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Predicting the Duration of Emotional Experience: Two Experience Sampling Studies

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The authors present 2 studies to explain the variability in the duration of emotional experience. Participants were asked to report the duration of their fear, anger, joy, gratitude, and sadness episodes on a daily basis. Information was further collected with regard to potential predictor variables at 3 levels: trait predictors, episode predictors, and moment predictors. Discrete-time survival analyses revealed that, for all 5 emotions under study, the higher the importance of the emotion-eliciting situation and the higher the intensity of the emotion at onset, the longer the emotional experience lasts. Moreover, a reappearance, either physically or merely mentally, of the eliciting stimulus during the emotional episode extended the duration of the emotional experience as well. These findings display interesting links with predictions within N. H. Frijda's theory of emotion, with the phenomenon of reinstatement (as studied within the domain of learning psychology), and with the literature on rumination.

Keywords: emotional experience, duration, predictors, discrete-time survival analysis

Emotions unfold over time. Several authors have emphasized the importance of the temporal dynamics of emotions and suggested that these should be given more attention in future research (Eaton & Funder, 2001; Hemenover, 2003; Schimmack, Oishi, Diener, & Suh, 2000). Davidson (1998) even named the research domain *affective chronometry*.

One basic temporal characteristic of emotions is the duration of emotional experience. Everyday experience suggests variation in the duration of single emotional episodes, within emotions (e.g., one can feel angry for only a couple of seconds but also for an entire day), between emotions (e.g., surprise has usually a shorter duration than sadness), and between persons (e.g., after a personal loss, some people remain sad for a long time, whereas others recover more quickly).

Remarkably, the amount of previous research on the variability of the duration of emotional experience is scarce. Exceptions include studies by Fitness and Fletcher (1993), Gilboa and Revelle (1994), Scherer, Walbott, and Summerfield (1986), and Sonnemans (1991). In the latter studies, it was found that an emotional experience can last from several seconds to several days and that some emotions take, on average, longer than others.

Given this striking variation, one may wonder which variables account for it. At a theoretical level, a variety of potential predictors of the duration of emotional experience can be thought of. As a whole, one could classify them in three groups: A first group, called *trait predictors*, consists of predictors that are stable both within and across emotional episodes (e.g., Big Five). Second, one may consider *episode predictors*, which are constant within a certain emotional episode but may vary across different emotional episodes (e.g., the importance of the situation that elicited a particular emotional episode). Third, predictors called *moment predictors* may fluctuate within one emotional episode (e.g., the intermittent physical reappearance of the person that elicited the emotional experience in the first place).

At an empirical level, only a few studies have addressed the prediction of the duration of emotional experience. As such, with regard to trait predictors, Schimmack (2003) reported for the duration of unpleasant affect a negative correlation with extraversion and a positive correlation with neuroticism. Sbarra (2006) found (within the context of emotional recovery following nonmarital relationship dissolution) that higher levels of attachment preoccupation were associated with longer episodes of sadness, whereas higher levels of attachment security were associated with shorter episodes of anger. Within the category of episode predictors, Sonnemans and Frijda (1995) found that the more important the situation that elicited the emotional experience, the longer the emotional experience will last. Finally, with regard to moment predictors, Sbarra and Emery (2005) found that contact with a former partner after relationship dissolution slowed the decline of both love and sadness.

In conclusion, a few studies on variability in the duration of emotional experience and its predictors have already been reported, but most of this research area has been left largely unexplored. In the present article, we contribute to filling this gap by means of two studies that focused explicitly on the duration of emotional episodes and possible predictors of it on the three levels as distinguished above. In both studies, data were collected by means of a daily diary method. This way, it was possible to capture emotional experiences as experienced in real life while at the same time reducing the distortions that affect delayed recall methods

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(Bolger, Davis, & Rafaeli, 2003; Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004).

Study 1

The goal of the first study was to describe variability in the duration of emotional episodes of fear, anger, and joy, and to account for this variability. In the present study, an emotional episode was defined to pertain to the unfolding of an emotional experience. An emotional experience refers to the subjective feeling component of emotions as described within a large number of emotion theories (e.g., Frijda, 1986; Russell, 2003; Scherer, 2005). An emotional experience, unlike a mood, is assumed to be clearly elicited by a certain event or situation for the subject undergoing it and, as a result, to have a clear onset point (Beedie, Terry, & Lane, 2005). The duration of an emotional episode may then further be defined as the period between this onset point and the moment the emotional experience is no longer felt. We expected that the duration of each of the emotions under study would be highly variable both within and between individuals (Fitness & Fletcher, 1993; Scherer et al., 1986; Sonnemans, 1991). Moreover, we expected fear to be on average the emotion with the shortest duration, followed by anger and then joy (Scherer et al., 1986).

To account for variability in the duration of emotional experience, we studied the relation with possible predictors of the three types as mentioned above. Concerning trait predictors, we first included the Big Five personality traits . Consistent with Schimmack (2003), we expected the duration of negative affect to correlate negatively with extraversion and positively with neuroticism. It may, however, be noted that in Schimmack's study, the duration of emotional experience was measured with a scale ranging from 0 to only 30 min, which is rather short in view of theoretical claims of leading scholars (e.g., Frijda, 2007) and in view of empirical work on the duration of emotional experience (Gilboa & Revelle, 1994; Scherer et al. 1986; Sonnemans & Frijda, 1994, 1995). In the present study, we overcame this limitation by making use of a time scale with a broader range.

