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Semantic Features of 'Stepped' versus 'Continuous' Contours in German Intonation

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Abstract

This study analyses the meaning spaces of German pitch contours using two modes of melodic movement: *continuous* or *in steps of sustained pitch*. Both the continuous and stepped movements are represented by a set of five basic patterns, the latter being derived from the former. Thirty-six German native speakers judged the pattern sets on a 12-scale semantic differential. The semantic profiles confirm that stepped contours can be conceived of as *stylized intonation*, in a formal as well as in a functional sense. On the one hand, continuous (non-stylized) and stepped (stylized) contours are assigned different overall meanings (especially on the scales *astonished – commonplace* and *interested – not interested*). On the other hand, listeners organize the two contour sets in a similar fashion, which speaks in favour of parallel pattern inventories of continuous and stepped movement, respectively. However, the meaning space of the stylized patterns is affected by formal restrictions, for instance in the step transformation of continuous rises.

1 Introduction

Melody in speech is generally characterized by continuous movement of pitch, loudness, and perhaps further parameters over time. However, occasionally, speech contains melodic patterns that follow a different mode of contour formation from the plain spoken mode. They are based on a terracing principle, with stretches of sustained pitch on a number of levels, and interval steps between them – which can often be categorized in musical terms as a second, third, fourth etc. Thus, the pitch course is stepped, homogeneous stretches alternating with abrupt changes.

In music, this second type of melodic movement is fundamental, and the difference between 'spoken' and 'chanted' melody has been a subject of music and general acoustic theory for a very long time. A clear description of two different kinds of vocal movement in speech as opposed to song, similar to the above distinction, was given by Aristoxenus [2004, p. 132] (354–c. 300 BC):

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There are two forms of this movement, the continuous and the intervallic. In the continuous form the voice seems to perception to traverse a space [topos] in such a way as never to stand still even at the extremities themselves, at least so far as its representation in perception is concerned, moving continuously to the point of silence; whereas in the other, which we call intervallic, it seems to move in the opposite way. During its course it brings itself to rest at one pitch and then another: … .

Aristoxenus [2004, p. 133] also indirectly mentions the occasional use of 'intervallic' movement in speech: '…we avoid bringing the voice to a standstill when we are talking, except that some affliction may sometimes force us into this kind of movement'.

In speech, stepped pitch patterns are mostly very simple, at least from a musical point of view. They usually comprise only few syllables and rarely more than three pitch levels. However, in an overall context of *continuous* pitch courses, *stepped* melodic patterns stand out. As islands in the otherwise continuous course of intonation, such patterns can take on specific functions in interpersonal communication.

The terms that are used for stepped patterns in the literature on intonation provide some indication as to their form and communicative function, and also point to two different conceptual treatments of the patterns. On the one hand, stepped patterns have been regarded as *call(ing) contours* [Abe, 1962; Ladd, 2008], as *calls* [Gibbon, 1976], as *vocative patterns* or *vocative contours* [Pierrehumbert, 1980]. Further terms are *vocative chant* [Liberman, 1975], *chanted call* [Gussenhoven, 1993], *spoken chant* [Pike, 1945]. These terms stand for what may be called the traditional perspective of stepped pitches in speech. This perspective is linked to communication at a distance, where the chanted tone makes the voice carry far [Abe, 1962, p. 520]. The notion of a calling or vocative contour focusses on one particular pitch pattern. Ladd [2008, p. 116] describes the pattern as 'a chanted tune on two sustained notes stepping down from a fairly high level to a somewhat lower level'. A more comprehensive account of calling patterns, mainly of the step-down type, is given by Gibbon [1998]. According to him, the use of level pitches (in German) is not limited to calling but includes greeting, leave-taking, thanking, discourse repairs. Gibbon [1998, p. 91] gives these uses a unified conceptual frame, i.e. signalling 'the opening, sustaining, and closing of a channel of communication'. Thus, stepped patterns have procedural functions which may be summarized as introducing new stages in the communicative process and thus controlling communication (see online suppl. material: see www.karger.com/doi/10.1159/000357112).

On the other hand, in a more recent approach, the use of stepped patterns is dealt with as *stylized intonation* [Ladd, 1978, 1983]. Related terms are *stereotyped patterns* [e.g. 't Hart, 1998], *intonation clichés* [e.g. Fónagy et al., 1983; Di Cristo, 1998], or *monotones* [Bolinger, 1986]. The notion of stylization aims at a different definition of the situational frame in which stepped patterns occur. In this interpretation, these patterns are not a particular feature of 'distance communication', that is of calling, but are rather connected with communicative situations or acts that are in some way stereotyped, routine, predictable, or have a formalized frame. Greetings, leave-takings, etc., quoted in the previous section, can be seen as routine or ritual utterances as well. Therefore, the two approaches to stepped patterns may in part be complementary. However, at the same time, the stylization approach implies that stepped patterns are transformations, modifications, or perhaps simplifications of corresponding continuous patterns called 'plain' [Ladd, 1978, 1983]. Therefore, the stepped contours are no longer an appendix to the inventory of continuous ones, nor does stepping need to be restricted to one, or one main, contour type. Rather, all patterns can undergo stepping, and accordingly, in the intonation system of a given language, there may be parallel inventories of plain and stylized contours: the two movement types are systematically connected. Thus, stylization is basically a functional concept, but is related to a particular formal adjustment of the melodic course. In addition, as between the continuous contours, functional distinctions may be expected between the different stepped or stylized contours.

Stepped patterns, vocative or stylized, have been described for many languages [see contributions in Hirst, 1998, and Di Cristo, 1998]. But detailed accounts exist for only few, e.g. English [Abe, 1962; Ladd, 1978], French [Fónagy et al., 1983], and German [Gibbon, 1976]. Additionally, the discussion of the patterns is mostly limited to particular well-known cases, and is often based on evidence from informal observation – since it is not easy to provide corpus material from natural conversation that covers a sufficient range of melodic patterns and related situational variables.

The aim of the present study is to analyse form and meaning of German stepped pitch patterns by applying the stylization approach within an experimental framework. The main assumption is that natural continuous and stepped patterns can be mapped onto each other and that their relationship can be examined in a perceptual setting using meaning scales. From a set of basic contours of German intonation an inventory of possible stepped patterns is derived, using a small number of transformations and retaining the key characteristics of the original continuous contours as far as possible. The resulting stepped patterns can then be called *stylized* because they are systematically related to *non-stylized* contours. Both stylized stepped and non-stylized continuous patterns are rated on scales of a semantic differential [Osgood et al., 1957]. In this frame, the formal characteristics and meaning features of the stylized patterns and of their non-stylized counterparts are compared with regard to three questions: (1) What meanings are attributed to stepped, stylized contours of German, compared with continuous, non-stylized contours? (2) Are different stylized contours uniform with respect to their meaning features? (3) If they are *not* uniform, can stylized contours be traced back to continuous ones on the basis of their semantic profiles? In other words, is there evidence that stepped contours are derived stylizations, or are they independent patterns? Thus, variation both between and within the two movement types will be accounted for by a semantic portrayal of corresponding melodic patterns in two different formal and functional frames.

Point of departure are the descriptions of stepped patterns in the literature and their expansion through repeated personal observation. On the basis of this impressionistic corpus, a systematic framework is developed inductively which focuses on the parallel relationship of continuous and stepped pitch patterns. Section 2.1 presents a general formal frame for stepped contour generation; section 2.2 illustrates it with an array of observed examples and interprets their semantic functions. Sections 2.3 and 2.4 elaborate the theoretical concept of two melodic modes in speech. This theoretical frame is then validated through an experimental investigation using the method of the semantic differential: section 3 describes the method. and section 4 the experimental procedure. Section 5 provides the results, section 6 discusses them.

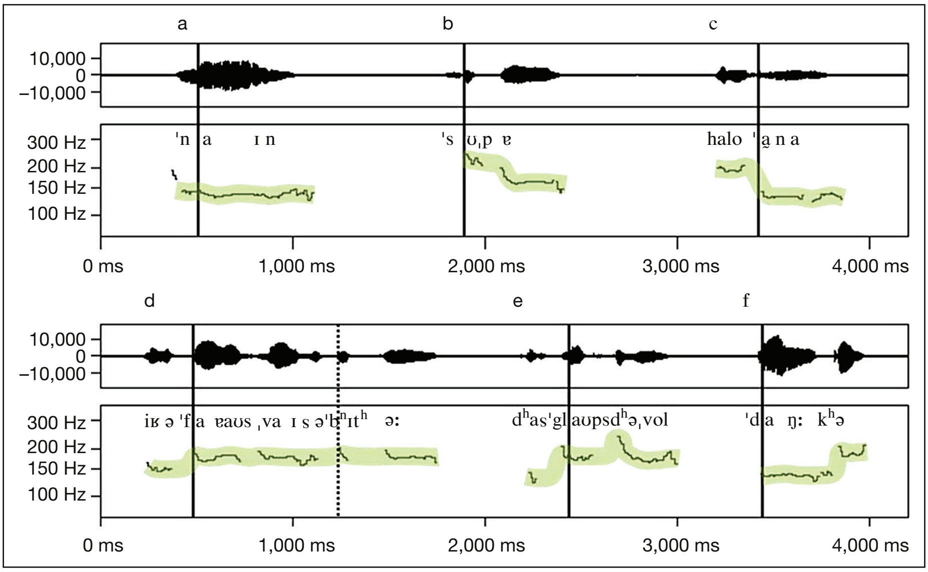

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Fig. 1. Some examples of stepped (stylized) contours in Standard German produced by a male native speaker (ed): **a** Nein (‘No’). **b** Super (‘Super’). **c** *Hallo, Anna* (‘Hallo Anna’). **d** *Ihre Fahrausweise bitte* (‘Tickets, please’). **e** *Das glaubst du wohl* (‘That’s what you believe’). **f** Danke (‘Thank you’). Speech signal and F0 contour, onsets of accented vowels are indicated by a vertical line, a smooth version of the F0 contour is overlaid in grey.

