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Intensity profiles of emotional experience over time

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A full understanding of emotions and emotion characteristics can only be reached when their dynamic nature is taken into account. As such, a primary objective of the present study is to describe and account for variability in temporal profiles of experienced emotional intensity. Participants were asked to make detailed drawings of intensity profiles of recently experienced episodes of anger, sadness, joy and affection. Functional data analysis revealed three features that together accounted for 84% of the total variability: (i) steepness at onset; (ii) skewness; and (iii) the number of peaks. Emotions differed with regard to the first two features, with the rise at onset being steeper for sadness and joy and affection being the most negatively skewed emotion under study. Individual differences regarding each of the three features were found, however, they did not strongly generalise across emotions.

Keywords: Intensity profile; Emotional experience; Time dynamics; Functional data analysis.

INTRODUCTION

Intensity is a salient characteristic of emotions. When people talk about emotional events, they not only describe the nature of their emotions but often report the level of intensity as well (e.g., “I was *very* angry”, “I was *a bit* disappointed”). Moreover, emotional intensity is not only a crucial parameter to understand the emotional life of normal individuals but it is also of high importance in clinical settings as emotional disturbances are often characterised by inappropriately intense or weak emotions (Frijda, Ortony, Sonnemans, & Clore, 1992).

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Therefore, it is rather surprising that for a long time the intensity of emotions has hardly been a topic of studies in emotion research (Reisenzein, 1994). It is only from the 1980s onwards that emotional intensity has received explicit attention (Frijda, 2007). Up till now, research on the intensity of emotions has mainly focused on the concept and determinants of emotional intensity.

Concerning the concept of emotional intensity, it has been argued that intensity is complex (Ben-Ze'ev, 1996; Frijda et al., 1992). This view has been empirically confirmed by Sonnemans and Frijda (1994) who found that subjective emotional intensity is multidimensional in nature. In particular, five constituent intensity dimensions have been revealed by these authors: (1) duration of the emotion and delay of its onset and peak; (2) perceived bodily changes and strength of felt passivity; (3) recollection and re-experience of the emotion; (4) strength and drasticness of action tendency, and drasticness of actual behaviour; and (5) belief changes and influence upon long-term behaviour. As a result, emotional episodes may be called intense for different reasons.

With regard to the determinants of emotional intensity, various researchers have suggested a range of factors that account for variability in intensity. Sonnemans and Frijda (1995) have drawn a distinction between four major groups of determinants: (1) concerns (i.e., motives, goals, and preferences or aversions for particular classes of stimuli); (2) appraisals; (3) regulation strategies; and (4) individual differences. Ben-Ze'ev (1996) from his side made a distinction between determinants constituting an event's impact (i.e., event strength, its degree of reality and its relevance) and determinants referring to background circumstances (i.e., accountability, readiness and deservingness). Finally, from a motivational perspective, Brehm (1999) showed that the intensity of an emotion is a non-monotonic function of deterrence to the aim associated with the emotion.

Whereas previous studies on variability in emotional intensity have primarily examined the nature of the concept and its determinants, other aspects of emotional intensity have received little research. One such aspect is the dynamic nature of intensity. Emotions unfold over time and, depending on external as well as internal events, the level of intensity may continuously change, which may result in an intensity profile across time. Recently a growing number of researchers have argued that a full understanding of emotions and emotion characteristics can only be reached when their dynamic nature is taken into account (e.g., Davidson, 1998; Eaton & Funder, 2001; Hemenover, 2003; Larsen, Augustine, & Prizmic, 2009 this issue; Scherer, 2009 this issue; Schimmack, Oishi, Diener, & Suh, 2000). Consequently, given that intensity is one of the most salient emotion characteristics that changes across time, one may argue that the present lack of studies on intensity dynamics is problematic.