As a second group of trait predictors, we included the tendency to make use of suppression or reappraisal to regulate emotions. Emotions are almost always regulated to a certain degree (Frijda, 2007), and the strategy people tend to use may have important implications for the nature of emotional episodes. Gross and John (2003) reported that reappraisers tend to experience more intense positive emotions and less intense negative ones, whereas for suppressors the reverse holds. One may wonder whether a similar relation holds for the duration of emotional experience as well.

On the level of episode predictors, we investigated the importance of the eliciting situation. Frijda, Mesquita, Sonnemans, and Van Goozen (1991) argued that the importance of the eliciting situation is an essential determinant of the duration of emotional experience, and Sonnemans and Frijda (1995) found empirical support for this. Yet, duration measurements in that study were rather impure because they typically pertained to chains of different emotional experiences (e.g., anger followed by fear when being pursued). In the present study, we measured the durations of different emotional experiences separately; we expected that situation importance would be a strong predictor of the purified duration measures.

As a second episode predictor, we included the intensity of the emotional experience at onset. It has been suggested that intensity is positively related to duration (Frijda et al., 1991). There is some evidence in support of this suggestion, although the strength of the relationship varied across studies from a weak (Sonnemans & Frijda, 1994) to a strong positive correlation (Schimmack, 2003). As already mentioned, however, both studies have limitations, which we tried to overcome in our present research, which should yield a stronger test of the hypothesized intensity–duration relation.

Finally, at the level of moment predictors, we investigated the influence of physical reappearances of the source that elicited the emotion under study. Such reappearances may be hypothesized to increase the length of the emotional episode in question. This hypothesis lines up, for instance, with the effects of stimulus reinstatement as studied within the context of emotional learning (e.g., Bouton, 1984; Bouton & Bolles, 1979; Dirikx, Hermans, Vansteenwegen, Baeyens, & Eelen, 2004). Similarly, Sbarra and Emery (2005) found that contact with the former partner led to longer episodes of anger and sadness in relationship partners who had just broken up. It seems plausible that a similar relation should also hold in other contexts and for other emotions.

Method

Participants

Participants were 60 students of the University of Leuven. Ten students participated in partial fulfillment of a course requirement, and the other 50 participants received money for participating (12 Euros for their willingness to participate, an additional 50 cents for every day they had completed the questionnaire, supplemented by 1 Euro if they had completed all questionnaires). One participant was removed from the sample because he reported emotions for the first 2 days only. The final sample, therefore, consisted of 59 participants, 27 men and 32 women. The mean age of the participants was 21 years ($SD = 1.7$).

Materials and Personality Scales

Daily questionnaire. The daily questionnaire was divided into three blocks, each block corresponding to one of the three emotions: anger, joy, and fear. The number of questions in each block varied by the number of emotional episodes the participants had experienced and the duration of each of the episodes. As an example, the questions on anger episodes are now presented; the questions on fear and joy were similarly structured.

Participants first answered how often they had experienced anger that day (0, 1, 2, 3, 4, 5, $>$ 5 times). This question was followed by a set of questions that were repeated for every anger experience reported with a maximum of five. For each anger episode, participants rated on an 8-point Likert scale (a) the importance of the event or situation that elicited the emotional episode (0 = *not important at all* to 7 = *very important*) and (b) the intensity of the emotion at the beginning of the emotional episode (0 = *not intense at all* to 7 = *very intense*). Then, participants indicated the duration of the emotional episode. For this purpose, a bar was presented, which was divided into eight intervals. The total length of the bar denoted 120 min, each interval

representing 15 min. Participants had to indicate in which of the eight intervals their emotional episode ended. If the emotional episode lasted for longer than 2 hr, participants put a cross in a checkbox labeled "the emotion took longer than two hours." Finally, participants indicated in each interval in which their emotional episode was still ongoing whether there had been a direct contact with the event or situation that elicited the emotion (i.e., "Did you have direct contact with the event or situation that elicited the emotion?").

Emotion Regulation Questionnaire. The Emotion Regulation Questionnaire (Gross & John, 2003) consists of 10 items, grouped into two scales, Reappraisal and Suppression. Cronbach's alpha coefficients for the two scales for our data were .74 and .83, respectively. Respondents were asked to indicate their agreement with each of the 10 statements on a 7-point scale (1 = *totally disagree* to 7 = *totally agree*).

NEO-FFI personality questionnaire. The NEO-FFI personality questionnaire was originally developed by Costa and McCrae (1992) and was translated to Dutch by Hoekstra, Ormel, and De Fruyt (1996). The questionnaire consists of 60 items, grouped into five scales of 12 items that measure the Big Five personality dimensions of extraversion, neuroticism, openness, agreeableness, and conscientiousness. Cronbach's alpha coefficients for the five scales in our data were .81, .89, .71, .77, and .76, respectively. Respondents indicated the degree to which they agreed with each of the statements, using a 5-point scale (0 = *strongly disagree* to 4 = *strongly agree*).

Procedure

Participants came to the psychology department for a first session where they received a palmtop computer. Some practice trials helped respondents get acquainted with the palmtop. At the end of the first session, respondents completed both personality questionnaires. During the next 2 weeks, the palmtop beeped at the same time each day just before bedtime, reminding the respondent to complete the questionnaire. The exact moment of the beep was chosen by the participant him- or herself and hence was allowed to differ across participants. After 14 days, participants returned their palmtops; subsequently, they were paid (if applicable) and thanked for their participation.

Data Analysis

Standard descriptive and inferential statistical techniques cannot be readily applied to describe and predict the duration of emotional episodes because the exact duration of some emotional episodes (i.e., the episodes that last longer than the registration window of 2 hr) is not known and because a moment predictor was included in the study. Therefore, the data were analyzed using discrete-time survival analysis, which is well suited to describe and model durational data (Singer & Willett, 2003). This type of analysis relies on three key statistics: hazard rate, survivor rate, and median lifetime.

