third, regarding the analysis of the relationships between vocational interest profiles and the external covariates, the analyses presented in this dissertation were conducted on the level of manifest dimensional scores derived from the observed scale scores. Consequently, it can be expected that the identified relationships might actually be even larger than reported here, because they were not disattenuated for unreliability due to measurement error. Future research on these relationships could consider the application of more elaborate methods that make it possible to analyze such relationships on the level of true scores. To this end, it might be considered to employ methods that make it possible to integrate external variables into

circumplex structures. Whereas earlier methods that have been proposed as a means to this end suffer from more or less severe limitations, in particular concerning the fact that they do not allow the simultaneous assessment of the circumplex structure and its relationship to the external variables (e.g., Yik & Russell, 2004; Zimmermann & Wright, 2017), recent advancements in this area show much promise for the elaborate estimation of such models (Nagy et al., in press).

Finally, a considerable part of this dissertation was concerned with a thorough analysis of the validity of a more elaborate interest model—the spherical model of vocational interests, as assessed with a German translation of the PGI (Tracey, 2002). Although much has been said about the potential benefits of this model, which primarily pertain to the more differentiated classification system of the People-Things and Ideas-Data circumplex and the introduction of the Prestige dimension, the empirical evidence for its validity and for the observed relationship patterns was limited to a single sample of university students from Germany. Consequently, it remains to be seen whether or not these presumed advantages can be verified in other applications of the instruments developed and whether or not the validity of the structural model can be substantiated in more heterogeneous populations. A particularly interesting question could be to compare the structural models underlying the PGI circumplex and the traditional RIASEC circumplex of the GIST (Bergmann & Eder, 2005). Moreover, it could be examined whether or not the two circumplex models are invariant with regard to the relationships between the circumplex structures and external variables. Given the presumed arbitrariness of the specific classification system used to derive the circumplex, it can be expected that analyses with either conceptualization would lead to highly comparable results.

## **6.5 Conclusion**

The research presented in this dissertation provides new insights into the opportunities and challenges of analyzing vocational interests from a profile-centered perspective. With the help of several proposed strategies to overcome these challenges, some new light has been shed on the issues of the stability and change of vocational interests and their congruence with the characteristics of particular work environments, the similarity between vocational interest

profiles within families, and the relationships between the dimensions underlying the vocational interest construct and relevant external criteria. It was shown that vocational interests and interest congruence of young adults in VET are relatively stable over the course of their training. However, there are considerable interindividual differences in these intraindividual stabilities. Interest congruence was shown to be a crucial factor in trainees' evaluation of their VET course and was found to be primarily established through processes of occupational selection, whereas occupational socialization appear to play a subordinate role. In addition, evidence was found for considerable similarities between vocational interests of mothers and fathers and those of parents and their children over and above mere normative similarities (or dissimilarities) due to effects of gender. Finally, it was shown that the two circumplex dimensions (People-Things and Ideas-Data) are distinctly related to individuals' gender and academic achievement, whereas the socioeconomic status of their desired profession was only related to the newly introduced Prestige dimension.

In all of the investigations, it could be demonstrated that the simultaneous consideration of the multivariate interest configuration is of utmost importance. Approaching these questions from a profile-centered perspective revealed some relationships in a different light compared to previous research that relied solely on the traditional variable-centered perspective and. The methods introduced herein present efforts to integrate these perspectives by considering interindividual differences in intraindividual profile similarity. A second major contribution of this dissertation is the introduction and thorough validation of German translations of the Personal Globe Inventory (PGI) and its abbreviated short version—the PGI-S. It was shown that the German translation of the PGI is a reliable and, in many respects, valid instrument to assess vocational interests in the sense of the spherical model of vocational interests. A particular finding worth mentioning was the striking evidence for the structural validity of the spherical model and the circumplex submodels, which were found to be invariant between PGI versions. This then opens up the possibility to advance research on vocational interests in German speaking countries by presenting a promising alternative to traditional interest inventories that is based on a differentiated classification system and that might turn out to supersede the long-standing idea of six—and only six—distinct interest domains.



# Zusammenfassung

## Theoretischer Hintergrund

Berufliche Interessen sind ein zentrales Konstrukt in der bildungswissenschaftlichen und arbeits- und organisationspsychologischen Forschung. Einer gängigen Definition zu Folge bezeichnen sie relativ zeitstabile Präferenzen für Aktivitäten oder Kontexte in denen eine Beschäftigung mit solchen Aktivitäten ermöglicht wird, die durch die Antizipation positiver Verhaltens- und Erlebenskonsequenzen bei der Ausführung dieser Aktivitäten zielgerichtetes Verhalten in Richtung bestimmter Umwelten motivieren (Rounds & Su, 2014). Berufliche Interessen haben sich als handlungsleitende und erlebensrelevante Eigenschaften der menschlichen Persönlichkeit ausgezeichnet. Insbesondere wird ihnen eine hohe Prädiktionskraft für berufliche und akademische Wahlentscheidungen (z.B. Hansen & Swanson, 1983; Nagy, 2006; Tracey & Hopkins, 2001; Volodina & Nagy, 2016) zugeschrieben.

Die berühmteste und am häufigsten untersuchte Konzeption beruflicher Interessen stammt aus der Berufswahltheorie von John L. Holland (1997). Im Rahmen dieser Theorie postulierte Holland sechs Persönlichkeits- und Umwelttypen, die mit Hilfe von sechs Interessendomänen beschrieben werden: Praktisch-technisch (**R**ealistic), intellektuell-forschend (**I**nvestigative), künstlerisch-sprachlich (**A**rtistic), sozial (**S**ocial), unternehmerisch (**E**nterprising) und ordnend-verwaltend (**C**onventional)—kurz RIASEC. Auf Basis dieser sechs Interessendomänen leitete Holland zwei zentrale Annahmen ab, die zum einen die Rolle der Passung zwischen Person und Umwelt für das Erleben und Verhalten von Individuen in pädagogischen und beruflichen

Kontexten (Kongruenzhypothese) und zum anderen ein Strukturmodell der Ähnlichkeitsbeziehungen zwischen den sechs Interessendomänen (Calculus-Hypothese) beschreiben.

### *Kongruenzhypothese*

Die Kongruenzhypothese besagt, dass das Erleben und Verhalten von Personen in pädagogischen und beruflichen Umwelten durch die Passung ihrer Interessen zu den spezifischen Anforderungs- und Gelegenheitsstrukturen dieser Umwelten bestimmt werde. So seien Personen a priori dazu bestrebt eine hohe Passung zwischen ihren Interessen und der Umwelt herzustellen, indem sie sich aktiv in eine passende Umwelt (z.B. ein bestimmtes Berufsfeld oder ein Studienfach) selektieren. Eine hohe Person-Umwelt (P-U) Kongruenz sei in der Folge assoziiert mit positiven Konsequenzen im Erleben und Verhalten, zum Beispiel mit einer erhöhten Wahrscheinlichkeit des Verbleibs in der Umwelt oder mit höheren Leistungen (Le et al., 2014; Nye et al., 2017; Spokane, 1985; Van Iddekinge et al., 2011). Zwar existieren auch kritische Stimmen, deren Argumente sich einerseits auf den mangelnden empirischen Nachweis der eigentlich sehr naheliegenden Assoziation zwischen P-U Kongruenz und Zufriedenheit (Tranberg et al., 1993; Tsabari et al., 2005), andererseits auf die generell eher niedrigen Effektstärken der gefundenen Zusammenhänge stützen (siehe insbesondere Tinsley, 2000). Jedoch zielen die vorgebrachten Argumente dabei eher auf methodische Aspekte (insbesondere die Operationalisierung der Kongruenz) ab und stellen den Kongruenzgedanken nicht grundsätzlich in Frage. Neuere empirische Untersuchungen unterstreichen diese Argumentation und liefern positive Befunde für den Zusammenhang zwischen Kongruenz und Zufriedenheit unter Verwendung elaborierterer Methoden (z.B. Volodina, Nagy, & Köller, 2015; Wille et al., 2014)