The lack of research focus on the dynamic properties of emotional intensity can be partially understood as symptomatic of the longstanding belief that emotions are activity bursts of relatively brief duration. Consistent with this belief, researchers identified intensity as peak amplitude of such a short outburst and no further questions were posed with regard to its dynamics (Frijda et al., 1992). In contrast, Frijda, Mesquita, Sonnemans, and Van Goozen (1991) argued that emotions are generally not brief, flash-like responses but often last for minutes, hours or even longer. This view has been empirically confirmed in a number of studies on the duration of emotional episodes including studies by Scherer, Walbott, and Summerfield (1986), Sonnemans and Frijda (1994) and Verduyn, Delvaux, Van Coillie, Tuerlinckx, and Van Mechelen (2009). During such prolonged emotional episodes, emotional intensity may continuously fluctuate. Consequently, one may wonder what accounts for such changes in emotional intensity over time.

The scarce work that has incorporated the dynamic nature of intensity includes the studies by Carrera and Ocejja (2007) and Sonnemans and Frijda (1994, 1995). Carrera and Ocejja (2007) showed that time-dependent measures of emotional intensity are necessary to distinguish between simultaneous and sequential mixed emotional states. However, these authors did not study the variability in intensity profiles *per se*. The only studies that have explicitly focused on variability in intensity profiles are the studies of Sonnemans and Frijda (1994, 1995).

Sonnemans and Frijda (1994, 1995) developed a procedure to have participants draw intensity profiles of recently experienced emotional episodes. The resulting profiles displayed considerable variability in shape. The authors captured this variability in terms of a number of features including the number of peaks and dips, the intensity of the highest peak and the area underneath the profile.

Although the studies of Sonnemans and Frijda (1994, 1995) constitute an important step forward in the study of intensity profiles, they do contain a number of limitations. First, the features used in their study were selected in an *ad hoc* manner. In particular, even though the chosen features meaningfully pertain to basic parameters of time-dependent functions, they have not been empirically inferred from the data. As a result, it is not clear whether they are the only and the best possible features to capture the variability in intensity profiles. Second, the relative importance of the profile features in terms of how much of the total profile variance they accounted for was unclear. It may well be that some features account for more variability than others. Identifying the main sources of variability is especially relevant as such sources may reflect the crucial psychological processes that drive the dynamics of emotional intensity. For example, if intensity profiles mainly differ with regard to the number of peaks, this may indicate that reactivation processes (due to external or internal events) are of

utmost importance to understand the dynamics of intensity. A third limitation of the studies of Sonnemans and Frijda (1994, 1995) is that the authors did not compare different emotions with regard to specific features of their intensity profiles. This is probably due to the fact that participants were free to decide which emotions to report, which resulted in a limited number of episodes for some emotions. For example, the number of episodes of specific positive emotions was so low that they could not be analysed separately. However, analysing all positive emotions as one group is not ideal as specific positive emotions may differ in terms of intensity profiles. A fourth and final limitation pertains to the study of individual differences in emotional intensity. Sonnemans and Frijda (1995) found individual differences in both overall time-independent measures of emotional intensity and specific features of intensity profiles (Sonnemans, 1991). However, both types of differences generalised only weakly across episodes. These findings do not link up with the finding from Diener, Larsen and colleagues (e.g., Diener, Larsen, Levine, & Emmons, 1985; Larsen & Diener, 1987; Larsen, Diener, & Emmons, 1986) that individual differences in overall emotional intensity strongly generalised across episodes, and even across episodes of different valence. This difference in results may perhaps be due to the rather limited sample of participants ($N=37$) in the studies of Sonnemans and Frijda (1994, 1995).

With the present study we aimed to extend the work of Sonnemans and Frijda (1994, 1995) on variability in intensity profiles and to address the limitations described above. Similar to their research, participants in our study were asked to draw intensity profiles of the subjective feeling component of recently experienced emotional episodes. To ensure that the resulting intensity profiles closely resembled the actual emotional experiences, participants were supported by a number of guiding questions while drawing the intensity profiles. Moreover, the emotional episodes: (1) were all elicited by a clear stimulus such that the episodes corresponded to emotions and not to moods (Beedie, Terry, & Lane, 2005); and (2) all had ended at the time of data collection.