The hazard rate is the conditional probability that an emotional episode that has not yet ended at the beginning of a given interval will end during that interval; it may be calculated as the number of emotional episodes that ended in the respective interval divided by the number of emotional episodes that were still ongoing at the beginning of the interval in question. The hazard rate denotes the conditional probability that an emotional episode ends during each specific interval, and these conditional probabilities cumulate into the survivor rate, which is the probability that an emotional episode will still be alive at the end of each specific interval. This survivor rate is computed as the number of emotional episodes that are still ongoing at the end of a given interval divided by the total number of emotional episodes. Finally, the median lifetime denotes the point in time at which half of the emotional episodes under study have ended.

In discrete-time survival analysis, the role of possible predictors of duration is investigated by modeling the logit of the hazard rates by means of a weighted sum of the predictors under study.[1] In the present analysis, all substantive predictors were added to the model simultaneously and, as such, we examined whether a predictor had a distinctive contribution in explaining the variability in duration on top of the other predictors under study. For ease of interpretation, a positive prediction weight means that a higher score on the predictor is associated with longer duration and a negative weight means that a higher score on the predictor is associated with shorter duration.

Results

The hazard functions of fear, anger, and joy are presented in Figure 1. In general, the hazard rates start rather high and subsequently decline over time. This means that, on the one hand, a relatively large number of emotional episodes end during the first intervals and that, on the other hand, episodes that survived the first intervals are often more long-lasting ones (the conditional probability that an emotional episode ends during the last intervals being relatively low).

In addition to this common trend, there are some differences between the hazard functions of the three emotions. A first difference is that the hazard rate of fear is higher at the first interval than the hazard rate of anger, which in turn is higher than the hazard rate of joy. This indicates that short episodes (i.e., shorter than 15 min) of fear are more common than short episodes of anger, which are in turn more common than short episodes of joy. A second difference relates to the shape of the three hazard functions: Whereas the hazard rate of fear drops more or less linearly after the first time interval, the hazard functions of joy and anger first show a small rise and only start to drop steeply after 1 hr. In conjunction with the differences in the first interval, this means that whereas fear episodes more often have a very short duration compared with anger and joy, the latter two emotions more often have a duration in the range of 15 to 60 min. To further explore the shape of the hazard functions, we performed a series of survival analyses. The hazard function was modelled in a number of different ways, including a model containing only an intercept, a linear model, a quadratic model, a cubic model, and a model containing eight dummies. Model selection based on the Bayesian information criterion (BIC), a selection criterion that takes goodness of fit as

[1] The substantive predictors are added to a model containing a number of dummy variables equal to the number of time intervals. Together, these dummy variables represent the baseline hazard function. Depending on the sign of the weight of a substantive predictor, a higher score on the predictor leads to an upward or downward shift of the baseline hazard function.

well as parsimony into account, confirmed a linear trend for fear and a quadratic one for anger. However, no evidence for a quadratic trend was found for joy, the model with eight dummies having the lowest BIC in this case (models with lower BIC values being preferable). The latter is probably because of a rise of the hazard function during the sixth and eighth intervals.

The survivor functions of fear, anger, and joy are presented in Figure 2. It should come as no surprise that they declined over time (as the hazard rate never equals zero), which implies a steadily decreasing number of surviving episodes. Moreover, the survivor functions show a steep drop during the 1st hr and a smaller decline thereafter, with 80% of the emotional episodes ending within the 1st hr; during the 2nd hr, only an additional 10% of the emotional episodes ended. This pattern links with the hazard functions taking higher values during the first intervals.

In addition to this common trend, some differences were observed between the survivor functions of the different emotions under study. In particular, the initial decrease of the survivor function of fear is steeper than that of anger, which in turn is steeper even for that of joy, even though the three survivor functions more or less coincide after 1 hr. This links with differences between the corresponding hazard functions. These differences are further reflected in the differences in the median lifetimes of the three emotions under study, which were 16 min for fear, 22 min for anger, and 26 min for joy.

With regard to the discrete-time survival analyses (in which the baseline hazard functions were represented by means of eight dummy variables),[2] the weights of the substantive predictors of fear, anger, and joy are presented in Table 1.

With regard to the moment predictor, a physical reappearance of the source that elicited the emotional episode was for all three emotions associated with longer emotional episodes. Furthermore, the weight of this predictor was significantly different from zero for two of three emotions.

Concerning the two episode predictors, more important eliciting situations and higher emotion intensity at onset were associated with longer emotional episodes for all three emotions. One may note that this last relation was not significant for episodes of joy. However, this appears to be due to the correlation between the importance of the eliciting situation and the intensity of joy at onset ($r = .46$); when removing the predictor importance of the situation from the model, the initial intensity was significantly related to the duration of joy as well ($\beta = 0.13$, $\chi^2_{(1)} = 14.22$, $p < .001$).

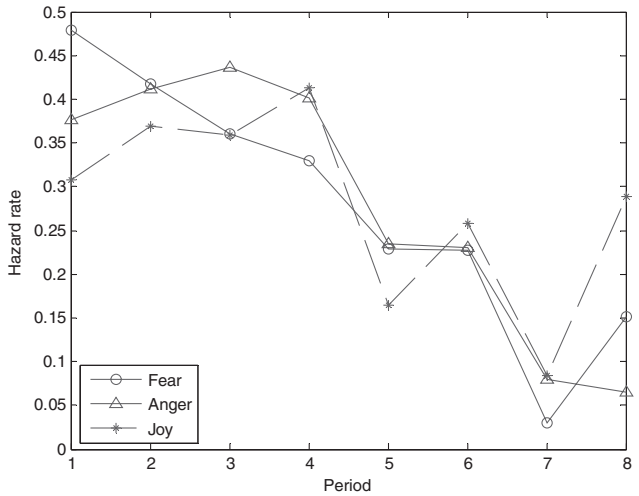


Figure 1. Hazard functions of fear, anger, and joy.