### *Calculus-Hypothese*

Die Calculus-Hypothese definiert ein zweidimensionales Strukturmodell, welches die Ähnlichkeitsbeziehungen zwischen den sechs Interessendomänen beschreibt. In ihrer "strengen" Formulierung seien die RIASEC Domänen demnach entlang der Eckpunkte eines Hexagons oder, äquivalent, in gleichen Abständen auf dem Umfang eines Circumplex (Guttman, 1954) angeordnet (siehe Abbildung 2 auf Seite 16). Dabei sei die psychologische Ähnlichkeit der



Interessendomänen antiproportional zur Distanz ihrer Lokalisation auf dem Circumplex. Der perfekte Circumplex dient dabei als ein idealisiertes Modell der theoretischen Ähnlichkeitsstruktur. In realen Datensituationen wird von einer Annäherung an dieses Ideal durch eine quasi-Circumplexstruktur ausgegangen, bei der einige Annahmen abgeschwächt werden (zum Beispiel durch die Auflockerung der Gleichabständigkeitsannahme). Die empirischen Untersuchungen dieser Strukturannahmen zeichnen ein überwiegend eindeutiges Bild, welches die Stabilität der Interessenstruktur etwa ab dem 14. Lebensjahr über Geschlechter, ethnische Gruppen und verschiedene Länder der westlichen Welt hinweg belegt (z.B. Nagy et al., 2010; Tracey & Rounds, 1993).

Als ordnendes Element des Circumplex wurden von Prediger (1982) zwei orthogonale Dimensionen vorgeschlagen: *People-Things* und *Ideas-Data*. Die *People-Things* Dimension unterscheidet Präferenzen für Aktivitäten welche die Arbeit mit Dingen, Werkzeugen und Maschinen beinhalten von Präferenzen für Aktivitäten welche die Interaktion mit anderen Menschen involvieren. Hinsichtlich der *Ideas-Data* Dimension werden Präferenzen für wenig strukturierte und kreative Aktivitäten von Präferenzen für hoch strukturierte und verwaltende Aktivitäten unterschieden. Die Validität dieser Dimensionen definiert sich unter anderem über den hohen Vorhersagewert der *People-Things* Dimension für Geschlechterunterschiede in beruflichen Interessen (Su et al., 2009).

### *Das sphärische Modell beruflicher Interessen*

In den letzten zwei Dekaden vollzog sich eine Bedeutungsverschiebung in der Interessenforschung dergestalt, dass die sechs RIASEC Domänen zugunsten einer stärkeren Fokussierung auf den Circumplex in den Hintergrund gerückt wurden. So schlugen Ackerman und Heggestad (1997) sowie Armstrong et al. (2008) vor, den Circumplex als Referenzstruktur zu betrachten, anhand derer sich die Beziehungen verschiedener individueller Unterschiedsvariablen (z.B. gemäß des Fünf-Faktoren Modells der Persönlichkeit; Digman, 1990) im Sinne eines nomologischen Netzes verankern lassen. Des Weiteren wiesen insbesondere Tracey und Rounds (1995) darauf hin, dass die sechs Interessendomänen nach Holland als Indikatoren für den Interessencircumplex betrachtet werden können und somit lediglich eine von theoretisch unendlich vielen

möglichen Kategorisierungen entlang der Dimensionen des Circumplex darstellen. Die konkrete Anzahl der Kategorien sollte sich dabei nach Ansicht der Autoren als Kompromiss zwischen Präzision (im Sinne der Erfassung des Circumplex durch die Indikatoren) und Parsimonität (im Sinne der Relevanz für die Forschungs- und Beratungspraxis) ergeben.

Eine Konsequenz der Erkenntnis der Arbitrarität der RIASEC Domänen war die Ergründung alternativer Kategorisierungen. Diese fand ihren vorläufigen Abschluss in einer weitläufigen Weiterentwicklung von Hollands Theorie: Dem sphärischen Modell beruflicher Interessen (Tracey, 2002; Tracey & Rounds, 1996b). Dieses Modell unterscheidet sich in zwei zentralen Punkten vom traditionellen RIASEC Modell. Erstens wird im Rahmen des sphärischen Modells die traditionelle Kategorisierung in die sechs RIASEC Domänen zugunsten einer differenzierteren Kategorisierung von acht grundlegenden Interessendomänen aufgegeben. Dabei stellen die acht alternativen Interessendomänen Indikatoren des gleichen Circumplex dar, der auch Hollands Modell zugrunde liegt und der durch die beiden Dimensionen People-Things und Ideas-Data aufgespannt wird. Unter anderem konnte bereits gezeigt werden, dass diese alternative Kategorisierung hinsichtlich der für die Strukturannahmen relevanten psychometrischen Eigenschaften der traditionellen Kategorisierung mindestens ebenbürtig (Tracey & Rounds, 1996b), in kulturübergreifenden Studien sogar überlegen ist (Tracey et al., 1997).

Zweitens wird eine weitere, zum Circumplex orthogonale, Dimension postuliert, die von den Autoren als *Prestige* bezeichnet wurde und die den zweidimensionalen Interessencircumplex zu einer dreidimensionalen Interessensphäre erweitert. Während die beiden Circumplexdimensionen Unterschiede in Präferenzen für verschiedene Inhaltsbereiche erfassen, soll die Prestigedimension Unterschiede in Präferenzen für Aktivitäten von unterschiedlicher Komplexität, Schwierigkeit, Verantwortung und unterschiedlichem assoziierten sozioökonomischen Status abbilden. In den letzten Jahren wurde im amerikanischen Sprachraum ein elaboriertes Instrument zur Erfassung von beruflichen Interessen gemäß dieses Modells vorgestellt: Das Personal Globe Inventory (PGI; Tracey, 2002). Empirische Untersuchungen mit diesem Instrument stützen die Validität des sphärischen Modells (z.B., Darcy, 2005; Hedrih, 2008; Šverko, 2008).

### *Interessenprofile*

Aus den in den vorangegangenen Abschnitten vorgestellten Ausführungen lässt sich schlussfolgern, dass bei der Analyse von Zusammenhängen zwischen beruflichen Interessen und anderen Variablen, aber auch bei der Analyse von Ähnlichkeiten beruflicher Interessen, etwa zwischen natürlichen Einheiten (zum Beispiel zwischen Familienmitgliedern) oder innerhalb von Personen über die Zeit (im Sinne der intraindividuellen Interessenstabilität), die durch die individuellen Ausprägungen der jeweiligen zugrundeliegenden Interessendomänen definierten Interessenprofile als zentrale Analyseeinheit herangezogen werden sollten. Solche Profile lassen sich im Allgemeinen durch drei Komponenten charakterisieren: Das *Profilniveau* (Mittelwert der Skalenwerte), die *Profildifferenzierung* (Streuung der Skalenwerte) und die *Profilform* (Muster der Skalenwerte in Relation zueinander). Im Falle der beruflichen Interessen nennt Holland zusätzlich noch die *Profilkonsistenz*, als einen Indikator für die Kompatibilität der Profilform mit der durch die Calculus-Hypothese postulierten Ähnlichkeitsbeziehung der Interessendomänen. Eine Besonderheit von beruflichen Interessenprofilen ist weiterhin, dass sich über die zugrundeliegenden Strukturannahmen des Circumplexmodells modellbasierte Interessenprofile aus den individuellen Rohwertprofilen ableiten (siehe auch Abbildung 2 auf Seite 16).

