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The co-occurrence of emotions in daily life: A multilevel approach

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Abstract

Zelenski and Larsen (2000) argued that a dimensional model may apply to emotional traits whereas a discrete model may apply to emotional states. This implies that between-subjects correlations among emotions of the same valence should be positive whereas within-subject correlations among these emotions should be negative. Zelenski and Larsen found (partial) support for such a distinction; however, their study suffered from some methodological shortcomings in terms of the data collection and data analysis. The present study remedied these problems by assessing momentary emotions using experience sampling methodology (ESM) and by analyzing the data using a multivariate random coefficient model that was able to estimate both between-subjects and within-subject correlations directly. The results suggest that a dimensional model applies to emotional traits. For emotional states, a discrete model applies to emotions of different valence whereas emotional blending occurs for emotions of the same valence.

Keywords: Co-occurrence of emotions; Experience sampling method; Multilevel random coefficient models

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1. Introduction

In emotion research, the co-occurrence or blending of emotions has been examined using two different approaches (Zelenski & Larsen, 2000). The first approach focuses on individual differences in the experience of emotions, whereas the second approach focuses on general emotion theories, with an emphasis on how different emotions may stem from different causes (Smith & Ellsworth, 1985; Smith & Lazarus, 1993). In terms of how emotions are dealt with, research relying on the first approach tends to measure dispositional affect or emotional traits (Watson, Clark, & Tellegen, 1988), whereas research relying on the second approach tends to measure emotional states (Ekman, 1992; Frijda, 1986).

The concept of dispositional affect has received considerable attention from Watson and Clark and their colleagues (Watson et al., 1988) as well as various other scholars (Baker, Cesa, Gatz, & Mellins, 1992; Baker, Zevon, & Rounds, 1994; Berry & Hansen, 1996; Reich, Zautra, & Potter, 2001). Those researchers suggest that people are predisposed to experience certain types or clusters of emotions. For example, some people may experience positive emotions more often than others, whereas for others the reverse may hold. Empirical research in this tradition has found support for such emotional traits. For example, research using the PANAS has consistently found that individuals who are prone to feel happy are prone to feel proud, whereas individuals who are prone to feel nervous are also prone to feel angry (e.g., Watson et al., 1988). In terms of correlations, at the between-subjects level, emotions with the same valence tend to be positively correlated. Furthermore, it is often found that positive and negative affect are independent dimensions (Watson et al., 1988) which may result in zero between-subjects correlations among emotions of different valence.

In contrast to considering emotions as traits or dispositions, emotional states are momentary experiences at particular moments in time. Such experiences are usually assumed to be mutually exclusive, implying that people may not experience different emotions at the same time (Ekman, 1992; Frijda, 1986; Izard, 1992; Stein & Oatley, 1992). For example, when a person is angry at a particular moment he or she does not feel guilty or anxious. In terms of correlations, at the within-subject level, emotions should be negatively correlated (irrespective of their valence).

Although it may seem counter-intuitive for constructs to have different relationships at different levels of analysis, such a possibility is perfectly reasonable. Relationships at different levels of analysis are mathematically independent (e.g., Nezlek, 2001). It is mathematically possible for two constructs to be positively related between subjects and negatively related within subjects (and vice versa). Moreover, between-subjects and within-subject covariation may measure or represent the operation of different processes (e.g., Tennen & Affleck, 1996), the precise point of our argument. In this context, research in the personality domain has already demonstrated that stability in traits and variability in states do not contradict one another. For example, with respect to Big Five relevant states, Fleeson (2001) found that the typical individual is characterized by a high within-subject variability (implying that he or she may experience all kinds of states in everyday life), while at the same time individual differences in the mean of these states (or in dispositions) are almost perfectly stable.

On a basis similar to that outlined above, Zelenski and Larsen (2000) hypothesized that a dimensional model may apply to emotional traits, whereas a discrete model may apply to emotional states. To test this hypothesis, they ran a study in which participants rated, among others, how angry, guilty, and sad they felt (negative emotions), and how happy, relaxed, and excited they felt (positive emotions). Reports were collected three times a day (at noon, early and late in the evening implying report periods of approximately 6 h) for 28 days. To calculate between-subjects correlations, they averaged ratings for each subject across time moments and then calculated correlations among average emotions; to estimate within-subject correlations, they standardized ratings for each subject and each emotion separately, and then calculated correlations among emotion ratings across all subjects and across all time moments.