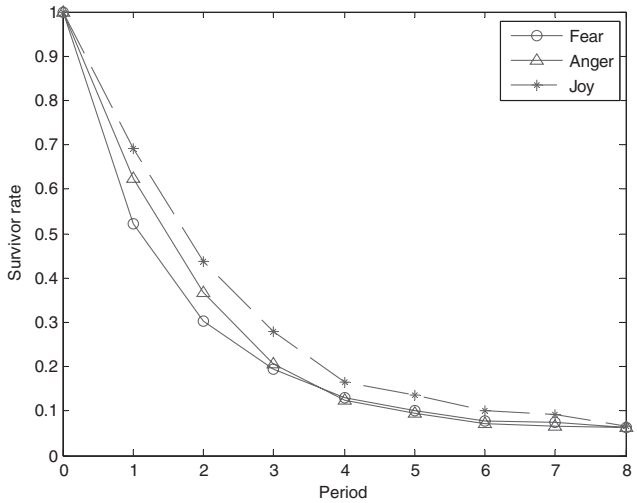


Figure 2. Survivor functions of fear, anger, and joy.

With regard to the trait predictors, the pattern of results is rather scattered. Moreover, only a relatively small number of relations were significant, and our hypotheses were at best only partially confirmed. A higher score on neuroticism was, as expected, associated with longer negative emotions, but this relation was only significant for anger. Moreover, people scoring high on neuroticism also experienced longer emotional episodes of the positive emotion, joy. Contrary to expectations, extraversion was related to a longer duration of negative emotional episodes. However, this relation was significant only for the emotion of anger. Suppression was, as expected, related to a longer duration of negative and shorter duration of positive emotional episodes, but these relations were marginally significant only for fear and joy. Finally, no significant relations between reappraisal and duration were found.

Discussion

This study contains evidence that the duration of emotional experience is highly variable. On the one hand, there is variability between emotions, as emotional episodes of fear are generally shorter than episodes of anger, which in turn are shorter than episodes of joy. This finding replicates the order of emotions as found in the study by Scherer et al. (1986). This may be explained by differences in the temporal focus of the emotions under study. Fear is typically a future-oriented emotion, whereas sadness and anger are past-oriented emotions. Consequently, fear may last until the fear-arousing event ends, whereas dwelling on the past can, in principle, be endless (Frijda, 2007).

[2] The same predictors are significant when a linear and a quadratic model were used to represent the baseline hazard functions of fear and anger, respectively.

Table 1
Weights of Predictors of the Duration of Fear, Anger, and Joy in Discrete-Time Survival Analyses (Study 1)

	Criterion					
	Fear		Anger		Joy	
Predictor	β	*SE*	β	*SE*	β	*SE*
Varying within and varying across episodes						
Physical contact with eliciting source	0.08	0.14	0.26*	0.12	0.69***	0.07
Stable within and varying across episodes						
Importance of the eliciting situation	0.40***	0.08	0.62***	0.06	0.17***	0.04
Intensity of the emotion at onset	0.22**	0.08	0.15*	0.06	0.05	0.04
Stable within and stable across episodes						
Agreeableness	0.05	0.09	−0.30***	0.06	−0.05	0.04
Conscientiousness	−0.08	0.08	0.03	0.06	0.01	0.04
Extraversion	0.05	0.10	0.22**	0.08	0.06	0.05
Neuroticism	0.13	0.09	0.29***	0.08	0.13**	0.04
Openness	0.03	0.07	0.14**	0.05	0.21***	0.04
Reappraisal	−0.09	0.08	0.01	0.06	−0.01	0.04
Suppression	0.15+	0.09	0.03	0.07	−0.07+	0.04

Note. All predictors were standardized except the binary predictor "physical contact with eliciting source."
* $p < .05$. ** $p < .01$. *** $p < .001$. + $p < .10$.

On the other hand, duration is also highly variable within emotions. To explain this, we have identified a number of relevant predictors, among which the most prominent ones are the moment and episode predictors. In particular, a first finding is that, for each emotion under study, higher emotional intensity at the onset of the episode is related to longer duration, which links with predictions of Frijda et al. (1991). In this regard, intensity is to be considered at the level of the stimulus as well as at the level of the organism experiencing the emotion. With regard to the former, it has been found that the more intense the stimulus that elicited the emotional episode (as reflected by the attributed importance of the situation), the longer the emotional episode lasts. With regard to the latter, the more intense the emotional reaction of the individual, the longer the emotional episode lasts.

A second finding is that the eliciting stimulus does not merely affect duration at the beginning of the emotional episode but also during its course. Indeed, physical reappearances of the eliciting stimulus tend to lead to a reactivation of the emotional experience and, as such, to a prolongation of the emotional episode. This extends earlier findings of Sbarra and Emery (2005) within the specific context of nonmarital relationship dissolution.

Although the present study yields some interesting results, it also gives rise to some new questions. A first such question pertains to the effect of the presence of the eliciting source on the duration of emotional episodes. From a psychological point of view, it may be argued that an eliciting stimulus can be psychologically present without being physically present. For instance, people may also think back during the emotional episode about the person or event that gave rise to the emotional experience. Otherwise, this can also be linked to the concept of rumination, the relation of which with emotion duration has been demonstrated in the case of depression (Nolen-Hoeksema, Morrow, & Fredrickson, 1993). As such, one may wonder whether an eliciting source can also influence the duration of subsequent emotional experiences without being physically present.