Obwohl allen Profilkomponenten eine mehr oder weniger gewichtige Bedeutung zukommt, lässt sich die Profilform als zentrales Charakteristikum des Interessenprofiles hervorheben, da durch die relative Ausprägung der Interessendomänen bestimmt wird welche Tätigkeitsbereiche (im Sinne der Tätigkeiten die typischerweise mit den sechs Interessendomänen assoziiert sind) eine Person präferiert und welche nicht. Auf der Ebene der modellbasierten Circumplexprofile lässt sich die Form mit Hilfe eines einzigen Parameters, der *Profilorientierung*, beschreiben. Diese gibt die Position auf dem Circumplex an, an der das modellbasierte individuelle Interessenprofil seine höchste Ausprägung erreicht. In einigen Studien konnte bereits eindrücklich gezeigt werden, dass vor allem die Profilform (bzw. die Profilorientierung) die Vorhersagekraft beruflicher Interessen für berufliche und pädagogische Wahlentscheidungen bestimmt, während zum Beispiel das Profilmittelniveau keinen Einfluss auf solche Entscheidungen hatte (z.B. Nagy, 2006; Prediger, 1998; Volodina, Nagy, & Retelsdorf, 2015).

### *Methodische Herausforderungen*

Die Fokussierung auf die Analyse multivariater Interessenprofile bringt nicht nur Vorteile mit sich, sie stellt Forscherinnen und Forscher auch vor konzeptionelle und methodische Herausforderungen, die sich insbesondere auch aus dem Spannungsfeld zweier konkurrierender Analyseperspektiven ergeben. Die erste, traditionelle Perspektive, aus der heraus die meisten sozialwissenschaftlichen Fragestellungen betrachtet werden wird im Allgemeinen als *variablenzentrierte* Perspektive bezeichnet (Howard & Hoffman, 2018). Aus dieser Perspektive werden Zusammenhänge zwischen einzelnen Variablen über alle Personen einer Stichprobe hinweg untersucht. In diesem Sinne lassen sich folglich Aussagen über Variablenzusammenhänge einer *durchschnittlichen* Person ableiten. Ein klassisches Beispiel für eine variablenzentrierte Herangehensweise an die Untersuchung von Stabilität ist die Untersuchung der Stabilität der Rangordnung einer bestimmten Variablen. Dabei werden die Vektoren der Personenwerte dieser Variablen zu zwei Messzeitpunkten miteinander korreliert. Diese Herangehensweise liefert somit eine Antwort auf die Frage, ob Personen, die zum ersten Messzeitpunkt eine hohe Ausprägung auf der untersuchten Variable haben auch zum zweiten Messzeitpunkt eine hohe Ausprägung vorweisen (jeweils in Relation zu den anderen Personen in der Stichprobe).

Obwohl die variablenzentrierte Herangehensweise viele Vorteile birgt (z.B. eine hohe Parsimonität und eine relativ einfache Interpretierbarkeit der Ergebnisse), so erscheint dieser Ansatz für die Analyse von vielen Fragestellungen (z.B. zur Entwicklung, Ähnlichkeit, und Passung) von Interessenprofilen nur bedingt geeignet, da durch die Fokussierung auf einzelne Interessendomänen das zentrale Charakteristikum des Interessenkonstrukts nicht erfasst wird: Die durch die Profilform gegebene intraindividuelle Interessenkonfiguration. Um dieser Komplexität gerecht zu werden benötigt es einen Perspektivwechsel hin zu einer Betrachtung individueller multivariater Persönlichkeitsprofile, die im Rahmen dieser Arbeit als *profilzentrierte* Perspektive bezeichnet werden soll. Zwar wurde diese Notwendigkeit unlängst von vielen Forscherinnen und Forschern erkannt und auch teilweise berücksichtigt, zum Beispiel durch profilbasierte Untersuchungen der Interessenstabilität, -ähnlichkeit und der P-U Passung (Grotevant et al., 1977; Le et al., 2014; Wille et al., 2014; Xu & Tracey, 2016, siehe z.B.), jedoch gehen die verwendeten

Ansätze dabei selten über die bloße Deskription oder den Vergleich von mittleren Profilähnlichkeitsmaßen (z.B. Profilkorrelation oder euklidische Distanz) hinaus. Die Fragen, inwiefern die dafür eingesetzten statistischen Methoden, die häufig aus der variablenzentrierten Tradition entliehen werden (z.B. *t*-Tests, Varianzanalysen, Tests der mittleren Profilkorrelation gegen null) adäquat sind und inwiefern interindividuelle Unterschiede in intraindividuellem Interessensstabilität oder -ähnlichkeit aufgefangen werden können, sind bisher jedoch nur unzureichend untersucht.

## **Forschungsanliegen**

Die vorliegende Dissertation hat zwei übergeordnete Ziele. Erstens sollen anhand von zwei zentralen inhaltlichen Fragestellungen methodische Herausforderungen der profilzentrierten Perspektive identifiziert und innovative Herangehensweisen vorgestellt werden, um diesen Herausforderungen gerecht zu werden. Diese beziehen sich zunächst im Rahmen von Studie 2 auf die Frage nach der Erfassung interindividueller Unterschiede in der intraindividuellen Stabilität, Veränderlichkeit und Passung beruflicher Interessenprofile im Kontext der beruflichen Erstausbildung. Dabei wird ein Vorgehen skizziert, das es erlaubt mit Hilfe von meta-analytischen Aggregationsmethoden latente Verteilungen individueller, abhängiger Effektgrößen (z.B. intraindividuelle P-U Kongruenz oder Profilstabilität) zu schätzen, die dann um relevante Kovariaten (z.B. Zufriedenheit) erweitert werden können. Im Rahmen von Studie 3 wird auf Herausforderungen bei der Erfassung von Ähnlichkeiten zwischen Interessenprofilen innerhalb von Familien Bezug genommen, die sich insbesondere aus der Problematik normativer Profilanteile ergeben (Wood & Furr, 2016). Hierbei wird ein Resampling-Verfahren vorgestellt, mit dessen Hilfe normative Profilanteile bei der statistischen Evaluation mittlerer Profilähnlichkeitsmaße berücksichtigt werden können.

Zweitens sollen im Rahmen dieser Dissertation Übersetzungen des Personal Globe Inventory (PGI) und dessen assoziierter Kurzform (PGI-S) erstellt und hinsichtlich zentraler psychometrischer Gütekriterien überprüft werden. Die positive Evaluation einer solchen Übersetzung würde die Möglichkeiten zur Erfassung beruflicher Interessen im deutschsprachigen Raum

substantiell erweitern, da bisher weder ein Instrument zur Erfassung beruflicher Interessen im Sinne des sphärischen Interessenmodells, noch ein Instrument zur differenzierten Erfassung von Interessenprofilen mit mehr als den sechs traditionellen RIASEC Domänen vorliegt. Ein besonderer Fokus soll dabei auch auf der Untersuchung von Gemeinsamkeiten und Unterschieden zwischen der vollen und der verkürzten Form des PGI—insbesondere im Hinblick auf die Äquivalenz des postulierten Strukturmodells und der Beziehung zu relevanten externen Variablen (z.B. Schulnoten)—liegen, da diese Aspekte in der bisherigen Forschung zum sphärischen Interessenmodell noch keiner systematischen Prüfung unterzogen wurden. In den folgenden Abschnitten sollen die vier Studien, in deren Rahmen sich dieser Fragestellungen angenommen wurde, sowie deren zentrale Befunde kurz vorgestellt werden.