To account for the expected variability in the intensity profiles, features were derived from the resulting profile data using functional data analysis (Ramsay & Silverman, 2005). This family of data-analytic methods allows one to empirically infer functional features, along with a measure of the importance of each feature in terms of the percentage of variance it accounts for. The resulting functional features may provide insight into the main processes that drive intensity changes across time. To address the third limitation outlined above, a large number of episodes of a few pre-specified emotions were collected. This enabled the reliable comparison of profile features (as empirically inferred by functional data analysis) across different specific emotions. Finally, we collected data from a large number of

participants to study whether individual differences in specific features of intensity profiles exist and to what degree these differences generalise across emotions. An analysis based on such a large sample of participants may allow an examination of whether the finding of Diener, Larsen and colleagues (e.g., Diener et al., 1985; Larsen & Diener, 1987; Larsen et al., 1986)—that individual differences in affect intensity generalise across emotional episodes—also holds for specific features of intensity profiles.

For our study, four emotions were selected: joy, affection, anger and sadness.¹ This specific set of emotions was chosen as it contained two positive and two negative emotions. Moreover, the set also contains one positive and one negative emotion that typically occur in an interpersonal context (i.e., affection and anger), as well as one emotion of each valence that occurs less frequently in an interpersonal context (i.e., joy and sadness). By making use of this structured set of emotions it may become possible to examine the basis of between-emotion variability in intensity profile characteristics. For example, in previous research, it has already been shown that whether or not an emotion typically occurs within an interpersonal context relates to emotion duration (Verduyn et al., 2009); one may therefore wonder whether this characteristic is also relevant for other dynamic properties such as features of intensity profiles.

METHOD

Participants

Participants were 303 psychology students of the University of Leuven, 61 men and 242 women. Their mean age was 19 years ($SD = 1.2$). Participation in the study was in partial fulfilment of a course requirement.

Materials

Participants received a booklet that was divided into four parts, each part corresponding to one of the four emotions. The questions within each part were identical except for the nature of the emotion. There were four different versions of the booklet, which differed only with regard to the order of the four emotions.²

Within each part of the booklet, participants were asked to remember a recent episode of the emotion in question and to briefly describe the situation that elicited it. Next, they were asked to draw as precisely as possible the

¹ The Dutch words used were *blijheid*, *genegenheid*, *kwaadheid* and *verdriet*, respectively.

² Order 1: Sadness, joy, anger, affection; Order 2: Joy, sadness, affection, anger; Order 3: Anger, affection, sadness, joy; Order 4: Affection, anger, joy, sadness.

intensity course of the emotion over time and to indicate with arrows and short sentences all significant internal and external events that occurred during the emotional episode. For this purpose, each part of the booklet contained a two-dimensional grid. The *Y*-axis represented the intensity of each emotion and was divided into 7 intervals with labels ranging from “no emotion” to “very intense”. The *X*-axis represented the time dimension.

Subsequently, participants were presented with a few control questions. In particular, participants were asked to indicate: (1) the number of times the intensity increased and decreased during the emotional episode; (2) the steepness of each increase and decrease; (3) the highest level of intensity during the emotional episode; (4) the level of intensity right before each internal and external event reported; and (5) whether the intensity increased, decreased or remained constant after each event reported. Finally, after having filled out these questions and after having checked whether their answers corresponded with the drawn intensity profiles, they were offered the opportunity to correct the profiles or the responses when necessary to make them match such that both the profiles as well as the answers to the questions corresponded to the actual emotional episode.

Procedure

Participants were invited to come to the psychology department in small groups of 20 to 30 people. A PowerPoint™ presentation was used to explain to them what kind of emotional episodes they had to recall (i.e., episodes elicited by a clear stimulus at some point in time and finished prior to the data collection) and how to draw intensity profiles of emotional episodes. With regard to the latter, the meaning of the *X* and *Y* axes were clarified, warnings were given against a number of mistakes (e.g., intensity cannot drop below the *X*-axis) and a concrete example (i.e., an anger episode resulting from minor physical aggression) was given. After this, participants received a booklet, a pencil and an eraser and were instructed to draw the requested intensity profiles in as much detail as possible. Participants finished within an hour after which they were thanked for their participation.