2 Stepped (Stylized) Patterns in German Intonation

2.1 Basic Conditions

In German, the stepped movement type can cover stretches from only one syllable within an utterance (i.e. one single level-pitch event) to whole utterances. As German intonation is based on accents, melodic patterns composed of stepped sustained pitches also need to be related to accents, in parallel to continuous contours. In the examples of stepped patterns in figure 1, the vowel onsets of accented syllables are marked, as reference points for detailed melodic interpretation (see sections 2.2 and 2.3).

Stepped patterns comprise at least one pitch level on a high-low scale. If there is only one pitch level, categorization depends on the speaker’s F0 range or adjoining continuous contour stretches: see the utterance *Nein*, ‘no’, in figure 1a, with low pitch, compared with the other utterances by the same speaker. However, in most cases sustained pitch combines two levels and two or more units are required to carry stepped patterns (fig. 1b–d, f). By combining two pitch levels, continuous pitch courses can be converted into pitch steps, obtaining stylized forms of rising, falling, or complex movements; both the direction of the pitch movements and the synchronization of the pattern with the related accented syllable nucleus are preserved. Stepped patterns can also have more than two levels and may then capture more detail of the continuous ones (an example is given in fig. 1e).

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If sustained pitch includes two levels, the minor third is supposed to prevail as an interval between them, i.e. 3 semitones [ST], see Gibbon [1998] and Ladd [2008]. In German this interval is sometimes referred to as the *Rufterz* ('calling third'). A high proportion of the minor third in linguistic level-pitch patterns has recently been shown to occur in an experiment by Day-O'Connell [2010] on American English. However, informal observation of natural German conversation suggests that the claimed prominent role of the minor third may be an idealization: the other intervals (4, 5, or more ST, sometimes only 2 or even just 1) will probably be in the majority. Corpus materials on this question are lacking. For a critical discussion of the role of the minor third in children's development of melodic abilities and on its use in music education see Gembris [1998, p. 38ff].

2.2 Some Examples

The formal and functional range of stepped patterns in German intonation may be illustrated with the set of examples quoted above (fig. 1, for the related sound material, see online suppl. material (www.karger.com/doi/10.1159/000357112)). The examples were produced by the author, taking into account frequently observed patterns that cover various melodic courses and include different intervals between the pitch levels. Possible semantic-pragmatic implications of the patterns are given, again by the author, based on native speaker intuitions. They illustrate that it will be useful to investigate the formal and functional organization of stepped contours through systematic multidimensional judgement by a group of native listeners.

The low-voiced flat *<u>Nein</u>* ('no') of figure 1a represents an act of denying, with a slightly threatening tone, establishing or re-establishing a rule that has to be respected. The utterance *<u>Su</u>per* ('super, great') in figure 1b expresses positive evaluation, but in a routine tone, just in passing and indicating that the speaker wishes to continue with his ongoing activities. Here, a high falling pattern is used. The interval is a fourth, but could be a third or second as well. This pattern is the prototypical vocative contour often used for calling a person, for greetings, announcements, warnings etc.

The low falling pattern in figure 1c, on *Hallo, <u>An</u>na* ('Hallo, Anna') is a form of greeting implying that the speaker does not want to bother the addressee or has expected to meet her. The fall moves from a high pre-accentual to a low accentual stretch. This pattern can, again, be realized with various intervals; here it has a fifth, a large interval suggesting something like a musical full closure and thus strengthening the functional meanings related to low falling pitch. The falling fifth is common in German, but not accounted for in treatments of stylized intonation. The downward step of figure 1c is also possible in other contexts, e.g. in stereotyped interactions, like calling a person in a waiting room (*Der <u>näch</u>ste, bitte*, 'Next, please'), or asking for tickets to be shown on trains (*Ihre <u>Fahr</u>ausweise, bitte*, 'Tickets, please') etc., with the same connotations.

However, semantic implications change if the falling pattern is replaced by a rising one in the same utterance and situational context, as in *Ihre <u>Fahr</u>ausweise, <u>bit</u>te* of figure 1d with a rising minor-third step to the syllable *Fahr-*. Here, the tone is less polite, sounds business-like and signals continuation of a routine process: passengers are to follow the instructions given to them. Interestingly, this is also the traditional vocative pattern attributed to market criers or street vendors hawking their goods (*Frische*

Brötchen, 'fresh rolls', *Heiße Würstchen*, 'hot sausages', etc.). In this case, the pattern may be interpreted as presenting new information in a routine way, again conveying a sense of continuation, i.e. coupled with an encouragement to buy.

The three-level motif in figure 1e (*Das glaubst du wohl*, 'That's what you believe') is different from the other patterns in that it has a rising as well as a falling step, starting with the accented syllable *glaubst*. This tune implies that previously given information is disputed by the speaker, but that it is done in a playful manner. A contrast is expressed between the speaker's view and the information given to him.

The rising pattern of figure 1f (*Danke*, 'Thank you') may be used when making one's way through a crowd, e.g. leaving a bus or train, entering a room etc. The pattern expresses routine, continuation, and reverence – the latter, in particular, by an extended stretch of low pitch on the lengthened syllable *Dan-*. The interval used is a rising fourth.

Figure 1 also illustrates that stepped contours need not always have sharp changes. Sequencing in the pitch trace may look smooth. The essential point is that there is sufficient stability in the more or less level sections to give the listener the impression of a sequence of separate pitches – see also the example of a non-stylized (continuous) and a stylized (stepped) contour in Hirst [1998, p. 72].

2.3 German Stepped Patterns and the Notion of Stylization

The examples of German stepped patterns in section 2.2 comprise basic melodic courses (fig. 1): rise (d, f), fall (b, c) – both in different synchronizations with their accented syllables (b and d vs. c and f), the combination of rise and fall (e), a flat course (a). As in continuous contours, these courses can be generally interpreted as representations of an upward or downward pitch excursion [*peak* or *valley*; see Kohler, 1991a, b] within the pitch register used by the speaker, and can be regarded as meaningful gestural units, related to accents [see Bolinger's, 1986, view of intonation]. Such melodic excursions may be expected to have both continuous and stepped manifestations. Accordingly, the above stepped examples may be complemented by corresponding continuous patterns, allowing us to set up two parallel pattern inventories based on the description of German intonation.

The common ground for the postulated parallel melodic pattern inventories are a *set of basic melodic meanings* as well as *basic signal or gestural systems* to express these meanings. Basic melodic meanings are (a) signalling the beginning, the continuation, or the closure of a communicative interchange, (b) highlighting and backgrounding, (c) expressing evaluation or emotional states, (d) expressing needs, intentions, and communicative roles. Signal or gestural systems and corresponding formal distinctions may be derived from the F0 code [Ohala, 1983, 1984], which is immediately directed to the opposition of rise and fall, or high and low, from the effort Code [Gussenhoven, 2002], and from other basic conditions of melodic pattern formation, e.g. in the vocal expression of emotion [Scherer et al., 2003]. Surface melody then depends on what may be called the *alternative modes of melodic contour formation* chosen by a speaker to express melodic distinctions (melodic modes). They determine the types of pitch movement: *continuous* versus *stepped*.

A common basis of the pattern inventories means that contours of continuous or stepped movement are systematically connected and can be derived from each other.

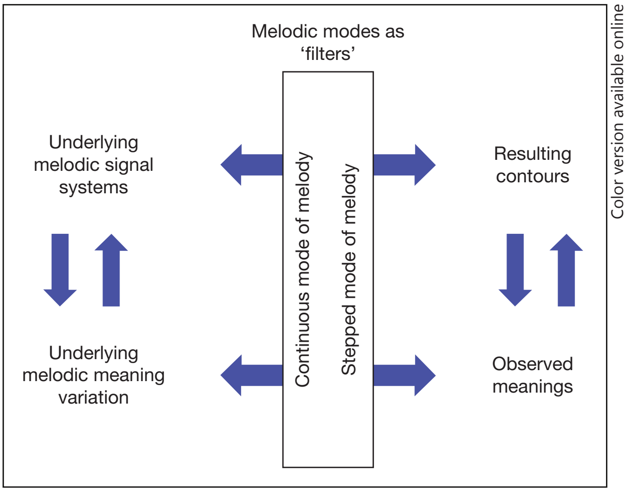

Fig. 2. Modes of melodic movement between underlying melodic conditions and surface melody.

The transformation between the movement types from continuous to stepped is called *level stylization* and has formal and functional implications. On the one hand, stepped movement has distinct general meaning characteristics of its own, different from continuous movement, which apply to all transformed contours (signalling stereotyped or predictable situations, controlling the communicative process etc.). This implies that, as the stepping procedure is the same for every element in the set of continuous patterns, the meaning differences between these are on the whole maintained. On the other hand, the two modes of melodic movement impose their own restrictions on the expression of melodic meanings as contrasts of melodic form may be weakened or disappear. These modes may therefore be seen as filters between the underlying coding of meaning and the 'observed melody' (fig. 2). Melodic restrictions particularly affect selected melodic features in specific contour types, e.g. the use of steps instead of glides in rising movement. Additional melodic or contextual information may then be required to ensure the understanding of the original meaning contrast. The present study treats continuous contours as being the result of a more or less direct mapping of underlying distinctions and the melodic surface, while the stepped mode of movement imposes restrictions on the melodic course.