Second, one may wonder whether the predictive characteristics of emotion duration might differ across emotions. Differences in duration as well as in the prediction were found but are not readily interpretable as the set of three emotions was rather unstructured. Therefore, we thought that it would be interesting to make use in the next study of a set of emotions that clearly differed with regard to certain preestablished dimensions.

Finally, in the present study participants did not receive explicit definitions of fear, anger, and joy; individual differences in interpretation could have resulted in a less desirable source of variability. Therefore, in a subsequent study, we thought that it would be desirable to present the participants with definitions of the emotions.

Study 2

The main aim of the second study was to replicate and extend the results from the first study. First, we wanted to investigate whether the effect of physical reappearance of the eliciting stimulus extended to mental reappearance. We hypothesized that both physical and mental reappearances would lead to a prolongation of the emotional episode.

Second, we explored whether emotion differences both in duration and in the predictors of duration could be explained by certain characteristics of the emotions themselves. For this purpose, we made use of a set of emotions that was selected to include two positive (i.e., gratitude and joy) and two negative emotions (i.e., anger and sadness), half of which typically occurs in an interpersonal context (i.e., gratitude, anger), whereas the other half does not necessarily (i.e., joy, sadness).

Third, we tested whether the results of our first study would be robust against variations in the method of data collection. In the first study, end-of-the day reports were collected on palmtop computers; in the second study, we made use of an Internet questionnaire.

Method

Participants

Participants were 50 volunteers who were individually contacted. Seven participants were removed from the sample because

they left the study early, which reduced the final sample to 43 participants, 16 men and 27 women. The mean age of the participants was 25 years ($SD = 7.2$).

Materials

The daily questionnaire was the same as in the first study, with five exceptions. First, the emotions under study were anger, gratitude, sadness, and joy. Second, each of the four emotion terms was defined the first time it appeared. Definitions were based on Wierzbicka (1992). Anger was defined as "an emotion that is felt when someone does something bad which you do not want and when you want to do something bad to this person." Gratitude was defined as "an emotion that is felt when someone does something good which you want and when you want to do something good to this person." Joy was defined as "an emotion that is felt when something very good is happening which you want." Sadness was defined as "an emotion that is felt when something bad happened which you did not want to happen and when you wish to do something but you cannot." Third, the bar that represented the duration of an emotional episode had a total duration of 1 hr divided in six intervals of 10 min. If the emotional experience reported lasted for longer than 1 hr, respondents had to put a cross in a checkbox that indicated "the emotion took longer than one hour." Fourth, the importance of the eliciting situation and the intensity of the emotion at onset were measured with 5-point scales. Finally, participants not only had to indicate for every time interval in which they felt an emotion whether they had had physical contact with the source that elicited the emotion (i.e., "Is the eliciting stimulus physically present?") but also whether they had had mental contact with the eliciting source (i.e., "Is the eliciting stimulus mentally present?"). We administered the same personality questionnaires as in the first study.

Procedure

Participants were given an envelope that contained the personality questionnaires and were asked to hand them in right away or else send them back within the next few days. The envelope also contained instructions on how to fill out the daily questionnaire. In these instructions, participants were told that they had to surf to a Website at a preset time during the evening (i.e., just before bedtime) where the daily questionnaire would be presented. The specific moment to answer these questions was chosen by each participant him- or herself, and hence differed across participants. The study started from the moment the respondents received the envelope and ended 14 days later.

Results

The hazard functions of anger, gratitude, joy, and sadness are presented in Figure 3. Overall, the hazard rates rise during the first 30 min and decline thereafter, indicating that there were not only a relatively large number of emotional episodes with a short duration (i.e., shorter than 10 min) but also that those episodes that survived the first 10 min still had a high probability of extinction during the next 20 min. However, the relatively low number of episodes that survived the first 30 min appear to be long-lasting ones as the conditional probability of extinction dropped during the last intervals.

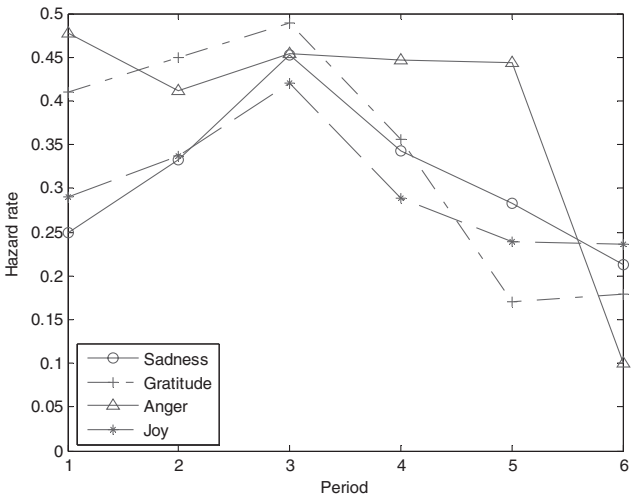


Figure 3. Hazard functions of anger, joy, gratitude, and sadness.