### **Studie 1**

In der ersten Studie wurden die Stabilität und Veränderbarkeit von beruflichen Interessen und der P-U Kongruenz im Verlauf der beruflichen Erstausbildung sowie der Zusammenhang zwischen P-U Kongruenz und der Zufriedenheit mit den Ausbildungsinhalten untersucht. Ausgehend von bisherigen Forschungsergebnissen zur Stabilität beruflicher Interessen (z.B. Low et al., 2005), die zum einen deren relativ hohe Stabilität über die Lebensspanne belegen, zum anderen jedoch typischerweise Effektgrößen finden die potenziell Raum für Veränderungen lassen und von der zentralen Annahme von Hollands Kongruenzhypothese, dass Individuen tendenziell dazu bestrebt sind die Kongruenz mit ihrer Umwelt zu erhöhen wurden drei spezifische Forschungsfragen untersucht: 1) Wie stabil sind berufliche Interessen im Verlauf der beruflichen Erstausbildung? 2) Verändern sich berufliche Interessen im Verlauf der Ausbildung hin zu einer höheren Kongruenz mit der Umwelt? 3) Sind Veränderungen von beruflichen Interessen assoziiert mit Veränderungen in der Zufriedenheit mit den Ausbildungsinhalten?

Als Datengrundlage diente die Studie *Mathematische und naturwissenschaftliche Kompetenzen in der beruflichen Erstausbildung* (ManKobE; Retelsdorf et al., 2013). Im Rahmen dieser Studie wurden Auszubildende aus verschiedenen Ausbildungsgängen des dualen Ausbildungssystems zu insgesamt drei Messzeitpunkten (kurz nach Beginn der Ausbildung, vor den Zwischenprüfungen und vor der Abschlussprüfung) untersucht. Die finale Stichprobe, bei der nur Ausbildungsgruppen berücksichtigt wurden die zu allen drei Messzeitpunkten getestet

wurden, umfasste  $N = 2611$  Auszubildende aus fünf verschiedenen Ausbildungsgängen (Industriemechaniker, KFZ-Mechatroniker, Elektroniker, Chemielaboranten und Industriekaufleute).

Um Mittelwerte von und interindividuelle Unterschiede in intraindividuellem Stabilität und Veränderung multivariater Interessenprofilen sowie deren Passung mit empirisch ermittelten Umweltreferenzprofilen zu erfassen wurde ein zweischrittiges Verfahren eingesetzt. Hierbei wurden zunächst auf Ebene der einzelnen Individuen Effektgrößen der Stabilität und P-U Passung ermittelt. Als Effektgröße der Wahl wurde die Profilkorrelation verwendet, da diese explizit nur die Stabilität und Veränderung in der Profilform erfasst. Im zweiten Schritt wurden diese mit Hilfe von meta-analytischen Aggregationsverfahren, die als Strukturgleichungsmodelle formuliert wurden (M. W. Cheung, 2013), zusammengefasst und schließlich noch um die Indikatoren der Ausbildungszufriedenheit erweitert.

Berufliche Interessen erwiesen sich erwartungsgemäß als zeitlich relativ stabil, wobei die Stabilität in fast allen Gruppen im Laufe der Ausbildung zunahm. Die aggregierten Effektgrößen waren, in Übereinstimmung mit vorherigen Forschungsergebnissen, jedoch nicht so groß, dass von einer perfekten Stabilität ausgegangen werden konnte. Des Weiteren zeigte sich auch, dass die intraindividuellen Stabilitäten, die sowohl zwischen als auch innerhalb der Ausbildungsgruppen signifikante interindividuelle Unterschiede aufwiesen, ihrerseits wiederum sehr stabil waren. Personen die also zu Beginn der Ausbildung eine hohe intraindividuelle Stabilität aufwiesen, zeigten in der Tendenz auch eine höhere intraindividuelle Stabilität zum Ende der Ausbildung hin.

Die mittlere P-U Kongruenz war in allen Gruppen zu Beginn der Ausbildung positiv und signifikant größer als ein jeweiliger, aus einer repräsentativen Stichprobe gewonnener, Referenzwert, ausgeprägt. Dieser Befund kann als ein weiterer Beleg für die prädiktive Kraft beruflicher Interessen für individuelles Wahlverhalten angesehen werden. In drei von fünf Gruppen zeigte sich ein signifikanter Anstieg der mittleren P-U Kongruenz über den gesamten Verlauf der Ausbildung, der im Vergleich zu den vorher ermittelten Selektionseffekten jedoch nahezu vernachlässigbar war. Wie bereits bei den Stabilitäten zeigte sich jedoch auch hier eine signifikante interindividuelle Variabilität in der P-U Kongruenz zu jedem Messzeitpunkt sowie auch in der Veränderung der Kongruenz im Verlauf der Ausbildung. In einem letzten Schritt konnte

schließlich gezeigt werden, dass sowohl die P-U Passung innerhalb eines jeden Messzeitpunktes als auch deren Veränderung signifikant und moderat positiv mit der Zufriedenheit mit den Ausbildungsinhalten bzw. deren Veränderung assoziiert war.

Die Ergebnisse lassen sich als Beleg für Hollands Kongruenzhypothese deuten und belegen eindrücklich, dass junge Erwachsene P-U Kongruenz vor allem durch ihr Wahlverhalten für bestimmte berufliche und pädagogische Umwelten herstellen. Innerhalb solcher Umwelten sind berufliche Interessen im Mittel äußerst stabil, wobei es jedoch bedeutsame Unterschiede in der Stabilität zwischen Personen gibt. Zwar lassen sich die nicht-perfekten Stabilitäten in der Tendenz nur rudimentär durch Sozialisationsprozesse im Sinne einer Zunahme der P-U Kongruenz erklären, jedoch sind solche Prozesse auf Ebene des Individuums mit parallelen Veränderungen in zentralen Einstellungen gegenüber dem Ausbildungsgang assoziiert. Zukünftige Forschungsarbeiten könnten an diesem Punkt anknüpfen und versuchen potenzielle Moderatoren dieser Stabilitäten und Veränderungen zu identifizieren.

## **Studie 2**

In der zweiten Studie wurde die Ähnlichkeit beruflicher Interessen innerhalb von Familien untersucht. Die Untersuchung dieser Fragestellung war einerseits inhaltlich motiviert, andererseits jedoch auch darauf ausgelegt methodische Defizite vorangegangener Studien zu diesem Thema zu identifizieren und diese durch ein angemessenes methodisches Vorgehen zu beheben. Hinsichtlich der Untersuchung von Müttern und Vätern wurde in Anschluss an bisherige Forschung zur Ähnlichkeit von Erwachsenen in Partnerschaften, in deren Rahmen oft eine signifikante Ähnlichkeit von Partnern in zentralen Persönlichkeitseigenschaften nachgewiesen wurde, vermutet, dass durch verschiedene aktive und passive Selektionsprozesse (z.B. Luo, 2017) auch eine bedeutsame Ähnlichkeit beruflicher Interessen zu finden sei. In Bezug auf die Ähnlichkeit zwischen Eltern und Kindern wurde vermutet, dass genetische (z.B. Bouchard & McGue, 2003; Moloney et al., 1991), sozial-kognitive (z.B. Bandura, 1986) und transaktionale Faktoren der P-U Beziehung (z.B. Holland, 1997) zu einer bedeutsamen Ähnlichkeit zwischen Eltern und Kindern führen sollten.

Aus methodischer Sicht wurden dabei an vorangegangenen Studien, die mal bedeutsame Ähnlichkeiten zwischen diesen mal zwischen jenen Eltern-Kind Dyaden identifizierten (z.B.