The stepped patterns may thus be regarded as stylized representatives of continuous counterparts because (1) the continuous contours give clear indications of the basic formal and functional conditions underlying both modes of melodic pattern formation and (2) stepped patterns can be described through *systematic transformation* of continuous courses. With this interpretation, *stylization* is a valid concept for the relationship between the two melodic modes, if an inventory of stepped pitch contours (as exemplified in section 2.2) can be derived from a basic set of continuous contours, and if this inventory has a similar semantic structure.

Although level stylization is a formal operation working on every contour type in the same way, preserving its individual character (unless there are melodic restrictions; see section 2.4), stylized patterns can also be expected to have shared meanings, different from *all continuous patterns* used in a given language. This leads to the study of three aspects of level stylization: (a) the *specific meanings of different* patterns, (b) the *general meaning of all* patterns, compared with continuous contours, and (c) the nature of *melodic restrictions*.

The present study differs from the current approach to stylized intonation in AM phonology. In the AM view [Pierrehumbert, 1980; Ladd, 2008], sustained level pitches (stepped patterns) do not follow from restrictions that are grounded in the properties of melodic movement and function as a filter superimposed on basic melodic conditions. Rather, they arise from different or modified configurations of (abstract) tonal events represented by tonal symbols. Stylized representatives of nuclear contours are analysed as having low instead of high boundary tones [Pierrehumbert, 1980], or as having down-stepped phrase accents [Grice et al., 2005] or down-stepped trailing tones [Ladd, 2008], with the additional use of tone spreading. Tonal representations of this type 'automatically' result in a stylized surface, without the assumption of two different melodic modes and melodic restrictions related to at least one of them. The treatment of stylization in Ladd [1978, 1983], by contrast, follows a feature perspective together with a contour approach, and is thus closer to the view of the present article. A similar view is adopted by Bolinger [1986].

The stylization procedure used below is simple, directly converting the characteristics of continuous contours into a stepped representation, at the same time keeping a maximum of the melodic information conveyed by the individual contour types. A similar direct stylization procedure has already been applied to German intonation by Isaçenko and Schädlich [1970], who projected German intonation patterns onto a structure of two alternating levels. In their approach, (continuous) melodic movements are modelled as tonal switches *(Tonbrüche)* between the levels, the switches being related to stressed syllables (conceived of as *ictus*). Isaçenko and Schädlich [1970] demonstrated by listening tests that their direct two-level representation of German melody can express fundamental functional contrasts. This kind of intonation modelling encourages the idea of parallel melodic inventories. However, Isaçenko and Schädlich's [1970] contour transformations are technical; they do not model the relationship between two modes of melodic movement in speech production and perception.

2.4 Defining Parallel Sets of Stepped (Stylized) versus Continuous (Non-Stylized) Patterns in German Intonation

The experimental study of the relationship between stepped (stylized) and continuous (non-stylized) contour inventories requires comparable pattern sets in the two modes of melodic movement. Such contour sets are defined in three steps: (1) An inventory of basic continuous patterns of German is assembled covering various melodic courses. (2) A formal frame is set in which the stepped or stylized contours will be formulated. (3) Rules are given that derive stepped contours from continuous ones, producing related stepped-continuous pairs. The contour pairs are shown in figure 3.

(1) Inventory

For a description of intonation in terms of continuous melodic movements, a contour-based approach is most suitable. A contour-based model of German intonation is the Kiel Intonation Model [KIM; Kohler, 1991a, b; Peters and Kohler, 2004]. KIM conceptualizes the course of speech melody as a global integration of locally bound

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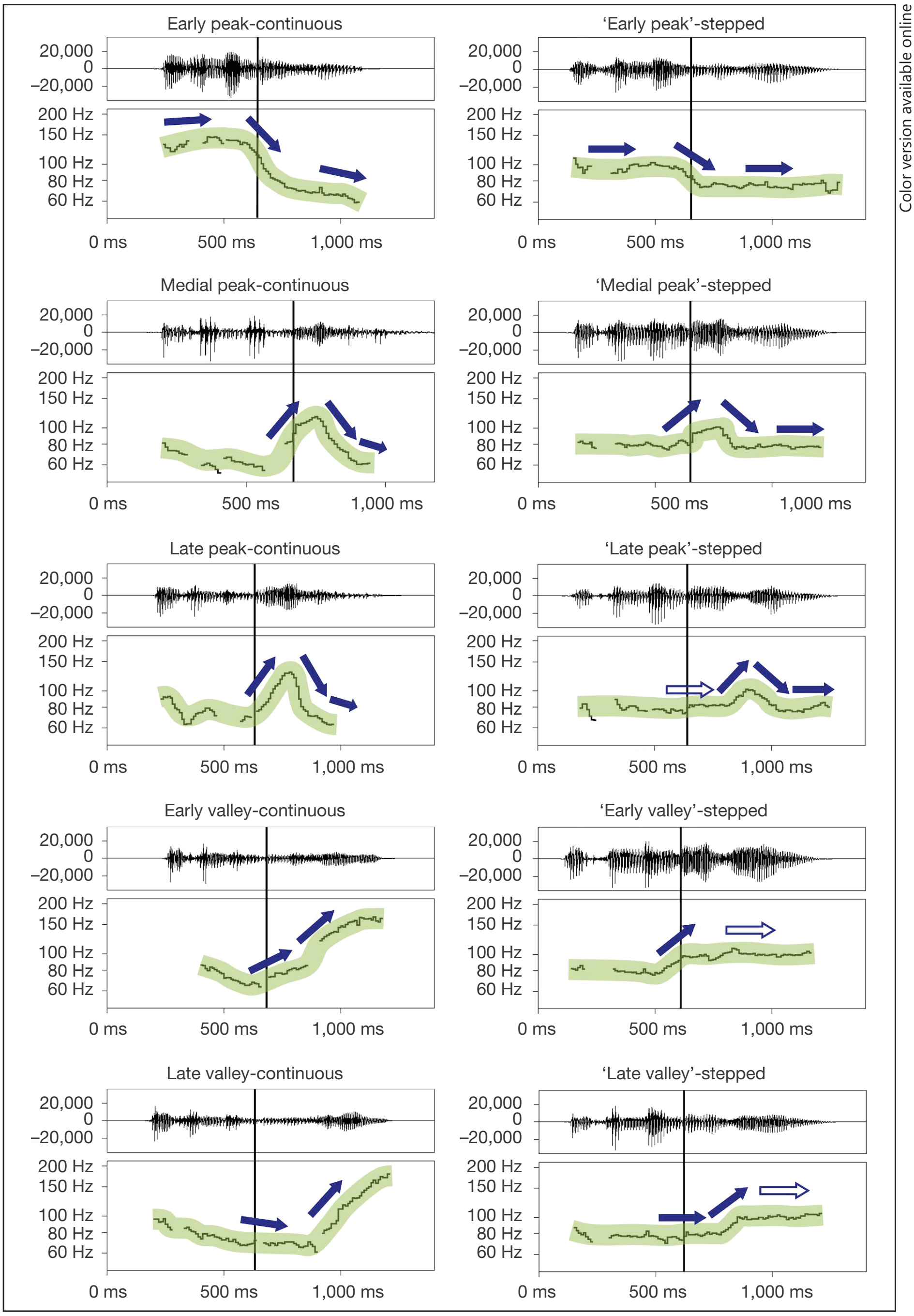

Fig. 3. The German utterance *In Anda*<u>*lu*</u>*sien* ('In Andalusia') with five peak and valley contours. *Continuous* (non-stylized) versions and *stepped* (stylized) transformations. The accented-vowel onset is indicated by a vertical line. A smooth version of the F0 contour is added in grey. Component movements are shown by arrows; white arrows show melodic restrictions.

patterns, *peak* and *valley* contours. Peaks and valleys are complex patterns in that they are characterized by a number of features which, on the one hand, determine their individual contour type and which, on the other hand, control their modification due to their concatenation with neighbouring contours or, at the end of phrases, due to the characteristics of the following phrase boundary. The two basic melodic courses, peak and valley, each show various synchronizations with the accented-vowel onset they are related to (i.e. vowels of syllables that carry sentence accent). Thus, peaks can be early, medial, or late; valleys can be early or late. Concatenation can be cohesive or non-cohesive [Peters et al., 2005]. Phrase-final movements can rise or fall in different degrees, can be level, or combined. The *level contour* of KIM [Kohler et al., 1995; Peters and Kohler, 2004] is intended for sentence accents that are realized neither by peaks nor valleys, but receive prominence because of other features such as duration. However, there is to date no systematic treatment of stepped patterns (e.g. the 'calling contour') in KIM. The five peak and valley contours of KIM are included in the present study as a basic inventory of accent-related patterns in German. The five continuous patterns in figure 3 are single-accent cases of these.

(2) Formal Frame

A set of stepped (stylized) patterns is derived from the five peak and valley contours (fig. 3). That is, rather than taking them from a spoken database, the patterns are designed on the basis of continuous (non-stylized) counterparts. Stylized and non-stylized contours are then produced by a trained speaker. By this procedure, speech material can be obtained that is under sufficient experimental control and, at the same time, comes close to speech from natural conversation. Particularly, using a trained speaker instead of digital contour manipulation, natural microprosodic variation, in particular, of the stepped contours can be preserved – which is important in a semantic judgement task that may be very sensitive to effects of technical manipulation.