There were some further differences between the hazard functions of the four emotions under study. First, the hazard rates of anger and gratitude were higher at the first interval than those of joy and sadness; this means that short episodes (i.e., shorter than 10 min) for anger and gratitude more frequently occurred than for joy and sadness. Second, whereas the hazard functions of gratitude, joy, and sadness showed a quadratic pattern, that of anger remained more or less constant during the first 50 min and dropped steeply thereafter; this indicates that emotional episodes of anger after they have survived a relatively long critical period only transform into an enduring state. This conclusion was confirmed by a series of survival analyses. The hazard function was modeled in a number of different ways, including a model containing only an intercept, a linear model, a quadratic model, a cubic model, and a model with six dummies. Model selection based on BIC confirmed the constant trend of anger and the quadratic trend of gratitude, joy, and sadness. Third, whereas the hazard functions of joy, gratitude, and sadness all have the same more or less quadratic shape, the hazard function of gratitude shows that the risk of extinction was clearly higher than that of the other two emotions during the first intervals; this implies that emotional episodes will typically be shorter for gratitude than for joy and sadness.

The survivor functions of anger, gratitude, joy, and sadness are presented in Figure 4. All four show a steep drop during the first 30 min and a smaller decline thereafter, which links with the relatively high values of the hazard functions in the first three intervals. Furthermore, 80% of the emotional episodes ended within the first 30 min, whereas during the next 30 min, only an additional 10% ended.

The differences between the hazard functions of the four emotions are also reflected in the corresponding survivor functions. In particular, the survivor functions of anger and gratitude initially dropped more steeply than the survivor functions of joy and sadness. Furthermore, the median lifetimes of the emotions of anger and gratitude were 11 min and 13 min, respectively, whereas the median lifetimes of joy and sadness were 19 min and 20 min, respectively.

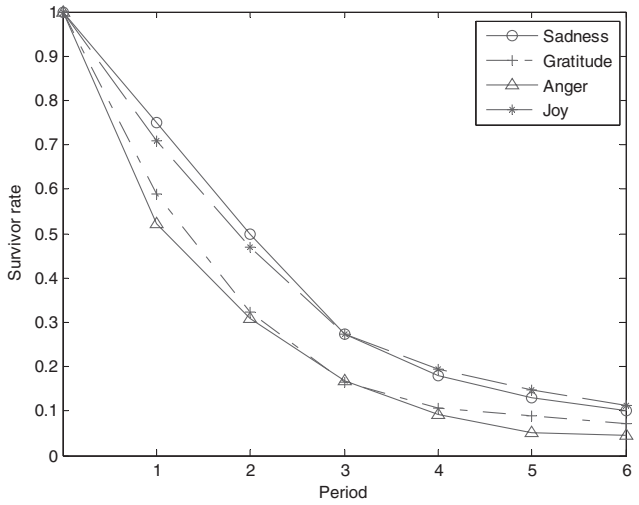


Figure 4. Survivor functions of anger, joy, gratitude, and sadness.

With regard to the discrete-time survival analyses (in which the baseline hazard functions are represented by means of six dummy variables),[3] the weights of the substantive predictors of the duration of anger, joy, gratitude, and sadness are presented in Table 2.

Concerning the moment predictors, as hypothesized, both physical and mental contact with the eliciting source were related to longer duration for all of the four emotions under study. Moreover, all but one of the corresponding regression weights appear to be highly significant.

With regard to the episode predictors, almost all results are in line with our hypotheses: Except for sadness, the more important the situation that elicited the emotional episode, the longer the emotional episode lasted; moreover, the more intense the emotional experience at onset, the longer the emotional episode lasted, and this relation was significant for all four emotions under study. For sadness only, the importance of the situation was related to duration, provided that the initial intensity of the emotion was removed from the model ($\beta = 0.27, \chi^2_{(1)} = 8.35, p < .01$).

Concerning trait predictors, as in the first study, extraverts tend to experience longer episodes of anger, whereas agreeable people tend to experience shorter episodes of anger, yet both relations were only marginally significant. The finding from Study 1 that people scoring high on neuroticism and open people experience longer episodes of anger and joy was not replicated; in contrast, people scoring high on neuroticism tend to experience shorter episodes of anger. With regard to the emotions of gratitude and sadness, we found that people who tend to suppress emotions experience longer episodes of gratitude and sadness. Finally, conscientiousness, extraversion, and neuroticism significantly related to sadness duration as well.

Discussion

Study 2 largely replicated the results of the first study, despite the slightly different methodology used in Study 2. Again, considerable within- as well as between-emotions differences in duration were found. Otherwise, with regard to the latter, the emotions that typically occur within an interpersonal context tend to be shorter than the other two emotions under study. Of course, given that only four emotions were considered, caution about this conclusion is warranted.

With regard to predictors of the duration of emotional experience, the higher the importance of the eliciting situation and the higher the initial intensity, the longer the emotional episode lasts; both results are congruent with the findings of the first study. Moreover, both predictors have a unique contribution in explaining the variability in duration for all emotions but sadness.

Furthermore, as in the first study, the eliciting stimulus also appears to be effective during the emotional episode. More precisely, it was again found that physical reappearances of the eliciting stimulus were associated with a prolongation of the emotional episode. This relationship especially holds for the interpersonal emotions under study. Moreover, Study 2 presents ample evidence that the stimulus does not need to reappear physically to be effective, as merely thinking about it also leads to a prolongation of the emotional episode.

Finally, the relationship between trait predictors and the duration of emotional experience is less clear: Results do not simply generalize across emotions, and the relations found in the first study were only partially replicated in the second. Further research will be needed to clarify this issue. Nevertheless, it may be noted that extraversion and neuroticism are both related to the negative emotions under study, whereas there is no relationship with the positive emotions.