DeWinne et al., 1978), zwei konkrete Dinge kritisiert. Einerseits operationalisierten einige Studien die Ähnlichkeit zwischen Eltern und Kindern nur auf Basis der Ausprägungen einzelner Interessendomänen. Außerdem wurden dabei die Interessen der Eltern oft nicht psychometrisch erfasst, sondern über eine Kodierung der elterlichen Berufe approximiert. Durch dieses Vorgehen war es folglich nicht möglich Ähnlichkeiten in Interessenkonfigurationen zu untersuchen, die möglicherweise zu gänzlich anderen Schlussfolgerungen geführt hätten. Andererseits wurden bei den wenigen Forschungsarbeiten, die die Ähnlichkeit von Eltern-Kind Dyaden auf Basis multivariater Interessenprofile untersuchten (z.B. Grotevant et al., 1977) zentrale Herausforderungen bei der Einschätzung der Ähnlichkeit beruflicher Interessenprofile nicht beachtet, die zu einer Über- bzw. Unterschätzung der tatsächlichen Ähnlichkeit geführt haben könnten. Hierzu zählt insbesondere die fehlende Beachtung normativer Profilanteile (Wood & Furr, 2016), die sich bei beruflichen Interessen insbesondere in den großen Geschlechterunterschiede entlang der People-Things Dimension (Su et al., 2009) manifestieren. So ist aufgrund dieser Anteile zum Beispiel zu erwarten, dass berufliche Interessenprofile von zufällig einander zugewiesenen, gleichgeschlechtlichen Eltern-Kind Dyaden in der Erwartung ähnlicher sind als solche von andersgeschlechtlichen Eltern-Kind Dyaden.

Auf der Grundlage von Daten von  $N = 1624$  Schülerinnen und Schülern aus der Studie *Transformation des Sekundarschulsystems und akademische Karrieren: Klassenstufe 10* (TOSCA-10 Trautwein et al., 2010) und Daten von jeweils mindestens einem Elternteil wurden im Rahmen dieser Studie die Ähnlichkeiten zwischen den Interessenprofilen von Mutter-Vater und allen möglichen Eltern-Kind Dyaden untersucht. Die Ähnlichkeit wurde dabei wieder als Übereinstimmung der Profilformen, also mit Hilfe von Profilkorrelationen, operationalisiert. Durch die Verwendung eines Pseudo-Paarungs Verfahrens (Kenny et al., 2006), bei dem die jeweiligen Dyaden durch einen Algorithmus wiederholt neu zusammengesetzt wurden, konnten die durchschnittlichen Profilkorrelationen gegen adäquate Referenzwertverteilungen, welche die Geschlechternormativität implizit berücksichtigten, evaluiert werden. Diese Analysen wurden sowohl auf der Ebene der Rohwertprofile als auch auf der Ebene der modellbasierten Circumplexprofile durchgeführt.

Die Ergebnisse dieser Analysen zeigten, dass alle untersuchten Dyaden signifikant höhere

durchschnittliche Profilkorrelationen aufwiesen als die jeweiligen Pseudo-Dyaden. Um potenzielle Effekte der Elternähnlichkeit auf die Eltern-Kind Ähnlichkeit zu untersuchen wurde der Zufallspaarungsalgorithmus in einem weiteren Analyseschritt dergestalt modifiziert, dass bei der Paarung der Pseudo-Dyaden die Ähnlichkeit zwischen den Eltern indirekt berücksichtigt wurde. Die Ergebnisse dieser Zusatzanalysen zeigten, dass unter Berücksichtigung der Elternähnlichkeit nur gleichgeschlechtliche Eltern-Kind Dyaden signifikant höhere durchschnittliche Profilkorrelationen aufweisen als die korrespondierenden Pseudo-Paare. Alle Ergebnisse konnten auf Ebene der modellbasierten Circumplexprofile repliziert werden. Dieser Befund legt nahe, dass die modellbasierten Profilparameter in der Lage sind die zentrale Information, die für die Ähnlichkeit zweier Profile verantwortlich ist, zu erfassen, und liefert somit weitere Unterstützung für die Validität des Circumplexmodells.

### **Studie 3**

Im Rahmen von Studie 4 wurde eine deutsche Übersetzung des Personal Globe Inventory (PGI; Tracey, 2002), einem Selbstberichtsfragebogen zur Erfassung beruflicher Interessen im Sinne des sphärischen Modells beruflicher Interessen (Tracey & Rounds, 1996b) angefertigt und anhand zentraler psychometrischer Kriterien evaluiert. Im Besonderen wurden 1) die strukturelle Validität der verschiedenen aus dem PGI ableitbaren Strukturmodelle (6- und 8-Skalen Circumplex sowie Interessensphäre), 2) die konvergente Validität der aus dem PGI abgeleiteten RIASEC Skalen mit den korrespondierenden Skalen aus einem anderen deutschsprachigen Instrument zur Erfassung beruflicher Interessen und 3) die Konstruktvalidität im Sinne einer Untersuchung der erwarteten Geschlechterunterschiede entlang der Skalen des Modells untersucht.

Auf der Grundlage einer via Online-Erhebung rekrutierten, heterogenen Gelegenheitsstichprobe von  $N = 526$  Studierenden von deutschen Universitäten wurde die strukturelle Validität zunächst konfirmatorisch mit Hilfe des *Randomization Test for Hypothesized Order Relations* (RTOR; Hubert & Arabie, 1987) untersucht. Über alle Itemtypen und Geschlechtergruppen hinweg lieferte der RTOR dabei signifikante und positive Correspondence Indices (CIs; ein Maß, das den Anteil der bestätigten Vorhersagen über die durch das Strukturmodell vorgegebenen Relationen der Werte in der entsprechenden Korrelationsmatrix angibt und zwischen  $-1 = keine$

*Vorhersage trifft zu* und *1 = alle Vorhersagen treffen zu* variiert). Da in einigen Submodellen, insbesondere bei denen des sphärischen Modells, merkliche Abweichungen von einer perfekten Vorhersage festgestellt werden konnten (CIs deutlich kleiner als 1), wurde in weiteren Analysen versucht mittels explorativer Datenvisualisierungsverfahren (Hauptkomponentenanalysen mit anschließender Zielrotation der Ladungsmatrix) zu ergründen ob diese Abweichungen die Gültigkeit des Strukturmodells insgesamt in Frage stellen oder ob sie auf Abweichungen einiger weniger Skalen zurückzuführen waren. Die Ergebnisse dieser Analysen deuteten darauf hin, dass die Daten die sphärische Struktur im Großen und Ganzen sehr gut approximierten und das über alle Itemtypen hinweg lediglich drei Skalen bedeutsame Abweichungen von der postulierten Position auf der Interessensphäre aufwiesen.

Die aus den PGI Skalen rekonstruierten RIASEC Skalen korrelierten insgesamt hoch mit den RIASEC Skalen aus dem Allgemeinen Interessen-Struktur-Test (AIST-R; Bergmann & Eder, 2005), der als Goldstandard zur Erfassung beruflicher Interessen im Sinne des RIASEC Modells im deutschsprachigen Raum betrachtet werden kann. Die einzige kleinere Ausnahme bildete die Conventional Skala, die nur moderat, aber dennoch signifikant positiv mit der korrespondierenden Skala des AIST-R korrelierte. Abschließend zeigte sich, dass die Geschlechterunterschiede in den 18 Skalen des PGI über alle Itemtypen und Prestigeebenen hinweg eine hohe Übereinstimmung mit den theoretisch postulierten Unterschieden aufwiesen. So erzielten männliche Studienteilnehmer signifikant höhere Werte auf Skalen, die nahe des Things Pols lokalisiert waren, während weibliche Studienteilnehmer signifikant höhere Werte auf Skalen nahe des People Pols erreichten. Bei Skalen die nahe der Pole der Ideas-Data Dimension lagen, fanden sich keine oder nur geringe Unterschiede zwischen männlichen und weiblichen Studienteilnehmern. Zusammengefasst kann aufgrund dieser Ergebnisse die Validität des übersetzten Instruments als bestätigt betrachtet werden.