All stylized patterns are given the same frame of reference. They consist of two pitch levels in a low-mid voice register using a 4-ST interval, i.e. a major third. This particular frame was to ensure a neutral representation of the continuous contours in the stepped mode. Four aspects are accounted for: (a) The stylized pitch patterns should use an interval size frequently occurring in natural speech, i.e. an interval of mid-size. (b) They should all be in the same pitch register within the range of the continuous contours. Although natural stepped patterns often have *higher* pitch than neighbouring speech this does not apply to all cases and probably not to all stepped contour types. There are no empirical data on this to date. (c) The minor third (3 ST) may sound marked in stylized patterns – because of certain semantic implications, i.e. conveying kindness, suggesting an interpretation in terms of the upper interval of a major triad. (d) Stylized intervals of mid-size can also comprise 5, 4, or 2 ST, or something in between. For instance, the fourth (5 ST) is very common in German stylized patterns, sounding more neutral than the minor third. Thus, there is no reason to assume that the minor third is structurally superior, even if it is a frequent interval. The 4-ST interval is selected here, forming the midway between fourth and minor third.

(3) Rules

Stepped patterns, which are intended to parallel continuous accent-related contours in terms of the contour categories of KIM should represent the basic pattern opposition of peaks versus valleys and the different synchronizations of the basic patterns with the accented-vowel onset as a point of reference (i.e. melodic movement with respect to this critical point). They should also account for the movement at the beginning and at the end of melodic patterns, and at the transition between patterns. In order to obtain the stepped version of a continuous pitch contour, basic formal features have to be extracted that allow the melodic information of the respective contour category to be represented by means of a small number of contour points in time. They determine the temporal onsets of level pitches or 'notes' (the steps), so the original continuous course can be traced back from its intervallic transformation and vice versa. For stylization, component parts of melodic movement are assigned to the contour types – although the contours are still conceived of as unified (i.e. holistic) patterns with all their parts interacting. The componential movements are taken from the continuous melody and are then transformed according to stylization rules. The movements are indicated by the arrows in figure 3. In the following, a set of rules is given for the level stylization in a two-level design; they lead to the contour pairs in figure 3. The rules are used as a means for experimental stimulus generation, but may, at the same time, be assumed to model speakers' and listeners' performance.

- The parts of the continuous contours (their component movements; arrows in fig. 3) are assigned to switches between level pitch events and to the level pitch events themselves, forming steps. Pitch events coincide with syllables. However, there may also be tonal switches within one syllable in continuous mode, resulting in a split-up into two syllables in stepped mode. These cases are avoided in the present experiment.
- Fast movements, i.e. the slopes of peaks or valleys, are converted to switches from the high to the low level and vice versa. This applies in particular to movements related to onsets of accented vowels [the prominence-lending pitch movements of the IPO approach; 't Hart et al., 1990]. See, e.g., the falling movement in the early peak and the rise in the medial peak in figure 3.
- Slow movements are turned into stretches of level pitch.
- If a pitch course contains two joined parts of movement in the *same direction*, the second part is converted to flat. This is a melodic restriction because the resulting single pitch step in the stylized version has to carry the melodic information of both parts of movement in the continuous version (see below and fig. 3, early and late valleys).
- Stepped contours begin and end with a flat section regardless of the initial or final pitch movement in the related continuous contour. This is an additional melodic restriction (see below) because stylized contours, by definition, cannot begin or end with a gliding movement.
- The pitch steps (or tonal switches) are subdivided into those occurring before, at, or after the onset of the accented syllable nucleus (vowel).

Parallel inventories of continuous and stepped (non-stylized and stylized) pitch contours are then defined with reference to the single-accent utterance *In Andalusien*, 'In Andalusia' (fig. 3), including the five peak and valley contours of KIM. The peak patterns (early, medial, and late) are terminal with their falling part continuing to the end of the phrase; the early peak contour is prefixed by a high prehead. The valleys (early and late) are high rising; their upward movement is therefore 'question-like' rather than only 'continuative'.

The transformation of the continuous contours includes different degrees of *melodic restriction*. Three cases of such restriction can be expected to affect the

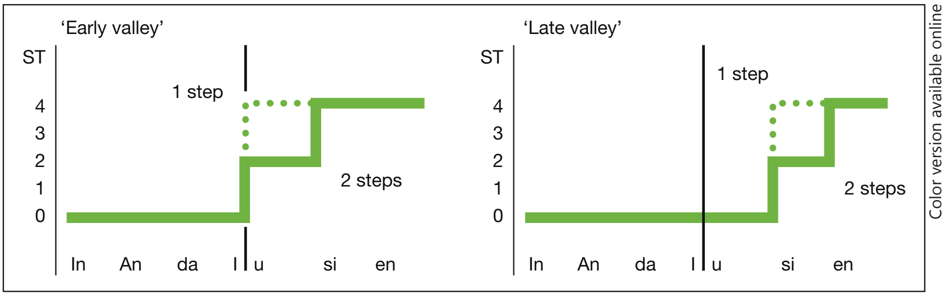

Fig. 4. Sketches of stepped versions of the early and late valleys in a two-level (one-step) and a three-level (two-step) representation. The accented-vowel onset is indicated by a vertical line.

semantic interpretation of the stepped patterns: (1) Stylized representatives of late peak patterns require a rising step after the accented syllable, starting from a level stretch. Therefore the delay feature characterizing this pattern is strengthened. (2) In the stylized early valley, the rising step to the accented syllable takes the entire 'rise' information of the continuous reference contour. The following final component movement is changed to flat by the stylization procedure. Because of this, the contour is similar to the stylized version of a medial peak without a fall. (3) Like the stylized early valley, the stylized late valley ends with a level section instead of the gliding rise at the end of its continuous counterpart. Therefore, the continuous reference contour may also be a late peak without a fall. Thus, in some cases, level stylization results in ambiguous patterns that are no longer clear representatives of the original contours. In figure 3, ambiguous cases are shown by white arrows. A full description of the component movements and melodic scripts of all five pairs of contours is given in online supplementary material (www.karger.com/doi/10.1159/000357112).

To control for the potentially ambiguous one-step stylization of the two rising contours (early and late valleys) additional two-step patterns were constructed in which the rising movement of 4 ST (a major third) was realized in two 2-ST steps over the syllables *da-lu-si* and *lu-si-en*, respectively. In these contours, which use three pitch levels, melodic restrictions can be supposed to be weakened (see section 5.6). Sketches of the patterns are given in figure 4.

3 Measuring Intonational Meaning by a Semantic Differential

Uldall [1960, 1964] adopted the semantic differential to investigate the meaning space of intonation, including a number of central melodic distinctions. She concentrated on general affective and attitudinal aspects. Edmonston [1966] and, later, Faltin [1979] applied this approach to the complex sound material in the neighbouring domain of music, in which melody has, however, no direct connexion to a verbal stratum. In Faltin's [1979] quite comprehensive study the semantic differential has been taken as a basis of a phenomenology of musical form. Recently, the semantic differential technique has been used several times in the context of KIM [Dombrowski, 2003; Ambrazaitis, 2005; Kohler, 2005; Rathcke, 2009; Dombrowski and Niebuhr, 2010]. In this work, semantic profiles have served as a device to test specific hypotheses on intonational meaning distinctions. Kohler [2005], particularly, has given an account of the meaning of basic German intonation contours with this method, analysing timing continua within the peak as well as valley patterns of KIM, as an alternative to the traditional categorical perception approach.

A particular property of the semantic differential is that an object can be looked at simultaneously from a range of different perspectives – so the object can be located in a multidimensional meaning space. It follows that, in prosody research, various formal and functional distinctions that contribute to perceptual and semantic judgements on intonation contours can be analysed in parallel by this method, and can thus be related. A multidimensional perspective of melodic meaning also matches the formal description of melodic patterns in terms of configurations of distinctive features. Such a feature approach is characteristic of KIM.

The semantic differential of the present study on stepped and continuous contours consists of 12 scales: (a) *belustigt – ernst* (‘amused – serious’); (b) *verwundert – alltäglich* (‘astonished – commonplace’); (c) *sicher – unsicher* (‘certain – uncertain’); (d) *abgeschlossen – offen* (‘closed – open’); (e) *dominant – nicht dominant* (‘dominant – not dominant’); (f) *emotional – sachlich* (‘emotional – matter-of-fact’); (g) *erregt – ruhig* (‘excited – calm’); (h) *freundlich – unfreundlich* (‘friendly – unfriendly’); (i) *interessiert – uninteressiert* (‘interested – not interested’); (j) *gereizt – gelassen* (‘irritated – composed’); (k) *wie eine Frage – wie eine Feststellung* (‘like a question – like a statement’), and (l) *neu – bekannt* (‘new – known’).

In order to ensure a complete representation of the meaning space of semantic differentials, the three basic dimensions ‘activity’, ‘evaluation’, and ‘potency’ are accounted for explicitly by introducing the scales (g/i), (h), and (e). At the same time, the most important meaning alternatives discussed in the literature on intonation are included: the distinction between question and statement (k) and between continuation and closure (d), the status of the information as ‘new’ or ‘given’ (l), the evaluation of new or given information, e.g. new information contrasting with expectation (a), (b), (c), speaker states (f), (g), (j), and speaker attitudes towards the listener (e), (h), (i) [see Kohler, 1991a, c, 2005, for KIM; Pierrehumbert and Hirschberg, 1990, for autosegmental-metrical phonology]. Although the functional aspects just quoted refer to different levels of linguistic description (such as information structure, pragmatics, expression of emotion), they all contribute to a unified prosodic meaning space. With this in mind, a domain-specific differential composed according to the above guidelines can be viewed as a multidimensional identification tool to test whether possible meaning distinctions are perceived in a set of prosodic stimuli [see, e.g., Kohler, 2005]. However, the study does not analyse potential systematic relations between the included linguistic concepts and the general dimensions of meaning in the semantic theory of Osgood et al. [1957], which would be an interesting issue for further research to improve the semantic differential technique as a tool of intonation research.