General Discussion

Recently, time-related characteristics of emotions have attracted an increasing amount of scientific attention. Theoretical frameworks have been developed to understand these dynamics (e.g., Davidson, 1998; Schimmack et al., 2000), and the number of empirical studies on the time dynamics of emotions is steadily growing (e.g., Feldman, 2007; Kuppens, Van Mechelen, Nezlek, Dossche, & Timmermans, 2007; Germans Gard & Kring, 2007). However, one of the most basic time-related characteristics of emotions, emotion duration, has hardly been examined (Frijda, 2007).

In the present two studies, we were able to identify a number of key predictors of the variability in the duration of emotional experience regardless of the exact nature of the emotion. These key predictors include the importance of the eliciting situation, the intensity of the emotion at onset, and reappearance of the emotion-eliciting source. The importance of their predictive role is supported by the fact that they not only generalize across emotions, but also across two studies that used somewhat different methodologies.

When taking a closer look at these key predictors, a first finding is that the onset and the end of an emotional experience are closely related. The higher the emotional intensity at onset, the longer it takes before intensity returns to baseline, even when controlling for the importance of the eliciting situation.

[3] The same predictors are significant when an intercept-only model is used to represent the baseline hazard function of anger and a quadratic model is used to represent the baseline hazard function of joy, gratitude, and sadness.

Table 2
Weights of Predictors of the Duration of Anger, Joy, Gratitude, and Sadness in Discrete-Time Survival Analyses (Study 2)

	Criterion							
	Anger		Joy		Gratitude		Sadness	
Predictor	β	*SE*	β	*SE*	β	*SE*	β	*SE*
Varying within and varying across episodes								
Physical contact with eliciting source	0.75***	0.17	0.48***	0.10	0.77***	0.16	0.34+	0.20
Mental contact with eliciting source	0.96***	0.20	0.86***	0.11	0.98***	0.19	1.04***	0.24
Stable within and varying across episodes								
Importance of the eliciting situation	0.22*	0.10	0.29***	0.06	0.37***	0.10	−0.09	0.13
Intensity of the emotion at onset	0.41***	0.10	0.30***	0.06	0.42***	0.10	0.59***	0.14
Stable within and stable across episodes								
Agreeableness	−0.15+	0.09	−0.08	0.06	−0.08	0.07	−0.09	0.10
Conscientiousness	−0.16	0.12	−0.08	0.06	−0.10	0.10	−0.55***	0.12
Extraversion	0.20+	0.11	0.06	0.06	0.11	0.10	0.30*	0.12
Neuroticism	−0.42***	0.11	−0.05	0.06	−0.15+	0.09	−0.42**	0.13
Openness	−0.02	0.09	−0.02	0.05	0.06	0.08	−0.06	0.10
Reappraisal	0.15	0.09	0.07	0.06	0.16+	0.09	0.06	0.11
Suppression	0.22*	0.10	−0.06	0.06	0.21*	0.09	0.23*	0.10

Note. All predictors were standardized except the binary predictors "physical contact with eliciting source" and "mental contact with the eliciting source."
* $p < .05$. ** $p < .01$. *** $p < .001$. + $p < .10$.

Furthermore, whereas previous studies have focused mainly on dispositional variables and process variables measured at the beginning of the emotional episodes as potential predictors of emotion duration, the present studies provide clear evidence that events that take place during the emotional episode may also have a strong effect on the duration of emotional experience. Physical reappearances of the eliciting source appear to lead to a prolongation of the emotional episode. This finding links with the effect of reinstatement as studied within the field of learning psychology (e.g., Bouton, 1984; Bouton & Bolles, 1979; Dirikx et al., 2004). Reinstatement refers to the phenomenon that after the extinction of a learned relation between an unconditional and a conditional stimulus, a reappearance of the conditional stimulus may reactivate the learned relation. Similarly, a reappearance of the eliciting stimulus may reactivate an emotional episode. In addition to physical reappearances, mental reappearances appear to lead to a prolongation of the emotional episode as well. This finding links with the effect of rumination on the duration of negative affective states such as depression (Nolen-Hoeksema et al., 1993). Moreover, our second study suggests the existence of a relationship between rumination and positive emotions.

Obviously, the present studies have a number of limitations that leave many opportunities for future research to extend our findings. First, the focus of both studies was on the subjective feeling component of emotions; the studies complement experiments that focus on the full emotional response. This also implies that our results cannot simply be generalized to the (prediction of the) duration of full emotional responses as such. Second, it has been shown that emotions influence the way people perceive time (Droit-Volet & Meck, 2007). Therefore, future studies could extend the present findings by focusing on other emotional components for which some more objective parameters are available (e.g., neurophysiological measures). Third, even though the results regarding the prediction of duration largely replicate across the two studies, the durations as such do not. A possible explanation for this is the fact that the time scale was not fully identical in both studies. Otherwise, in future research it might be interesting to make use of a time scale that also allows for differentiating between very short episodes. Fourth, the data still contain some retrospection (albeit at the within-day level). Future studies may avoid this by making use of repeated online measurement of emotional experience. Fifth, it would be interesting to increase the number of emotions to examine whether the present findings generalize across other emotions as well. Sixth, the number of different predictors could also be increased, which could lead to a better understanding of the variability in the duration of emotional experience. Finally, predictors such as the ones that were included in the present studies could also be studied at different levels of variability. For example, in this research, we examined the importance of the eliciting situation as an episode predictor, but it would be interesting to study whether changes in the perceived importance of the situation during the course of the emotional episode are related to changes in the duration of emotional experience as well. This dynamic approach would pave the way for a more in-depth study of the relationship between reappraisal and the duration of emotional experience, reappraisal in the present study being measured at the trait level only.