Analysis

Intensity profiles were removed from the sample if participants reported emotional episodes that did not meet our instructions or could be considered conceptually flawed. In particular, drawings were removed for one or more of the following reasons: (a) The graph did not start on the *X*-axis; (b) the graph did not end on the *X*-axis (which is a mistake as the episodes had to be finished prior to the moment of the data collection); (c) the graph crossed the

Figure 1. Examples of intensity profiles of three selected emotional episodes.

X-axis (this is a mistake as negative intensities do not make sense); and (d) the graph was not a function (i.e., each X -value must correspond to at most one Y -value as two intensity values of the same emotion at the same point in time does not make sense). As a result a total of 167 graphs were removed. The final dataset contained 1045 graphs (Joy: 260, Affection: 259, Anger: 264, Sadness: 262). A sample of intensity profiles is presented in Figure 1.

In order to analyse the data by means of functional data analysis, all graphs were first converted into a set of points using a digitising tablet (Wacom Graphire III 6×8). Subsequently, each set of points was transformed into a function by means of linear interpolation (i.e., connecting adjacent points by means of straight lines). Next, the functions were horizontally stretched such that each drawing had the same start and end point. This also implies that we did not take the objective duration of emotional episodes into account, and that we removed a dominant source of variation as intensity profiles may correspond to emotional episodes lasting for minutes, hours or even longer (Sonnemans & Frijda, 1994, 1995). An important advantage of this approach was that it allowed us to compare variability in shapes of intensity profiles that otherwise would be suppressed by differences in absolute duration. Studying variability in shape is particularly interesting as it may, as argued above, reveal the underlying processes that drive the time dynamics of emotional intensity.

The resulting functions were then submitted to a functional data analysis. This method is well suited to analyse time-profile data (Ramsay & Silverman, 2005) and has already been applied in many scientific disciplines including climatology (e.g., Hlubinka & Prchal, 2007), spectrometry (e.g., Antoniadis & Sapatinas, 2007), economics (e.g., Cuesta-Albertos & Fraiman, 2007) and biostatistics (e.g., Chiou & Müller, 2007). For the present analysis, we relied on one specific functional data-analytic technique, namely functional principal component analysis. Similar to classical multivariate PCA, functional principal component analysis decomposes the original data³ into

³ In particular, before computing the components, we first subtracted the pointwise mean function from each function and, consequently, we discretised the functions into time series data, making use of 150 equally spaced time intervals (Ramsey & Silverman, 2005). Next, we subjected the 1045×150 data matrix to a PCA.

component loadings and component scores. The component loadings take the form of component profiles over time and represent the functional features that explain the variability in the profile data. Moreover, each functional feature is associated with an indication of its importance in terms of the percentage of variance it accounts for. The component scores of a particular intensity profile are weights that indicate to which extent the profile in question is characterised by each of the features. As such, functional principal component analysis reconstructs the original profile data by a weighted sum of component profiles.

As the intensity profiles of all different emotions were submitted to a single functional PCA, it was possible to study variability in intensity profiles between emotions. In particular, by comparing the component scores of the profiles between emotions, it was possible to examine whether emotions differed with regard to specific intensity profile features. Our analysis also allowed us to study individual differences in profile features in terms of differences across individuals in mean component scores. Finally, by studying the correlation of component scores between emotions across individuals, we could examine to what degree individual differences in profile features generalised across emotions.

A graphical representation of functional principal component analysis is presented in Figure 2. It should be noted that this example is based on the solution obtained from the data of the present study, the results of which will be discussed in the next section.

RESULTS

The appropriate number of functional components was determined by means of a scree plot (see Figure 3). As this plot displays an elbow at the fourth component, a three-component solution is retained. This solution explains 84% of the variability in the data.