The above set of scales is to capture semantic variation *within* each of the two pattern inventories – considering basic dimensions of melodic meaning. Thus, the main concern is to investigate the parallel pattern variation in the two modes of melodic movement. However, the overall meaning characteristics expected of stylized intonation, such as the indication of routine activities or of predictability, or its use as a means to organize communication, are captured by the scales as well. For example, a routine utterance spoken with a stylized contour may sound ‘commonplace’, scale (b), less ‘interested’, scale (i), or less expressive, scales (a), (g), and (h).

4 Research Question and Listening Test

4.1 Experimental Design

In the preceding sections, two corresponding sets of melodic patterns have been proposed, stepped (stylized) and continuous (non-stylized), and a set of rating scales has been put together to measure the meanings of the patterns. The semantic spaces of the stylized and the non-stylized contours are now examined comparatively in a perception experiment, based on judgements on the rating scales. In this experiment all the 5 × 2 contours of figure 3 and the additional two-step patterns (fig. 4; see section 2.4) are included. Thus, the experiment comprises 12 instead of 10 melodic patterns. The semantic judgements allow mutual comparison of all patterns with regard to two main questions: comparison between stylized and non-stylized contours, and comparison within each mode of melodic movement. The resulting sets of comparisons *within* the two melodic modes can then be related. Accordingly, the design of the experiment contains two factors: 'melodic modes' (stylized vs. non-stylized) and 'contour types' (five patterns). Contour types will be analysed within each melodic mode, decomposing the contour factor into two nested factors, one for each mode, with separate tests for the additional patterns.

4.2 Procedure

Stimulus Utterances

The elliptic sentence *In Andalusien* ('In Andalusia') was chosen as a carrier of the contours. This sentence ensured a large proportion of voiced segments. Furthermore, it had the potential of two post-nuclear syllables allowing all stepped, stylized patterns without a tonal switch within one of the syllables. The sentence was semantically neutral in that it did not by itself suggest the use of a particular stylized or non-stylized pattern.

The stimuli (five continuous peak and valley contours, their one-step stylized counterparts, and the two additional two-step patterns) were naturally produced by a male Northern German speaker (ke, Flensburg). The speaker had received professional training as an actor and was also musically experienced. He got training sessions in producing basic KIM contours. The stepped patterns were realized according to a musical script, but in a speech-like manner. The speaker was instructed to use alternating pitch levels with a major-third distance, A2 and F2, matching his low voice. The intended pitch was given with a tuning fork. Recordings were made in a sound-treated booth (Institute of Phonetics and Digital Speech Processing at Kiel University).

In the recording session, each contour type was produced several times. For each peak and valley category, one example was then selected that could be regarded as a prototypical and neutral realization. Stepped patterns were selected with regard to the clearest realization of their melodic scripts. Three of the stepped patterns were additionally modified using *Praat* [Boersma and Weenink, 2004/2012; see Hellwig et al., 2005]. The stylized early and late valley contours were lowered by 0.5 ST (3 Hz) or raised by 1 ST (6 Hz), respectively, in order to ensure equal overall pitch register across all stepped contours. The peak syllable *lu* of the stylized medial peak was lowered by 1 ST (6 Hz) to obtain a clear impression of a major third instead of a fourth, which the speaker tended to produce despite instructions. Pitch corrections retained microprosodic variation. The resulting 5 + 5 + 2 = 12 stimulus utterances made up the test material.

The acoustic measurements of the stimulus utterances are as follows (for a more detailed description and the sound files, see online suppl. material). The average utterance duration was slightly longer in the stepped versus the continuous contours: 1,124 – 967 ms. This difference is, however, smaller than can be expected in sung as against spoken speech. The mean pitch range decreased from 15.2 ST in the continuous to 6.3 ST in the stepped mode. Averaged F0 minima were 61.2 and 72.2 Hz, averaged F0 maxima 147.4 and 104.2 Hz. This implies that the observed F0 minima and maxima of the stepped contours deviated from the perceived interval size, which was always about a major third between G2 sharp, 82.4 Hz, and E2, 103.8 Hz (i.e. the interval was realized slightly lower than intended). Figure 5 illustrates the low-mid stylization range within the ranges of the continuous contours of the test stimuli, including the perceived interval as well as the measured F0 range of the

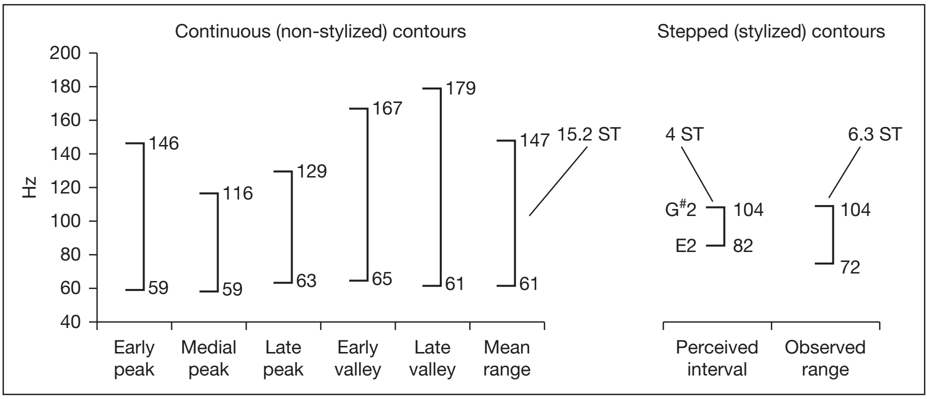

Fig. 5. Position of the averaged F0 range of the five-stepped (stylized) contours within the F0 ranges of the continuous (non-stylized) contours in the test stimuli.

stepped patterns. As is known from recordings of sung speech, the stepped patterns produced by the speaker had 'quasi-continuous' transitions. However, the listener can easily identify the two pitch levels.

Arrangement of the Judgement Task

The listening material was presented over loudspeaker; each stimulus was introduced by 370 ms of white noise, and followed by 3 s of silence for the semantic judgement. The 12 stimulus utterances were arranged in 12 blocks, each containing all stimuli in a separately randomized order. Additionally, the semantic scales were randomized. Each combination of a stimulus and a scale was presented only once and each stimulus was rated on a single dimension at a time. The experiment was prefixed by a training set of 12 stimuli. Therefore it comprised a total of 12 × 12 + 12 = 156 stimuli. The concept pairs of the semantic differential were rated on a 7-point scale (3–2–1–0–1–2–3). Every concept pair on the answer sheets (e.g. 'new – known') was introduced with the words *Die Äußerung klingt …* ('The utterance sounds …'). The stimulus utterances were presented to the listeners without specifying any particular linguistic or situational context, in order to prevent influences on their judgements from semantic features other than those conveyed by the melodic patterns themselves. The experiment took about 60 min.

Subjects

Thirty-six Standard German speakers participated in the experiment, 18 males, 18 females, aged 24 on average. Almost all were undergraduates in the Department of Psychology, Kiel University. None of them had phonetic training. Subjects were tested in five groups of 6–8 participants.

5 Results

5.1 Overview

The statistical evaluation of the semantic profiles was done in four steps. First, a two-factor repeated measures MANOVA was carried out on the complete data set. The factors were *Melodic Modes* (*stepped, stylized* vs. *continuous, non-stylized*) and *Contour Types (early peak, medial peak, late peak, early valley, late valley)*. The overall MANOVA was to test the general differences between the two melodic modes, and the interaction between the modes and the contour types. Second, separate MANOVAs were run on each level of the melodic-modes factor. They were to test the differences between the contour types within the two melodic modes. Third, three discriminant analyses (DAs) were calculated to get interpretations of the multivariate results with respect to the 12 semantic scales. DA1 accounted for the semantic profiles of all stepped compared with all continuous contours. DA2 and DA3 dealt with the profile differences between the five contour types, separately for the stepped and the continuous mode. Fourth, separate two-way ANOVAs were carried out to compare the melodic modes, the contour types, and the interaction between both on each semantic scale. The two-step cases of the stylized valleys (additional contours) were compared with the respective one-step patterns using t tests. Scale mean differences and discriminant functions were tested with $\alpha = 0.01$. Degrees of freedom of F tests were Greenhouse-Geisser-corrected. To be interpretable mean differences should be no smaller than 1 scale point, but since the compared means have standard errors, 0.7 has been chosen as the criterion. Anything smaller than this is disregarded even if it is significant in a statistical sense.

5.2 Overall Tests of All Scales (MANOVA)

The overall MANOVA shows significant main effects for *Melodic Modes* (Wilks' Lambda [Λ] = 0.047, $F_{12;24} = 40.209$, $p < 0.001$, eta-squared [η^2] = 0.953) and *Contour Types* ($\Lambda = 0.051$, $F_{48;468.90} = 12.113$, $p < 0.001$, $\eta^2 = 0.525$), but also a strong interaction between both ($\Lambda = 0.094$, $F_{48;498.96} = 8.799$, $p < 0.001$, $\eta^2 = 0.446$). This confirms that contour-type differences should be analyzed separately for each melodic mode. The MANOVAs carried out on the two levels of the *Melodic-Modes* factor are both significant (stepped contours: $\Lambda = 0.042$, $F_{48;498.96} = 13.214$, $p < 0.001$, $\eta^2 = 0.546$; continuous contours: $\Lambda = 0.200$, $F_{48;498.96} = 5.390$, $p < 0.001$, $\eta^2 = 0.331$). However, effect size is higher in the continuous condition.