Zelenski and Larsen (2000) found that between-subjects correlations among emotions of the same valence were larger than the corresponding within-subject correlations. For positive emotions, the mean between-subjects correlation was .57, whereas the mean within-subject correlation was .37. For negative emotions, the mean between-subjects correlation was .58, whereas the mean within-subject correlation was .19. From the within-subject findings, the authors also concluded that positive emotions tend to be more blended than negative ones. Furthermore, the between-subjects and within-subject correlations among emotions of different valence were rather small (as opposed to large and negative).

The present study was intended to examine the same issues as those examined by Zelenski and Larsen (2000) with two improvements. The first improvement concerned the time period over which emotional states were measured, and the second concerned how the data were analyzed, particularly how within-subject correlations were estimated.

With regard to the first improvement, as suggested by Zelenski and Larsen themselves, it is possible that, because they assessed emotions every 6 h, they did not assess momentary emotions (or emotional states). Over a 6 h time period people may experience various emotions indeed. As a consequence, Zelenski and Larsen may have had a weak basis for determining if people experience different emotions at the same point in time. To address this issue, we collected data using an experience sampling method (ESM) that allowed us to assess emotional states rather than moods. In particular, participants received a wristwatch that signaled them at nine random times a day for two consecutive weeks. At each signal, they reported their momentary emotions rather than summarizing their emotions over hours or days (Csikszentmihali & Larson, 1987; Shiffman & Stone, 1998). In comparison to traditional self-report, this type of data is less subject to biases introduced by recall and retrieval processes (Shiffman & Stone, 1998; Stone et al., 1998). In addition, ESM data are ecologically valid because they are based on representative samples of participants' real world experiences (Shiffman & Stone, 1998).

With regard to the second improvement, in addition to possible problems with the time interval over which Zelenski and Larsen sampled emotions, there may also have been some shortcomings in how they analyzed their data, and particularly their method of calculating within-subject correlations. Zelenski and Larsen first standardized the emotion ratings for each subject and each emotion separately and then calculated correlations among emotion ratings across all subjects and across all time moments. Although seemingly sensible, this is only an ad hoc procedure that is not based on a well-understood statistical model.

Zelenski and Larsen's analyses had numerous shortcomings. We will mention the three most important. First, the analyses assumed that all participants had the same within-person relationships (correlations were not calculated separately for each participant). Second, the analyses did not model the two sources of error inherent in data that are collected for multiple individuals across multiple occasions. As is standard, the sampling error associated with participants was modeled, but the error associated with sampling days was not. That is, the sample of days obtained for each participant was drawn from a universe of days in each participant's life, just as participants were randomly sampled from the universe (population) of participants. Data collected during another sets of days would probably have produced different relationships. Third, the estimated correlations did not correct for unreliability. See Nezlek (2001) for a description of the problems that occur when multilevel data are analyzed using ordinary least squares (OLS) techniques.

In contrast, we analyzed our data with a multilevel random coefficient model (MRCM) that represents a well-documented statistical model. In particular, the analyses we conducted were three-level multivariate MRCM analyses (Bryk & Raudenbusch, 1992; Goldstein, 1995; Schwartz & Stone, 1998; Snijders & Bosker, 2000) in which ratings were nested within occasions and occasions were nested within people. In addition to providing more accurate estimates of within-subject correlations, these analyses also provided more accurate estimates of between-subjects correlations. Part of this increased accuracy was due to the fact that our MRCM based analyses corrected between- and within-subject correlations for attenuation (i.e., unreliability). Another advantage of the MRCM is that it allows for missing observations, which are inevitable in data collected with the ESM.

The aim of this paper is to examine the co-occurrence of emotional traits as well as emotional states by means of a multivariate MRCM on the basis of momentary assessed emotions that people experience throughout their daily life. We hypothesize that individual differences in emotional traits can be captured by two dimensions, positive and negative affect. As a result, we expect high between-subjects correlations among emotions of the same valence and zero between-subjects correlations among emotions of different valence. Furthermore, we hypothesize that people experience a single emotional state at a time as a unique and separate experience; hence, we expect within-subject correlations among emotional states to be negative, irrespective of their valence.

2. Method

2.1. Participants

Participants in this study were 36 students of the University of Leuven who were recruited via the Job Service Center. Participants received 40 € for taking part in the study. The sample consisted of 13 men and 23 women with a mean age of 22.17 ($SD = 2.42$; min = 19; max = 33). Students came from the whole range of departments of the University of Leuven including exact sciences (including mathematics, physics, chemistry and so forth), biomedical sciences, and the humanities.