#### **Studie 4**

In Studie 4 wurden aufbauend auf den Ergebnissen von Studie 4 weitere Aspekte der Validität des PGI und erstmals auch der assoziierten Kurzversion, dem PGI-S (Tracey, 2010), sowie die Äquivalenz dieser Validitätsaspekte zwischen den beiden PGI Versionen untersucht. Der PGI-S fokussiert im Gegensatz zum PGI, der mit seinen  $3 \times 108 = 324$  Items ein für viele

Zwecke (z.B. Large Scale Assessment) zu umfangreiches Instrument darstellt, stark auf die Erfassung der beiden Circumplexdimensionen. Dabei werden die acht Indikatorskalen dieser Dimensionen mit jeweils 4 Items gemessen werden. Des Weiteren umfasst der PGI-S jeweils 4 Items für die High Prestige bzw. Low Prestige Skalen, die als Proxy für die Prestige Dimension herangezogen werden. Im Unterschied zu Studie 4 wurde in dieser Untersuchung ein besonderes Augenmerk auf Validitätsaspekte der drei Dimensionen, die dem sphärischen Modell zugrunde liegen, gelegt. Des Weiteren wurden erstmals auch Aspekte der Validität im Sinne der Beziehung dieser Dimensionen zu wichtigen externen Variablen untersucht.

Erstens wurde die Validität der beiden Circumplexdimensionen durch eine elaborierte konfirmatorische Methode untersucht: Dem *zirkulären stochastischen Prozess mit einer Fourierreihe* (ZSPF; Browne, 1992). Die Spezifikation dieses Modells als Strukturgleichungsmodell erlaubte es einerseits die Passungsgüte des Circumplexmodells flexibler zu untersuchen als dies mit dem RTOR möglich gewesen wäre, andererseits konnte durch die Erweiterung dieses Modells auf den Mehrgruppenfall ein konfirmatorischer Test für die Äquivalenz der Modellparameter zwischen den beiden PGI Versionen durchgeführt werden. In ähnlicher Weise wurden ferner die konvergenten Zusammenhänge der Dimensionswerte untereinander, über Itemtypen und PGI Versionen hinweg, evaluiert. Schließlich wurden die korrelativen Zusammenhänge der PGI Dimensionen mit zentralen externen Variablen (Geschlecht, Schulnoten und der mit dem Wunschberuf der Probanden assoziierte sozioökonomische Status) sowie die Äquivalenz dieser Beziehungen zwischen den PGI Versionen untersucht.

Als Datengrundlage diente die gleiche Stichprobe die auch in Studie 4 herangezogen wurde, jedoch wurden nun auch erstmals die Daten von jenen Probanden hinzugenommen, die in einer separaten Studienbedingung den PGI-S bearbeitet hatten. Es zeigte sich zunächst, dass die Skalen des PGI-S im Vergleich zum PGI geringere Reliabilitäten aufweisen, die allerdings die Reliabilität der beiden Circumplexdimensionen nicht negativ beeinflussten. Für die Prestigedimension zeigte sich, dass diese mit dem PGI-S nur mit unzureichender Reliabilität erfasst werden konnte. Hinsichtlich der Validitätsaspekte zeigte sich zunächst, dass die acht grundlegenden Interessensskalen der beiden PGI Versionen über alle Itemtypen hinweg eine sehr gute bis gute Passung zum Circumplexmodell aufweisen und dass sich die zentralen Parameter des

Modells (vor allem die Skalenpositionen) nicht signifikant zwischen den PGI Versionen unterscheiden. Auch die Beziehungen der Circumplexskalen zu den Außenkriterien erwiesen sich als weitestgehend erwartungskonform und invariant zwischen PGI Versionen. Die größten Unterschiede in den Beziehungen ergaben sich erneut für die Prestigedimension, die jedoch über alle Itemtypen und PGI Versionen schwach positiv mit dem zentralen Validitätskriterium, dem sozioökonomischen Status der Wunschberufe, assoziiert war. Zusammengenommen legen die Ergebnisse nahe, dass der PGI-S insbesondere dafür geeignet ist die Circumplexdimensionen effizient, reliabel und valide zu erfassen, während bei Untersuchungen der Prestigedimension auf den PGI zurückgegriffen werden sollte.

## **Fazit**

Die Ergebnisse der Studien 1 und 2 belegen eindrucksvoll, dass die Übernahme einer profilenorientierten Perspektive bei der Analyse der intraindividuellen Stabilität und Veränderlichkeit beruflicher Interessen sowie bei der Analyse der Ähnlichkeit von beruflichen Interessen zwischen Familienmitgliedern komplexe Zusammenhänge aufzudecken vermag, die durch die traditionelle, variablenzentrierte Betrachtungsweise verborgen bleiben. Im Zuge dieser Untersuchungen wurden zwei explizite methodische Strategien vorgeschlagen, deren Übertragbarkeit auf andere Forschungsfragen es in zukünftigen Forschungsarbeiten zu überprüfen gilt. Im Rahmen der Studien 3 und 4 wurde schließlich gezeigt, dass die deutsche Übersetzung des Personal Globe Inventory und dessen assoziierter Kurzform einer ausführlichen und elaborierten Evaluation ihrer zentralen psychometrischen Eigenschaften weitestgehend standhalten. In diesem Sinne offenbaren sich im Anschluss an diese Dissertation neue Möglichkeiten zur Erfassung und Untersuchung beruflicher Interessenprofile im deutschsprachigen Raum unter Rückgriff auf eine differenziertere Kategorisierung des Interessencircumplex und eine Erweiterung des Konstruktbereichs um eine weitere relevante Interessensdimension.



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# Appendix

## **Appendix A: German translation of the Personal Globe Inventory**

This Appendix presents the German translation of the PGI items. Table A1 displays the items for the activity preferences and activity competence beliefs item types. These item types consist of the same exact activity descriptions. The difference between these item types is that for the activity preferences item type, participants are asked to rate how much they like these activities, whereas for the activity competence beliefs item type participants are asked to indicate how competent they feel to perform these activities. Table A2 presents the translated occupational titles, that are used to assess the occupational preferences item type. The items are presented in the same order as in the original monograph (Tracey, 2002, p. 166–169). Finally, Table A3 presents the subset of activity items comprised in the PGI-S. Again, the item order is adopted from the original paper (Tracey, 2010, p. 13–14). For copyright reasons, the original item descriptions must be looked up in the original sources.

Items are scored on a 7-point Likert scale. For the activity preferences and occupational preferences item types, the question prompt for each item is “Wie sehr mögen Sie die folgende Aktivität [How much do you like the following activity]?”. Verbal anchors are placed at: 1 = *Überhaupt nicht* [Strongly dislike], 3 = *Neutral* [Neutral], and 7 = *Sehr gerne* [Strongly like]. For the activity competence beliefs item type, the question prompt is “Wie gut beherrschen Sie diese Aktivität [How good are you at performing this activity]?”. The respective verbal anchors are: 1 = *Kann ich gar nicht* [unable to do], 3 = *Kann ich mittelmäßig* [Moderately competent], 7 = *Kann ich sehr gut* [Very competent]. Templates for producing raw scores for each scale can be found in Tracey (2002, p. 169) and Tracey (2010, p. 14).