5.3 Semantic Profiles of Continuous versus Stepped Contours (DA1)

Most of the semantic scales differ significantly between the two melodic modes. The difference is largest on the scales 'interested – not interested' (3.66 scale points), followed by 'astonished – commonplace' (2.64 scale points) and 'new – known' (2.24 scale points). These findings are reflected in the results of the related DA (DA1; eigenvalue = 3.670, CR = 0.886, $\Lambda = 0.214$, $\chi^2_{12} = 542.491$, $p < 0.001$, see fig. 6): the discriminant function is mainly determined by the scale 'interested – not interested' which has a fairly high loading on this function, further important variables are 'astonished – commonplace' and 'friendly – unfriendly'. Similarly, 'interested – not interested' and 'astonished – commonplace' have high discriminant weights. The relatively high weight of 'certain – uncertain' may be discarded because this scale shows no significant difference between continuous and stepped contours.

Based on the discriminant function of DA1, 95.8% (cross-validated: 95.3%) of the semantic profiles delivered by the listeners for the individual stimulus utterances can be classified in the correct contour categories.

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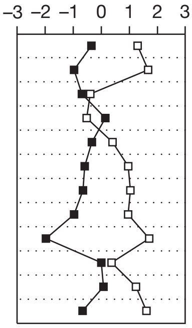

		Weights	Loadings	Wilks Λ	p
Amused	Serious	0.09	0.33	0.718	0.000
Astonished	Commonplace	**0.33**	**0.48**	**0.547**	0.000
Certain	Uncertain	0.34	0.05	0.992	0.085
Closed	Open	0.14	–0.09	0.974	0.002
Dominant	Not dominant	0.08	0.11	0.960	0.000
Emotional	Matter-of-fact	–0.19	0.26	0.804	0.000
Excited	Calm	0.20	0.32	0.729	0.000
Friendly	Unfriendly	**0.25**	**0.41**	**0.619**	0.000
Interested	Not interested	**0.74**	**0.86**	**0.269**	0.000
Irritated	Composed	0.04	0.06	0.989	0.045
Question	Statement	0.10	0.15	0.921	0.000
New	Known	0.09	0.34	0.705	0.000

Fig. 6. DA1. Averaged meaning profiles of *continuous* (■) and *stepped* (□) contours, discriminant weights of the semantic scales, loadings on the discriminant function (or factor), probabilities and effect sizes for each scale. Highest weights, highest loadings, and lowest Λ values of significant scales are in boldface.

5.4 Semantic Characteristics of Continuous Peak and Valley Contours (DA2)

Non-stylized peak and valley contours produce different meaning profiles. Perceived meaning differences can be analysed by means of three significant (of four) discriminant functions pointing to important semantic distinctions between the contour types (table 1): function 1 (eigenvalue = 4.555, CR = 0.906, $\Lambda_{(1–4)} = 0.085$, $\chi^2_{48} = 419.945$, $p < 0.001$), function 2 (eigenvalue = 0.665, CR = 0.632, $\Lambda_{(2–4)} = 0.473$, $\chi^2_{33} = 127.576$, $p < 0.001$), and function 3 (eigenvalue = 0.218, CR = 0.423, $\Lambda_{(3–4)} = 0.788$, $\chi^2_{2} = 40.634$, $p = 0.004$). The proportion of explained variance is quite high (82.1%); 83.1, 12.1, and 4.0% of the explained variance are apportioned to functions 1, 2, and 3, respectively. The means of the contours on the significant discriminant functions (i.e. their coordinates in the discriminant space) are shown in figure 7a: function 1 separates between the two basic contour shapes, *peak and valley*, and at the same time between a *low falling versus high rising end* of the contours. Differences are largest between the early peak and the valleys. Function 1 is characterized by high loadings of the scales ‘question – statement’, ‘certain – uncertain’, ‘closed – open’, and ‘astonished – commonplace’. Highest discriminant weights are again found for ‘question – statement’, ‘certain – uncertain’, and ‘astonished – commonplace’. Function 2 particularly marks the *late peak* (that has a delay of the rising side of the contour). Scales with (relatively) high loadings on this function are ‘astonished – commonplace’, ‘emotional – matter-of-fact’, ‘certain – uncertain’, and ‘amused – serious’. Discriminant weights are highest for ‘astonished – commonplace’, ‘certain – uncertain’, ‘excited – composed’, and ‘irritated – composed’. Function 3 makes a distinction between the *medial peak* and the remaining contours. It has high loadings of the scales ‘friendly – unfriendly’, ‘irritated – calm’, ‘dominant – not dominant’, and ‘new – known’. Here, discriminant weights are highest for friendly – unfriendly’, ‘dominant – not dominant’, ‘question – statement’, and ‘interested – not interested’.

The findings reported here are reflected in the graphs of the individual rating-scale means (fig. 8): e.g., ‘question – statement’ shows a steep gradient from the

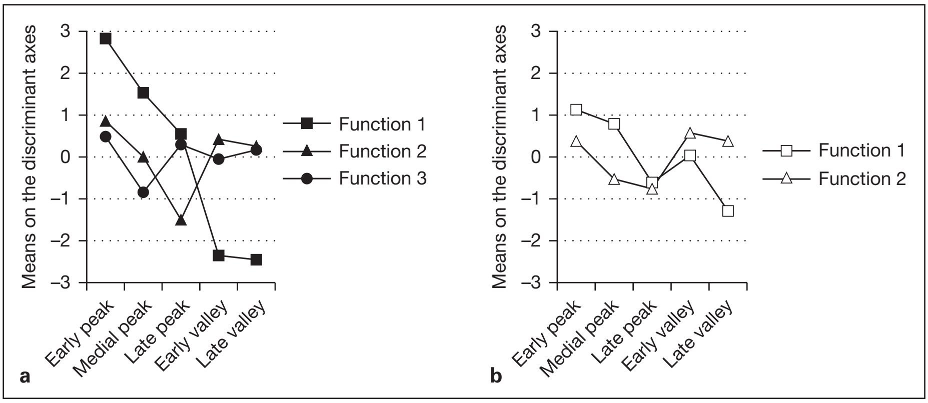

Fig. 7. Means of the contour types on the discriminant functions (factors) of DA2, continuous contours (**a**), and DA3, stepped contours (**b**): coordinates of the respective group centroids.

Table 1. DA2 (continuous mode)

Scales	Weights			Loadings			Wilks' Λ	p
	1	2	3	1	2	3		
Amused – serious	0.16	0.26	0.08	0.19	**0.33**	–0.07	0.810	0.000
Astonished – commonplace	**0.32**	**0.68**	–0.04	**0.45**	**0.61**	0.01	**0.462**	0.000
Certain – uncertain	**–0.45**	**0.37**	0.07	**–0.68**	**0.39**	0.20	**0.313**	0.000
Closed – open	–0.22	–0.21	–0.18	**–0.46**	–0.15	–0.14	**0.508**	0.000
Dominant – not dominant	–0.12	0.16	**0.40**	–0.37	0.17	**0.40**	**0.592**	0.000
Emotional – matter-of-fact	–0.02	0.27	–0.20	0.26	**0.46**	–0.09	0.684	0.000
Excited – calm	–0.13	–0.36	–0.07	0.02	–0.12	0.25	0.966	0.195
Friendly – unfriendly	–0.01	0.14	**–0.78**	0.21	0.02	**–0.72**	0.757	0.000
Interested – not interested	0.23	0.02	**0.35**	0.26	0.10	0.14	0.757	0.000
Irritated – composed	–0.01	**0.38**	0.18	–0.06	0.14	**0.48**	0.925	0.008
Like a question – statement	**0.45**	–0.22	**0.31**	**0.68**	–0.24	0.18	**0.315**	0.000
New – known	0.10	–0.28	0.19	0.23	–0.07	**0.30**	0.787	0.000

Discriminant weights, loadings of the semantic scales on three discriminant functions (factors), probabilities, effect sizes. Highest weights, highest loadings, and lowest Λ values of significant scales are in boldface.

early peak towards the two valleys (rises), similar to function 1 in figure 7b; the late peak and the valleys have low scale means in 'astonished – commonplace', i.e. they sound 'astonished' (function 2); the medial peak scores comparatively high on the 'friendly – unfriendly' scale, i.e. it does not sound as 'friendly' as the other contours (function 3).

The prediction rate of the continuous contour types based on the discriminant functions is well above chance level (64.4%, cross-validated 56.7%, compared with 20%). Confusion of contour types is most frequent in the two valleys (which may be auditorily less distinct than the other contours, see online suppl. material).