The loadings of the three components are presented in Figure 4. While the first component is characterised by positive loadings across the entire profile (with especially high loadings at the beginning), the other two components comprise both positive and negative loadings. To ease interpretation of the components, in line with the suggestions of Ramsay and Silverman (2002, 2005), we produced reconstructed intensity profiles⁴ of emotional episodes scoring high (i.e., two standard deviations above the mean score), average, and low (i.e., two standard deviations below the mean score) on the component in question while taking an average score on the

⁴ The weighted sum of component profiles is added to the pointwise mean function as the latter was subtracted from each function before computing the components.

Figure 2. Illustration of the decomposition of an intensity profile into a weighted sum of three components and the mean profile. The four lower panels show the sequential updates that result from adding each new component.

Figure 3. Scree plot of the eigenvalues.

Figure 4. Component loadings.

other components (see Figure 5). From this figure, it appears that a high component score on the first component corresponds to an intensity profile that has a steep onset, whereas a low score corresponds to an intensity profile that is far less explosive. Consequently, the first component can be interpreted as steepness at onset. Episodes scoring high on the second component have profiles with a relatively low intensity in the first half and a relatively high intensity towards the end, while the reverse holds for the episodes scoring low on the component in question. Consequently, the second component can be interpreted as the skewness of the intensity profile. With regard to the third component, a high component score yields an intensity profile that contains two peaks, whereas a low score yields a profile with a single peak only. Consequently, the third component can be interpreted as the number of peaks. The importance of each component is further reflected by the percentage of the total variance it accounts for. In particular, 40% of the variability is explained by the steepness at onset, 29% by the profile skewness, and an additional 15% by the number of peaks.

In a next step we examined whether the emotions under study differed with regard to each of the features as empirically inferred by means of the functional data analysis. For this purpose, three separate repeated-measure analyses of variance (ANOVAs) were performed, with the component score on the first, second, and third component respectively as dependent variables, and the nature of the emotion as the independent variable. The main effect of emotion was significant in two out of the three analyses. In

Figure 5. Reconstructed graphs.

particular, emotions differ with regard to steepness at onset, $F(3, 770) = 8.56$, $p < .0001$, and skewness of the profile, $F(3, 770) = 6.55$, $p < .001$, but not with regard to the number of peaks, $F(3, 770) = 1.93$, *ns*).

To study the differences between emotions in more detail, pair-wise comparisons between emotions were performed for each component separately, the results of which are presented in Table 1. It appears that sadness and joy scored significantly higher than affection and anger on the first component, indicating that the rise at onset is highest for the two emotions that are not inherently interpersonal. With regard to the second component, affection scored higher than the three other emotions with the difference with the two negative emotions also significant. This indicates that affection episodes have a more outspoken negatively skewed intensity profile that reaches its highest intensity towards the end. These conclusions are confirmed by a visual comparison of the mean intensity profiles of the four emotions under study. To ease comparison, the overall mean profile has been subtracted from each of the four mean intensity profiles (see Figure 6). Inspection of this figure clearly shows that the intensity at onset is highest for the emotions of joy and sadness. Moreover, one may notice that whereas the intensity of affection is relatively low in the first half of the episode, it becomes relatively high in the second half of the episode.

Finally, we examined possible individual differences with regard to the three functional features under study. In each of the three ANOVAs mentioned above the main effect of the person factor was significant for steepness at onset, $F(271, 770) = 2.44$, $p < .0001$, skewness of the intensity profile, $F(271, 770) = 1.97$, $p < .0001$, and the number of peaks, $F(271, 770) = 1.71$, $p < .0001$. Hence, individual differences were found for each of the three functional features under study. To examine these individual differences in more detail we checked the degree to which they remained constant across emotions. For this purpose, correlations between emotions across participants were calculated for the scores on each functional feature separately. The resulting correlation matrices are presented in Table 2. All correlations are positive but rather low, indicating that individual differences only weakly generalise across emotions.