Table A1: German Translation of PGI Activity Items

No.	Scale	Item Translation
001	Social Facilitating	Menschen, die ein Geschäft betreten, begrüßen
002	Managing	Ein Hotel managen
003	Business Detail	Finanzberichte erstellen
004	Data Processing	Eine Gruppe von Datenanalytikern/innen anleiten
005	Mechanical	Elektrische Leitungen installieren
006	Nature/Outdoors	Tiere und Pflanzen kategorisieren
007	Artistic	Gedichte schreiben
008	Helping	Anderen helfen
009	Social Facilitating	Gäste in einem Restaurant bedienen
010	Managing	Anderen Waren verkaufen
011	Business Detail	Kosten neuer Vorgehensweisen einschätzen
012	Data Processing	Computer reparieren
013	Mechanical	Eine Baustelle leiten
014	Nature/Outdoors	Einen wissenschaftlichen Artikel schreiben
015	Artistic	Eine Statue bildhauen
016	Helping	Kindern mit Lernschwierigkeiten helfen

*continued on next page*

Table A1: German Translation of PGI Activity Items

No.	Scale	Item Translation
017	Social Facilitating	Personen für eine Umfrage interviewen
018	Managing	Ein Büro leiten
019	Business Detail	Finanzberichte eines Büros führen
020	Data Processing	Ein Elektrizitätswerk leiten
021	Mechanical	Elektronische Systeme entwickeln
022	Nature/Outdoors	Naturwissenschaftliche Fächer unterrichten
023	Artistic	Ein Porträt malen
024	Helping	Menschliches Verhalten untersuchen
025	Social Facilitating	Kleidung verkaufen
026	Managing	An- und Verkäufe überwachen
027	Business Detail	Versicherungsberichte erstellen
028	Data Processing	Computerprogramme für Unternehmen entwickeln
029	Mechanical	Flugzeuge reparieren
030	Nature/Outdoors	Medizinische Illustrationen zeichnen
031	Artistic	Ein Theaterstück schreiben
032	Helping	Menschen das Tanzen beibringen
033	Social Facilitating	Personen durch ein Fernsehstudio führen
034	Managing	Bürounterlagen organisieren
035	Business Detail	Waren Ein- und Ausgänge aufzeichnen
036	Data Processing	Computerprogramme entwickeln
037	Mechanical	Die Sicherheit von Baustellen überprüfen
038	Nature/Outdoors	Sternenkarten erstellen.
039	Artistic	Cartoons zeichnen
040	Helping	Anderen das Kochen beibringen
041	Social Facilitating	In einem Laden Geschenke einpacken

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Table A1: German Translation of PGI Activity Items

No.	Scale	Item Translation
042	Managing	Einen Kopierer bedienen
043	Business Detail	Ein Buchhaltungsverfahren entwickeln
044	Data Processing	Vermessungskarten überarbeiten
045	Mechanical	Optische Präzisionsgeräte zusammenbauen
046	Nature/Outdoors	Die Tier- und Pflanzenwelt untersuchen
047	Artistic	Romane schreiben
048	Helping	Kinder in einer Tagesstätte beaufsichtigen
049	Social Sciences	Personen mit Eheproblemen helfen
050	Influence	Juristische Dokumente erstellen
051	Business Systems	Aktien und Anleihen verkaufen
052	Quality Control	Gebäude bewachen
053	Manual Work	Einen Lastkraftwagen fahren
054	Personal Service	Bei anderen eine Maniküre durchführen
055	Financial Analysis	Finanzberichte von Betrieben prüfen
056	Science	Chemische Experimente durchführen
057	Construction/Repair	Autos reparieren
058	Basic Service	Essen in einer Cafeteria servieren
059	Social Sciences	Menschen mit sprachproblemen helfen
060	Influence	Vorlesungen vor großen Gruppen halten
061	Business Systems	Eine Bank leiten
062	Quality Control	Den Fortschritt eines Werkauftrags prüfen
063	Manual Work	Einen Bus fahren
064	Personal Service	Anderen die Haare schneiden
065	Financial Analysis	Finanzen prüfen
066	Science	Medizinische Beschwerden behandeln

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Table A1: German Translation of PGI Activity Items

No.	Scale	Item Translation
067	Construction/Repair	Metallwerkstücke abschleifen
068	Basic Service	Einen Staubsauger bedienen
069	Social Sciences	Geistig behinderten Menschen helfen
070	Influence	Die Auswirkungen von Wahlen untersuchen
071	Business Systems	Ein Kaufhaus leiten
072	Quality Control	Inventar und Bestandslisten führen
073	Manual Work	Container beladen und befördern
074	Personal Service	Große Essensbestellungen zubereiten
075	Financial Analysis	Die Ursachen von Börsenschwankungen untersuchen
076	Science	Fragestellungen aus dem Themenbereich Genetik bearbeiten
077	Construction/Repair	Stoßdämpfer in Autos einbauen
078	Basic Service	Kleider waschen
079	Social Sciences	Gründe für delinquentes Verhalten bei Jugendlichen untersuchen
080	Influence	Soziale Programme aufbauen
081	Business Systems	Andere bezüglich finanzieller Investitionen beraten
082	Quality Control	Eine Gruppe von Arbeitern über Funk anweisen
083	Manual Work	Ein Taxi fahren
084	Personal Service	Hunde trainieren
085	Financial Analysis	Mit anderen über Geschäftsführungsmodelle diskutieren
086	Science	Wissenschaftliche Experimente durchführen
087	Construction/Repair	Einen Bagger bedienen
088	Basic Service	Anderen Haustieren verkaufen
089	Social Sciences	Menschen bei persönlichen Problemen helfen
090	Influence	Menschen helfen Arbeit zu finden
091	Business Systems	Finanzielle Beratungen durchführen

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Table A1: German Translation of PGI Activity Items

No.	Scale	Item Translation
092	Quality Control	Mülldeponien inspizieren
093	Manual Work	Eine Maschine zur Holzbearbeitung bedienen
094	Personal Service	Sich um Haustieren kümmern
095	Financial Analysis	Die Budgetplanung eines Betriebs erstellen
096	Science	Die Verschiebung der Kontinentalplatten untersuchen
097	Construction/Repair	Einen Kran bedienen
098	Basic Service	Hot Dogs bei einer Sportveranstaltung verkaufen
099	Social Sciences	Menschen mit Hörproblemen helfen
100	Influence	Personen vor Gericht verteidigen
101	Business Systems	Kredite verwalten
102	Quality Control	Autos inspizieren
103	Manual Work	Holzmöbel mit Schleifpapier glätten
104	Personal Service	Kleidungsstücke entwerfen
105	Financial Analysis	Finanzberichte analysieren
106	Science	Pflanzen untersuchen
107	Construction/Repair	Bäume fällen
108	Basic Service	Angelzubehör vermieten
<i>Additional Items (optional)</i>		
109	People	Mit Menschen arbeiten
110	Things	Mit Geräten arbeiten
111	Ideas	Mit Ideen arbeiten
112	Data	Mit Daten arbeiten
113	Prestige	In hoch angesehenen Tätigkeiten arbeiten

Table A2: German Translation of PGI Occupation Items

Number	Scale	Item Translation
001	Social Facilitating	Leiter/in einer sozialen Einrichtung
002	Managing	Kassierer/in (Banken)
003	Business Detail	Finanzanalytiker/in
004	Data Processing	Leiter/in eines Kraftwerks
005	Mechanical	Flugzeugmechaniker/in
006	Nature/Outdoors	Ökologe/in
007	Artistic	Bildhauer/in
008	Helping	Schulpsychologe/in
009	Social Facilitating	Personalleiter/in
010	Managing	Büroleiter/in
011	Business Detail	Bankrevisor/in
012	Data Processing	Elektrotechniker/in
013	Mechanical	Kraftfahrzeugmechatroniker/in
014	Nature/Outdoors	Forstwirt/in
015	Artistic	Musiker/in
016	Helping	Sprachtherapeut/in
017	Social Facilitating	Werbeleiter/in
018	Managing	Kaufhausmanager/in
019	Business Detail	Bankangestellte/r
020	Data Processing	Mikrotechniker/in
021	Mechanical	Luftfahrttechniker/in
022	Nature/Outdoors	Meeresforscher/in
023	Artistic	Komponist/in
024	Helping	Sozialarbeiter/in