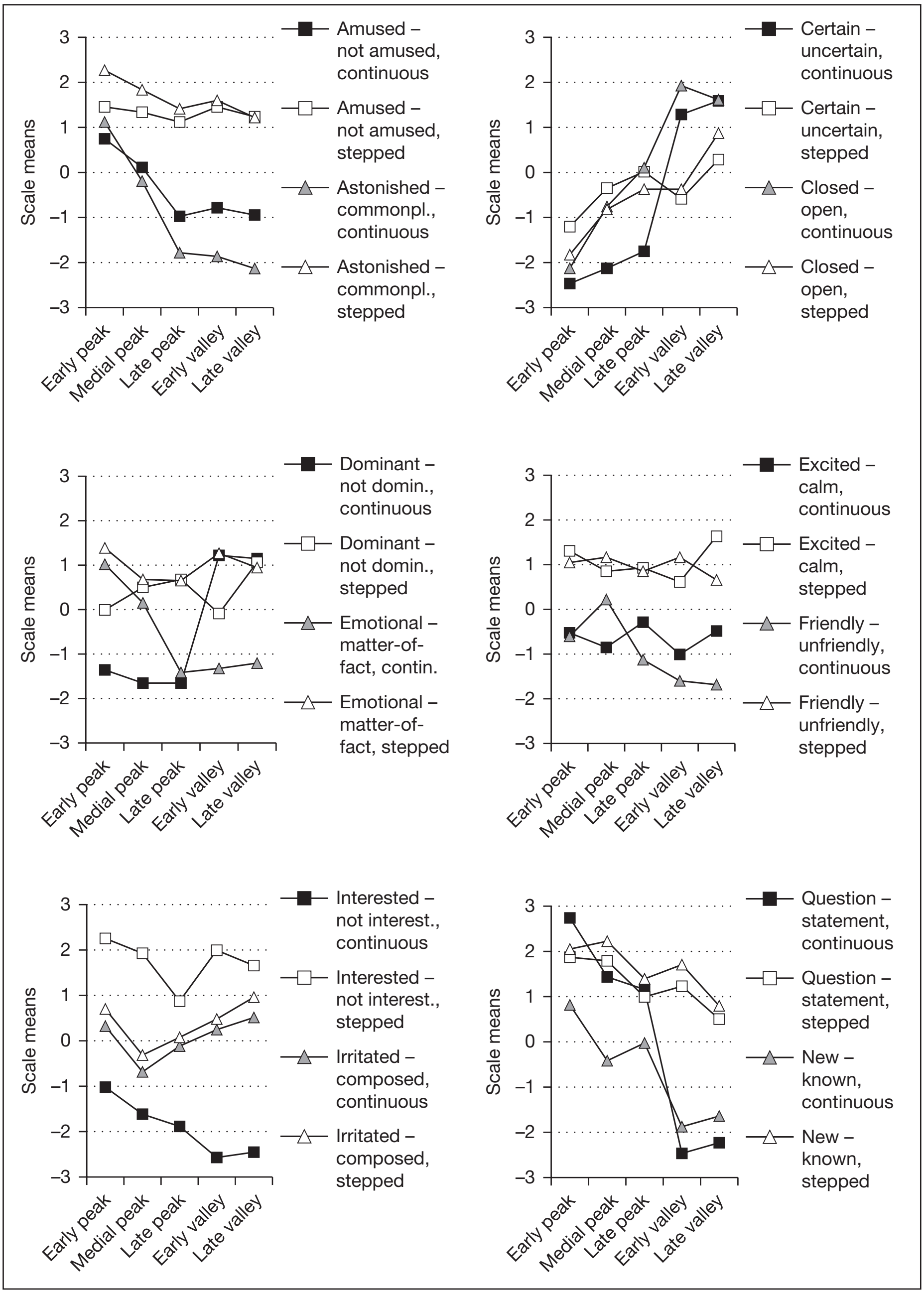

Fig. 8. Scale means of five contour types on 12 semantic scales for the continuous and stepped melodic modes. The graphs show the results for two scales each, in alphabetical order. The first of the two expressions denoting a scale (e.g. 'amused – not amused') gets negative, the other positive values (although for some of the scales the expressions may suggest the opposite).

Table 2. DA3 (stepped mode)

Scales	Weights		Loadings		Wilks' Λ	p
	1	2	1	2		
Amused – serious	–0.11	0.15	0.10	0.15	0.985	0.609
Astonished – commonplace	0.26	–0.21	0.37	0.07	0.892	0.000
Certain – uncertain	–0.25	–0.30	–0.37	–0.24	0.877	0.000
Closed – open	**–0.43**	0.17	**–0.57**	0.07	**0.765**	0.000
Dominant – not dominant	0.19	**–0.54**	–0.26	–0.21	0.910	0.002
Emotional – matter-of-fact	–0.15	0.32	0.08	0.35	0.956	0.093
Excited – calm	–0.13	–0.02	–0.12	0.15	0.927	0.010
Friendly – unfriendly	–0.04	–0.05	0.18	0.00	0.961	0.135
Interested – not interested	**0.43**	**0.67**	0.37	**0.62**	**0.794**	0.000
Irritated – composed	–0.15	**0.42**	–0.12	**0.45**	0.917	0.004
Like a question – statement	**0.46**	–0.39	**0.52**	–0.10	**0.817**	0.000
New – known	**0.42**	–0.21	**0.51**	–0.16	**0.814**	0.000

Discriminant weights, loadings of the semantic scales on two discriminant functions (factors), probabilities, effect sizes. Highest weights, highest loadings, and lowest Λ values are in boldface.

5.5 Semantic Characteristics of Stepped Peak and Valley Contours (DA3)

The stepped peak and valley contours, like their corresponding continuous models, differ in their meaning profiles. However, differences are not as large as observed with plain contours. There are two clearly significant discriminant functions (table 2): function 1 (eigenvalue = 0.812; CR = 0.669; $\Lambda_{(1–4)} = 0.349$, $\chi^2_{48} = 179.304$, $p < 0.001$) and function 2 (eigenvalue = 0.303; CR = 0.482; $\Lambda_{(2–4)} = 0.633$, $\chi^2_{33} = 77.968$, $p < 0.001$). The remaining two functions (3 and 4), with p = 0.036 and p = 0.067, do not reach the significance criterion of $\alpha = 0.01$. The proportion of variance explained by all four functions is 44.8%, which is less than the explained variance in the continuous contours, despite statistical significance; 61.6 and 23.0% of this variance are apportioned to functions 1 and 2. The remaining non-significant discriminant functions contribute further 7.9 and 7.5%, respectively. But they do not seem to represent independent meaning clusters that can be allocated to specific contour types in a clear way. Similar to the first function in DA2, the means of the contours on Function 1 (fig. 7b) show a falling gradient from the *early peak* to the *late valley*, which are the contours that may be regarded as the clearest representatives of falling as opposed to rising movement. However, in this case, the early valley may be grouped with the early and medial peaks, whereas the late peak may be grouped with the late valley. Function 1 is marked by high loadings of the scales 'closed – open', 'question – statement', and 'new – known' and has highest discriminant weights for 'question – statement', 'closed – open', 'interested – not interested', and 'new – known'. Function 2 separates the *medial* and *late peaks*, i.e. contours with bidirectional movement, from the remaining contours (fig. 7b). This function has relatively high loadings of the scales 'interested – not interested' and 'irritated – composed'. Highest discriminant coefficients are found for 'interested – not interested', 'dominant – not dominant', and 'irritated – composed'.

The differences observed between the coordinates of the stepped contours within the discriminant space (i.e. between the group centroids; fig. 7b) can again be traced

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back to differences on the level of individual scales (fig. 8): so, the scales ‘question – statement’ and ‘closed – open’ show a clear falling or rising profile from the early peak to the late valley with a special position of the stepped counterpart of the early valley (see function 1), whereas the scale ‘interested – not interested’ produces a low means for the stepped version of the late peak (see function 2). Three scales do not show significant overall differences between the contours: ‘amused – serious’, ‘emotional – matter-of-fact’, ‘friendly – unfriendly’.

The prediction rates calculated for the stepped patterns (55.6%, cross-validated 44.2%) are clearly above chance level (20%) but lower than those of DA2. False assignments of observed semantic profiles to contour types based on the discriminant functions show a particular pattern: profiles of the stylized early and medial peaks are rarely assigned to the late peak or valley; profiles of the stylized early valley have the highest proportion of confusions with the medial peak, and those of the late valley with the late peak (see online suppl. material). These findings are in agreement with the configuration of group means on the discriminant factors (fig. 7b).

5.6 Comparison of the Two Sets of Contours: Interaction between Contour Type and Melodic Mode

In sections 5.4 and 5.5, the meaning configuration of the five contour types under study is described separately for each of the two modes of melodic movement. The correspondences and differences between the two semantic descriptions can be made to show up in detail by testing the contour means on the individual scales of the semantic differential, i.e. by univariate ANOVAs based on the bifactorial design of the study (fig. 8).

In the stepped mode there is a more or less steep gradient from the early peak to the two valleys in 9 of 12 semantic scales (exceptions are ‘excited – calm’, ‘irritated – composed’, and ‘friendly – unfriendly’). In all of these cases there is a clear change from continuous to stepped patterns. Interactions are strongest in ‘question – statement’ ($F_{3.1;140} = 51.17$, $p < 0.001$, $\eta^2 = 0.594$), ‘certain – uncertain’ ($F_{3.3;140} = 45.04$, $p < 0.001$, $\eta^2 = 0.563$), ‘dominant – not dominant’ ($F_{3.4;140} = 21.53$, $p < 0.001$, $\eta^2 = 0.381$), and ‘astonished – commonplace’ ($F_{3.6;140} = 18.74$, $p < 0.001$, $\eta^2 = 0.349$). In part, the change from continuous to stepped looks like a general regression of the means to a mid-level. However, at the same time, changes are particularly obvious in specific contour types, above all in the *early valley*, but also in the *late valley*, and sometimes in the *late peak*. Changes in the early and late valleys are most clear in ‘question – statement’, ‘certain – uncertain’, ‘closed – open’, and ‘emotional – matter-of-fact’. Moreover, stepped peaks are judged as less ‘dominant’ than their continuous counterparts, whereas, conversely, the stepped early valley moves in the direction of ‘dominance’. On the scales ‘question – statement’ and ‘certain – uncertain’, the two-step early valley strengthens the impression of a ‘question’ and of ‘uncertainty’ (mean differences of 0.667 and –0.806 scale points; $t_{35} = 2.913$, $p = 0.006$; $t_{35} = -3.090$, $p = 0.004$). Thus, the two-step condition is closer to the continuous valley patterns (see also online suppl. material), and melodic restriction is weaker than in the one-step condition. However, the stepped late valley does not show an effect of this kind. Here, the restriction was less pronounced in the one-step contour.