TABLE 1
Scores on functional components by emotion

<i>Functional component</i>	<i>Joy</i>	<i>Affection</i>	<i>Sadness</i>	<i>Anger</i>
Steepness at onset	0.12 _a	-0.15 _b	0.14 _a	-0.12 _b
Skewness	0.04 _{a,b}	0.10 _a	-0.15 _b	-0.09 _b
Number of peaks	0.08 _a	-0.10 _a	-0.04 _a	0.02 _a

Note: Means in the same row that do not share subscripts differ at $p < .05$ in the Tukey honestly significant difference comparison.

Figure 6. Mean intensity profile of joy, affection, anger and sadness after subtracting the overall mean profile.

TABLE 2
Correlations between emotions across participants for scores on three functional components

	<i>Joy</i>	<i>Affection</i>	<i>Anger</i>	<i>Sadness</i>
<i>Component 1: Steepness at onset</i>				
Joy	—	.29	.30	.30
Affection		—	.26	.19
Anger			—	.27
Sadness				—
<i>Component 2: Skewness</i>				
Joy	—	.28	.24	.18
Affection		—	.32	.09
Anger			—	.11
Sadness				—
<i>Component 3: Number of peaks</i>				
Joy	—	.13	.16	.18
Affection		—	.14	.21
Anger			—	.11
Sadness				—

DISCUSSION

Features of intensity dynamics

Intensity is a dynamic characteristic of emotions (e.g., Frijda, 2007; Germans Gard & Kring, 2007; Larsen et al., 2009 this issue; Russell, 2003). Yet, in previous research on emotional intensity, its dynamic nature is either

neglected or considered to follow a pre-specified pattern. As to the latter, the paradigmatic shape of an intensity profile, as usually described in the literature, is characterised by a single peak located at the beginning of the episode, a steep rise to that peak and a gradual offset back to base level (Frijda, 2007).

The present results, however, indicate that intensity profiles may take many different shapes with the paradigmatic shape described above only one out of many possibilities. This finding aligns with the studies on intensity profiles by Sonnemans and Frijda (1994, 1995) who reached the same conclusion. In the present study three functional features have been empirically inferred, which together account for a sizeable part of variability in the intensity profiles. Moreover, these features are mutually independent, which implies that they account for different parts of the variability. As such, they can be considered distinct building blocks of intensity profiles.

The first feature is the steepness of the intensity profile at onset. This is the most important building block that accounts for 40% of the variability in the data, implying that intensity profiles differ fairly widely with regard to the way they set off. As such, some emotional episodes may be explosive, reaching a high intensity right from the start; conversely, other emotional episodes may have a low intensity only at the very beginning. This feature may reflect a first underlying process that drives emotional intensity across time, namely the process of reactivity. The extent to which this process is activated probably depends on characteristics of the eliciting stimulus (e.g., stimulus expectedness) as well as characteristics of the person experiencing the emotion (e.g., some people may be more reactive than others).

The second feature, accounting for 29% of the variability in the data is the skewness of the intensity profile. Whereas the first feature mainly concerns the birth and youth of the life course of the emotional episode, the second feature primarily pertains to adulthood and old age. Apparently, some emotional experiences are early bloomers that reach their highest intensity during the first half of their life whereas others are late-bloomers that attain their highest peak towards the end only. Otherwise, it should be emphasised that this second feature is independent from initial steepness at onset. After an initial onset, which may be steep or not, intensity may continue to increase and reach its highest intensity towards the end or it may start to decrease and return to baseline immediately. This feature may reveal a second process that drives emotional intensity over time, namely the process of accumulation. An emotional event may either reach its full impact right from the start or due to accumulation processes its full impact may only be achieved later on. Accumulation may result from mental processes (e.g., rumination) as well as interpersonal interventions (e.g., an

initially weak argument may result in a real fight due to continuous reciprocal insults).