References

Beedie, C. J., Terry, P. C., & Lane, A. M. (2005). Distinctions between emotion and mood. *Cognition & Emotion, 19,* 847–878.

Bolger, N., Davis, A., & Rafaeli, E. (2003). Diary methods: Capturing life as it is lived. *Annual Review of Psychology, 54,* 579–616.

Bouton, M. E. (1984). Differential control by context in the inflation and reinstatement paradigms. *Journal of Experimental Psychology, 10,* 56–74.

Bouton, M. E., & Bolles, R. C. (1979). Role of conditioned contextual stimuli in reinstatement of extinguished fear. *Journal of Experimental Psychology: Animal Behavior Processes, 5,* 368–378.

Costa, P. T., Jr., & McCrae, R. R. (Eds.). (1992). *Revised NEO Personality*

Inventory (NEO-PI–R) and the Five-Factor Inventory (NEO-FFI): Professional manual. Odessa, FL: Psychological Assessment Resources.

Davidson, R. J. (1998). Affective style and affective disorders: Perspectives from affective neuroscience. *Cognition & Emotion, 12,* 307–330.

Dirikx, T., Hermans, D., Vansteenwegen, D., Baeyens, F., & Eelen, P. (2004). Reinstatement of extinguished conditioned responses and negative stimulus valence as a pathway to return of fear in humans. *Learning and Memory, 11,* 549–554.

Droit-Volet, S., & Meck, W. H. (2007). How emotions colour our perception of time. *Trends in Cognitive Sciences, 11,* 504–513.

Eaton, L. G., & Funder, D. C. (2001). Emotional experience in daily life: Valence, variability, and rate of change. *Emotion, 1,* 413–421.

Feldman, R. (2007). On the origins of background emotions: From affect synchrony to symbolic expression. *Emotion, 7,* 601–611.

Fitness, J., & Fletcher, G. J. O. (1993). Love, hate, anger, and jealousy in close relationships: A prototype and cognitive appraisal analysis. *Journal of Personality and Social Psychology, 65,* 942–958.

Frijda, N. H. (1986). *The emotions.* Cambridge, England: Cambridge University Press.

Frijda, N. H. (2007). *The laws of emotion.* Mahwah, NJ: Erlbaum.

Frijda, N. H., Mesquita, B., Sonnemans, J., & Van Goozen, S. (1991). The duration of affective phenomena or: Emotions, sentiments and passions. In K. T. Strongman (Ed.), *International review of studies on emotion* (pp. 187–225). Chichester, England: Wiley.

Germans Gard, M., & Kring, A. M. (2007). Sex differences in the time course of emotion. *Emotion, 7,* 429–437.

Gilboa, E., & Revelle, W. (1994). Personality and the structure of affective responses. In S. Van Goozen, N. E. Van De Poll, & J. A. Sargent (Eds.), *Essays on current issues in the field of emotion theory* (pp. 134–159). Hillsdale, NJ: Erlbaum.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85,* 348–362.

Hemenover, S. H. (2003). Individual differences in rate of affect change: Studies in affective chronometry. *Journal of Personality and Social Psychology, 85,* 121–131.

Hoekstra, H. A., Ormel, J., & De Fruyt, F. (1996). *NEO-PI–R, NEO-FFI Big Five Persoonlijkheidsvragenlijsten: Handleiding* [*Big Five Personality Questionnaires: Manual*]. Lisse, the Netherlands: Swets & Zeitlinger B. V.

Kahneman, D., Krueger, A. B., Schkade, D. A., Schwarz, N., & Stone, A. A. (2004, December 3). A survey method for characterizing daily life experience: The day reconstruction method. *Science, 306,* 1776–1780.

Kuppens, P., Van Mechelen, I., Nezlek, J. B., Dossche, D., & Timmermans, T. (2007). Individual differences in core affect variability and their relationship to personality and adjustment. *Emotion, 7,* 262–274.

Nolen-Hoeksema, S., Morrow, J., & Fredrickson, B. L. (1993). Response styles and duration of depressed moods. *Journal of Abnormal Psychology, 102,* 20–28.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110,* 145–172.

Sbarra, D. A. (2006). Predicting the onset of emotional recovery following nonmarital relationship dissolution: Survival analyses of sadness and anger. *Personality and Social Psychology Bulletin, 32,* 298–312.

Sbarra, D. A., & Emery, R. E. (2005). The emotional sequelae of nonmarital relationship dissolution: Analysis of change and intraindividual variability over time. *Personal Relationships, 12,* 213–232.

Scherer, K. R. (2005). What are emotions? And how can they be measured? *Social Science Information, 44,* 693–727.

Scherer, K. R., Walbott, H. G., & Summerfield, A. B. (1986). *Experiencing emotions: A cross-cultural study.* Cambridge, England: Cambridge University Press.

Schimmack, U. (2003). Affect measurement in experience sampling research. *Journal of Happiness Studies, 4,* 79–106.

Schimmack, U., Oishi, S., Diener, E., & Suh, E. (2000). Facets of affective experiences: A framework for investigations of trait affect. *Personality and Social Psychology Bulletin, 26,* 655–668.

Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence.* New York: Oxford University Press.

Sonnemans, J. (1991). *Structure and determinants of emotional intensity.* Unpublished doctoral dissertation, University of Amsterdam.

Sonnemans, J., & Frijda, N. (1994). The structure of subjective emotional intensity. *Cognition & Emotion, 8,* 329–350.

Sonnemans, J., & Frijda, N. (1995). The determinants of subjective emotional intensity. *Cognition & Emotion, 9,* 483–506.

Wierzbicka, A. (1992). Defining emotion concepts. *Cognitive Science, 16,* 539–581.

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