On six scales, the overall continuous profile is still recognizable in the semantic interpretations of the stepped patterns, despite the changes described above (fig. 8). In this overall trend from the early peak to the late valley semantic effects of medial and late peaks can be singled out in both melodic modes. They emerge in the positions of the group centroids of the second and third discriminant functions of DA2 and DA3 (fig. 7a, b).

6 Discussion

The data analysis shows that continuous and stepped contours are connected with different meanings in German. Stepped level pitch makes an utterance sound ‘not interested’, ‘commonplace’, or conveys the impression of something ‘known’. Additionally, semantic distinctions among stepped patterns are generally weakened. Both findings match the functional meaning of level pitches assumed by Ladd [1978], who relates them to situations that are stereotyped, stylized, routine, predictable, and sets up the distinction between ‘plain’ and ‘stylized’ intonation for the continuous versus stepped melodic modes. The results presented here provide empirical evidence for this interpretation. At the same time, the meanings attributed to stepped patterns point to a special status in the communicative process. Some indications of how to understand the role of stepped patterns are given in Ladd [1978] and in Gibbon [1976, 1998]. Accordingly, utterances marked by stepped pitches are procedural rather than content elements in a conversation, e.g. greetings. Such procedural elements may be seen as ‘communicative switches’ (online suppl. material).

The semantic variation observed in the present experiment for the continuous mode of melodic movement confirms basic formal and functional distinctions proposed in the literature on German intonation. In particular, the results are in accord with the findings in Kohler [2005]. The meaning profiles mirror the contrast of rise and fall, and they support the meaning configuration assumed for the peak and valley contours of KIM [Kohler, 1991a]. For example, the late peak is associated with semantic features signalling a contrast between new information and the speaker’s expectation (e.g. ‘astonished’). The medial peak is associated with features that can be related to emphasis for contrast, to insisting on a point, to highlighting new information.

The meaning differences found between German stepped patterns parallel the differences described above between their continuous counterparts. There is a similar distinction between ascending and descending patterns, and an additional semantic grouping of the medial and late peaks against the remaining patterns. Thus, ‘level stylization’ of continuous contours (see section 2.3) seems to be neutral with respect to the meaning configuration of the five patterns. The two melodic modes, continuous versus stepped, can be regarded as corresponding. It seems thus justified to look at them as parallel sets of contours. The findings also suggest that concepts like ‘stylization’ or ‘stereotyping’ do not sufficiently, nor even primarily, define a particular class of communicative situations or actions that generally attract specific melodic patterns of stepped level pitch. Rather, the concepts can be applied to the shape of the patterns themselves, i.e. to the formal relation between corresponding pairs of stepped and continuous contours (defined in section 2.4). Thus, the term ‘stylization’, as it is used here, describes the relation between stepped and continuous pitch both in a formal and a functional sense.

Level stylization of continuous contours, however, also implies an overall weakening of semantic contrasts – which is not surprising in view of the drastic change of the melodic profile due to the terracing principle, and to the reduction of the pitch range in the process of stylization. The weakening of meaning contrasts may be part of the general meaning of stepped patterns (see the example *Das glaubst du wohl*, fig. 1e) – though, in stylized patterns observed in everyday communication, the decrease in melodic options is less extensive than in the present experiment.

Apart from these general findings, there are some characteristic differences between the pattern inventories of stylized and non-stylized melody in speech that can be seen as a result of the *melodic restrictions* described in section 2.4. They concern above all the stepped *early valley*, whose rising movement is realized in one rising step towards the accented syllable and consequently loses the part of the rise after the accented-vowel onset. In this stylized pattern, formal features are strengthened that are also characteristic of medial peaks – stylized or non-stylized, i.e. the highlighting by high pitch of an accented syllable, whereas features are weakened that characterize valley contours, i.e. final rising glides. Accordingly, the stylized early valley takes an intermediate and thus ambiguous position on the semantic dimension established by the first discriminant function of DA3 – between the early and medial peaks (low and high fall) on the one side and the late peak and late valley (rise-fall and rise) on the other. In a musical context, the loss of melodic information through level stylization can be compensated for to a degree by some other, specifically musical, information. Dombrowski et al. [2007] have shown that rising level-tone intervals are more likely to be assigned to a prosodic high rise pattern (early valley) than to a high fall (medial peak) if they are large as opposed to small, or dissonant as opposed to consonant.

Like the stylized early valley, the stylized late valley has lost its final gliding movement. However, the rise within and after the accented syllable is still retained, now forming a step-up to the post-accentual syllable (fig. 3). This rising step adopts the signalling function of the rising glide and, correspondingly, the stylized pattern maintains its position on the first discriminant factor (fig. 7a, b). It is due to the stylized version of the late valley that we can speak of a similar formal and semantic configuration in continuous and stepped contours. According to Gibbon [1976, 1998], this pattern is not used in German stylized intonation, but it is sometimes quoted as a stylized pattern of English [Abe, 1962; Gibbon, 1976, 1998; Ladd, 1978; Bolinger, 1986, 1998]. However, the present data suggest that the ‘stylized late valley’ is at least a possible pattern in German. This is also illustrated by examples such as that of figure 1f in section 2.2.

A delayed rising movement is also a feature of the ‘stylized *late peak*’. Because in a two-level stylization this contour type requires a low contour section on the accented syllable, the delay is even strengthened compared with the non-stylized version. This is reflected in the semantic judgements: in accordance with their formal characteristics, both late contours (peak and valley) get similar mean values on the first discriminant factor and may be grouped together (fig. 7b). Thus, the expression of ‘question’, ‘openness’, or ‘new’ through a rising movement seems to be independent of whether the rising movement is part of a valley or of a peak contour, i.e. whether it forms the end of the contour or is followed by a falling component movement.

The shift of perceived meaning from continuous to corresponding stepped contours seems to depend mainly on the two aspects discussed above: the loss of the gliding rise particularly in the early valley contour and the strengthening of the delay feature in the late peak contour. The different behaviour of the early and the late valley in the stylized mode (see their mean values on the first factor of DA3; fig. 7b) also indicates that semantic effects of stylization cannot simply be ascribed to the reduction of the F0 range in stepped contours. Rather, they follow from a more complex intervention in melodic structure.

Like the continuous contours, stepped contours have particular meaning characteristics that cannot be traced back to a contrast of rising versus falling movement. There is also a configuration of meaning features characterizing contours that comprise a combination of rise and fall within one accent group, namely the stylized medial and late peak contours used in the present study. The salient pitch obtrusion in these contours, coupled with the mainly involved semantic scales, may be linked to Bolinger's [1986, 1998] notion of an *accent of interest*. In the present data, this applies particularly to the stylized late peak.

7 Conclusions

The semantic judgement of German continuous and stepped contours by a sample of native speakers leads to the following conclusions:

(1) The relation between continuous and stepped contours in German intonation can be interpreted as stylization. In a formal respect, stylization, more exactly 'level stylization', characterizes one of two modes of melodic movement occurring in speech. At the same time, stylized intonation constitutes a separate functional class because its general meaning differs from that of non-stylized intonation.

(2) Semantic profiles of stepped compared with continuous contours emphasize meaning features that can be connected with stereotyped communicative actions and that may also apply to procedural elements in conversation.

(3) The meaning profiles of the five contour types in the two melodic modes show that listeners organize continuous and stepped patterns in a similar fashion. Therefore, in different general functional environments (ordinary or ritualized acts of communication) and in different formal conditions (continuous or stepped contours) corresponding pattern inventories can be assumed.

(4) On the other hand, there are some characteristic deviations between the stylized and non-stylized modes of melody. In arranging parallel pattern inventories we have to cope with formal restrictions, e.g. the transformation of continuous into stepped rising movements. The semantic findings reveal that a rising movement in the stepped mode, especially if it consists of a single rising step in a two-level pattern, is not the same as a rise in the continuous mode. By transformation into a stepped representation, the early valley loses its original meaning, obtaining a new one or becoming ambiguous.

(5) As the stepped mode of melodic movement is characteristic of music, the parallels between the semantic organization of continuous and stepped contours in speech also point to potential connections between speech melody and musical melody. So,

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the linguistic findings of this study may also contribute to the current discussion on music and intonation [e.g. Patel, 2008].

Two remarks may be added: this study analyses the representation of two subsets of prosodic contours in the hearer's mind; it deals with the perceptual spaces of melodic patterns in the two modes of melodic movement, stylized and non-stylized, taking a semantic perspective. In a methodological respect, the study is based on an experimental setting using audio samples that are controlled for a number of variables potentially distorting the output. It might be questioned whether empirical evidence of this kind is valid for stepped versus continuous contours *in natural conversation*. However, as representative corpus studies on stylized intonation are lacking and statements on the occurrence or the role of particular stylized patterns are generally based on casual observation, studies using the semantic-differential technique in combination with contours derived from a current description of intonation, in this case of German, can provide interesting insights into the relations between the melodic contours used in speech, and into the particular properties of stylized patterns.

Finally, it may be emphasized that the present study is based on speech material by 1 male North German speaker with individual voice characteristics and his individual realization of Northern German intonation. For a replication of the study it would be interesting whether – and to what degree – the findings may be confirmed with different speaker characteristics: e.g. high instead of low male voice, low and high female voices, or dialectal variation. Additionally, alternative strategies of stimulus generation should be tested: completely resynthesized F0 contours versus extensive recording sessions with trained speakers followed by a well-defined stimulus selection. In a replication, the first discriminant function in analyses such as DA2 and DA3 may be expected to show a similar composition of scales with high weights and loadings, and a similar configuration of the group means. In the other discriminant functions there could be some variation of the dominant scales. Thus, the semantic portrayal of the two melodic modes given here cannot be final.

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