The third feature which accounts for an extra 15% of the variability in the profile data concerns the number of peaks. After having reached a peak, the intensity does not necessarily return to baseline in a straightforward way: The return may be interrupted by a second increase and subsequent peak. This feature could reflect a third process that drives intensity dynamics, namely the process of reactivation. Similar to the first two processes, reactivation may result from internal (e.g., a sudden reappraisal of the situation) as well as external causes (e.g., a physical reappearance of the eliciting stimulus).

Obviously, the whole of the three features indicates that the characteristics of the paradigmatic shape of intensity profiles described above (i.e., steep onset, gradual return to baseline, single peak) do not all have to be present. Intensity profiles may have a low intensity at the very beginning, they may reach their highest intensity towards the end only and, they may contain more than one peak. Moreover, the existence of the three induced features clearly points at the existence of substantial and meaningful differences in intensity profiles between emotions and between individuals.

Differences between emotions

In a second step we compared the four emotions with regard to each of the functional features. In previous studies, the intensity of different emotions has been compared as well (e.g., Scherer et al., 1986) but in those cases intensity was typically captured with a single overall time-independent measure. As such, our comparison of emotions with regard to the distinct intensity features may be considered a more fine-grained analysis.

A first difference between the studied emotions is the steeper onset of sadness and joy in comparison with anger and affection. Apparently, emotions that do not inherently imply an interpersonal context are more explosive in nature than their interpersonal counterparts. As such, it seems that the likely presence of another person prevents a relatively fast and strong emotional reaction. This slower reactivity perhaps results from the complexity of interpersonal situations, which may require a relatively high number of (secondary) appraisals before a full understanding of the emotional event can be reached (e.g., Did he really insult me or did he not mean it that way? Did he really want to help me or did he help me to win favour?). Of course, given that only four emotions were considered, caution about the generalisation of these conclusions is advised.

Besides steepness at onset, in our study emotions also differed with regard to profile skewness. In particular, the intensity profile of affection appears to reach its highest intensity rather towards the end of the emotional episode

(in comparison with the profiles of the other emotions). As such, affection appears to be an emotion that grows steadily over time and that fully blooms only towards the end of its life. This conclusion aligns with findings in the attachment literature where it has been shown that affection needs time to develop (e.g., Brazelton & Cramer, 1990).

Individual differences

The present study not only revealed differences in features of intensity profiles between emotions but also between persons. In particular, individual differences were found for each of the three functional features. Subsequently, one may wonder whether such differences generalise across emotions. For example, is it possible to distinguish a group of people who can be typified as explosive characters whose emotion intensity profiles have steep onsets regardless of the specific emotion? If this were the case, this would provide evidence for the existence of intensity traits as captured by affect intensity measures (Diener et al., 1985; Larsen & Diener, 1987; Larsen et al., 1986), yet now with regard to more specific intensity features. Our results, however, indicate that individual differences concerning each of the three functional features generalise only weakly across emotions. This implies that trait-like individual differences with regard to specific intensity features, if they exist, are emotion specific.

Remaining challenges

The present study extends previous work on emotion intensity in various respects. Yet various possibilities for future studies to deepen our understanding of (the variability in) intensity profiles remain open. In particular, emotions are multi-componential processes, including such components as subjective feelings, expressive motor behaviours, cognitive appraisals, physiological arousal and action readiness (e.g., Frijda, 1986; Leventhal & Scherer, 1987; Scherer, 1984). The present study focused on the subjective experience component of emotions only. However, other emotion components are inherently dynamic as well and likewise their intensity may vary across time. One may wonder whether the features that characterise intensity profiles of components other than subjective experience are similar to the three features retrieved in the present paper. Moreover, it would be interesting to study both between emotion and person differences in such features. It would further be of interest to collect multiple episodes of specific emotions from a large group of individuals and subject such data to a functional principal component analysis. This would allow for a more in-depth study of differences between and within individuals than in the current study, in which only a single episode of each emotion was collected from every participant. Finally, one may wonder how intensity profiles of different emotional components relate to one

another. Insight into the latter would constitute a significant step forward in the development of a multi-componential dynamic process model of emotions.

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