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Table A2: German Translation of PGI Occupation Items

Number	Scale	Item Translation
025	Social Facilitating	Fachwirt/in (Bekleidung)
026	Managing	Kaufmann/-frau Einzelhandel
027	Business Detail	Kostenrechner/in
028	Data Processing	Elektroniker/in
029	Mechanical	Ingenieur/in (Chemietechnik)
030	Nature/Outdoors	Naturforscher/in
031	Artistic	Dichter/in
032	Helping	Erzieher/in
033	Social Facilitating	Tourismuskaufmann/-frau
034	Managing	Vertriebsleiter/in
035	Business Detail	Wirtschaftsprüfer/in
036	Data Processing	Elektroingenieur/in
037	Mechanical	Chemisch-technische/r Assistent/in
038	Nature/Outdoors	Fisch- und Wildhüter/in
039	Artistic	Dramatiker/in
040	Helping	Ehe- und Familientherapeut/in
041	Social Facilitating	Aerobiclehrer/in
042	Managing	Hotelmanager/in
043	Business Detail	Buchhalter/in
044	Data Processing	Elektromonteur/in
045	Mechanical	Maschineneinrichter/in
046	Nature/Outdoors	Tierarzt/ärztin
047	Artistic	Autor/in
048	Helping	Pädagogische/r Psychologe/in
049	Social Sciences	Klinische/r Psychologe/in

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Table A2: German Translation of PGI Occupation Items

Number	Scale	Item Translation
050	Influence	Wissenschaftliche/r Forschungsleiter/in
051	Business Systems	Computerspezialist/in in Unternehmen
052	Quality Control	Maurer/in
053	Manual Work	Hauswirtschaftler/in
054	Personal Service	Flugbegleiter/in
055	Financial Analysis	Finanzberater/in
056	Science	Sozialwissenschaftler/in
057	Construction/Repair	Baggerführer/in
058	Basic Service	Empfangsmitarbeiter/in (Hotel)
059	Social Sciences	Psychotherapeut/in
060	Influence	Wissenschaftliche/r Mitarbeiter/in
061	Business Systems	Entwickler/in für Unternehmenssoftware
062	Quality Control	Schlosser/in
063	Manual Work	Zählerableser/in
064	Personal Service	Fremdenführer/in
065	Financial Analysis	Wirtschaftsanalytiker/in
066	Science	Biologe/in
067	Construction/Repair	Kranführer/in
068	Basic Service	Hotelfachmann/-frau
069	Social Sciences	Kinderarzt/-ärztin
070	Influence	Chirurg/in
071	Business Systems	Wirtschaftsinformatiker/in
072	Quality Control	Brückenwärter/in
073	Manual Work	Glasreiniger/in
074	Personal Service	Restaurantfachfrau/mann

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Table A2: German Translation of PGI Occupation Items

Number	Scale	Item Translation
075	Financial Analysis	Marktforscher/in
076	Science	Anthropologe/in
077	Construction/Repair	Baumpfleger/in
078	Basic Service	Friseur/in
079	Social Sciences	Hausarzt/-ärztin
080	Influence	Genetiker/in
081	Business Systems	Systemanalytiker/in
082	Quality Control	Rohrleitungsbauer/in
083	Manual Work	Schausteller/in
084	Personal Service	Barkeeper/in
085	Financial Analysis	Anlageberater/in
086	Science	Geowissenschaftler/in
087	Construction/Repair	Bauarbeiter/in
088	Basic Service	Post Angestellte/r
089	Social Sciences	Soziologe/in
090	Influence	Phsyiker/in
091	Business Systems	Computer Operator/in
092	Quality Control	Gebäudainspektor/in
093	Manual Work	Garderobier/e
094	Personal Service	Reiseführer/in
095	Financial Analysis	Leiter/in für Kundenangelegenheiten
096	Science	Geologe/in
097	Construction/Repair	Dachdecker/in
098	Basic Service	Begleitperson
099	Social Sciences	Fachkrankenpfleger/in (Psychatrie)

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Table A2: German Translation of PGI Occupation Items

Number	Scale	Item Translation
100	Influence	Astronom/in
101	Business Systems	Datenverarbeitungsarchitekt/in
102	Quality Control	Lehrer/in für Werkunterricht
103	Manual Work	Busfahrer/in
104	Personal Service	Pflegedienstleister/in
105	Financial Analysis	Börsenmakler/in
106	Science	Chemiker/in
107	Construction/Repair	Bauunternehmer/in
108	Basic Service	Sekretär/in

Table A3: German Translation of the PGI-Short

Number	Scale	Item Translation
001	Social Facilitating	Gäste in einem Restaurant bedienen
002	Managing	Ein Hotel managen
003	Business Detail	Finanzberichte erstellen
004	Data Processing	Eine Gruppe von Datenanalytikern/innen anleiten
005	Mechanical	Elektrische Leitungen installieren
006	Nature/Outdoors	Tiere und Pflanzen kategorisieren
007	Artistic	Eine Statue bildhauen
008	Helping	Kindern mit Lernschwierigkeiten helfen
009	High Prestige	Vorlesungen vor großen Gruppen halten
010	Low Prestige	Einen Bus fahren
011	Social Facilitating	Personen für eine Umfrage interviewen
012	Managing	Ein Büro leiten
013	Business Detail	Finanzberichte eines Büros führen
014	Data Processing	Ein Elektrizitätswerk leiten
015	Mechanical	Eine Baustelle leiten
016	Nature/Outdoors	Einen wissenschaftlichen Artikel schreiben
017	Artistic	Ein Porträt malen
018	Helping	Menschen das Tanzen beibringen
019	High Prestige	Die Auswirkungen von Wahlen untersuchen
020	Low Prestige	Container beladen und befördern
021	Social Facilitating	Kleidung verkaufen
022	Managing	An- und Verkäufe überwachen
023	Business Detail	Waren Ein- und Ausgänge aufzeichnen
024	Data Processing	Computerprogramme für Unternehmen entwickeln

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Table A3: German Translation of the PGI-Short

Number	Scale	Item Translation
025	Mechanical	Die Sicherheit von Baustellen überprüfen
026	Nature/Outdoors	Naturwissenschaftliche Fächer unterrichten
027	Artistic	Ein Theaterstück schreiben
028	Helping	Anderen das Kochen beibringen
029	High Prestige	Soziale Programme aufbauen
030	Low Prestige	Ein Taxi fahren
031	Social Facilitating	Personen durch ein Fernsehstudio führen
032	Managing	Bürounterlagen organisieren
033	Business Detail	Ein Buchhaltungsverfahren entwickeln
034	Data Processing	Vermessungskarten überarbeiten
035	Mechanical	Optische Präzisionsgeräte zusammenbauen
036	Nature/Outdoors	Die Tier- und Pflanzenwelt untersuchen
037	Artistic	Cartoons zeichnen
038	Helping	Kinder in einer Tagesstätte beaufsichtigen
039	High Prestige	Personen vor Gericht verteidigen
040	Low Prestige	Holzmöbel mit Schleifpapier glätten

## Lebenslauf

### Persönliche Angaben:

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