2.2. Materials

The selection of the emotions in this study was based on the work of Diener, Smith, and Fujita (1995) who sampled emotions to develop a set of emotion words that would capture the major emotions common to emotion theories including the cognitive, biological–evolutionary, and empirical tradition. Their procedure yielded six emotion groups: Four negative emotion categories (anger–disgust, fear, shame–guilt, and sadness) and two positive emotion categories (joy and love) with each category being represented by four emotion words. In this study, we chose two emotion words from each emotion category to represent the category. The final questionnaire included the following questions (emotion categories are indicated between parentheses): At this moment (a) I feel irritated, I feel angry (anger–disgust), (b) I feel guilty, I feel ashamed (shame–guilt), (c) I feel anxious, I feel nervous (fear), I feel sad, I feel sorrowful (sadness), (e) I feel happy, I feel satisfied (joy), (f) I feel sympathy, I feel affection (love). It should be noted that these questions are only a subset of the questions participants had to answer; we only mention the questions that are relevant for the present study.

2.3. Procedure

Participants received instructions, a digital wristwatch (Casio PC Unite Module No. 1910), a pencil, and 14 booklets (one booklet a day) each containing 9 copies of the emotion questionnaire. From the next day on, they received nine beeps a day for two consecutive weeks (9 beeps × 14 days = 126 beeps). The beeps were programmed according to a stratified random interval time-series (Delespaul, 1995). This means that a day was subdivided in nine successive blocks of 90 min starting from the moment the person was woken up by the alarm of the watch; this moment could be chosen by the participant. Within each block of 90 min, one beep was generated, with each minute of the time block having the same probability of being selected. Such a randomization technique reduces the likelihood of anticipation and leads to less unwanted effects such as changing of behavior, anticipatory thoughts and so forth (Delespaul, 1995).

After each beep, participants had to indicate on a 11-point scale *(0 = not applicable at all, 10 = completely applicable)* to what extent they experienced each of the mentioned emotions just before the moment of the beep. An 11-point scale was chosen as such a scale is widely used in Belgium's school and educational system. At the end of the questionnaire, participants had to indicate what time it was at the moment they filled out the questionnaire. It was stressed that their time report had to be based on the wristwatch (and not on another device) and that they had to report when they filled-out the questionnaire, not when they heard the alarm.

2.4. Analysis

An important rationale for the use of ESM is that the reliability of the assessment of an experience can be enhanced by reducing the time between the moment of observation and the moment of the report. For this reason, it is common in ESM research to exclude assessments that are reported outside a certain time window. In this study, all reports completed more than 15 min after the signal were excluded from the analysis. The choice of this time reliability window was based on research of Delespaul (1995) who showed that reports completed outside this time window are less reliable and consequently less valid. By doing this, 18% of the data records at the beep level were excluded, which is fairly good for an ESM study. The number of valid records the participants filled out varied from 53 to 125 ($M = 103$, $SD = 2.84$).

For the estimation of the between-subjects and within-subject correlations, a MRCM was used (Goldstein, 1995; Snijders & Bosker, 2000) with the emotions as criteria and random time-specific and subject-specific intercepts. The term multivariate refers to the fact that there are multiple dependent variables, namely the different emotions. Multilevel refers to the fact that there are different levels in the model: For each emotion, measurements at level 1 (measurement level) are nested within times at level 2 (time level), which in turn are nested within persons at level 3 (person level). The model can be written as follows:

$$Y_{hijk} = \beta_{ohjk} + E_{hijk} \quad \text{(Level 1 : measurement level)},$$

$$\beta_{ohjk} = \beta_{ohk} + U_{hjk} \quad \text{(Level 2 : time level)},$$

$$\beta_{ohk} = \beta_{oh} + V_{hk} \quad \text{(Level 3 : person level)}$$

with Y_{hijk} denoting the score on emotion h (with $h = 1, \ldots, 6$) at measurement i ($i = 1, \ldots 2$) at time j ($j = 1, \ldots, J_k$) for person k ($k = 1, \ldots, 36$). Each emotion h was assessed using two measurements (two emotion words).[1] Furthermore J_k denotes the number of valid time moments nested within person k (which may differ across persons), β_{ohk} is the intercept of emotion h for person k, β_{oh} the overall intercept of emotion h, V_{hk} the random part of the intercept for emotion h in person k (level 3), β_{ohjk} is the intercept for emotion h at time j for person k, U_{hjk} the random part of the intercept for emotion h at time j (level 2) in person k (level 3), and E_{hijk} the random part of the intercept for emotion h for measurement i (level 1) at time j (level 2) in person k (level 3). In fact, the latter term is an error term. After substitution, this model can be written as follows:

$$Y_{hijk} = \beta_{oh} + V_{hk} + U_{hjk} + E_{hijk}.$$

[1] Note that the particular MRCM as proposed in this paper requires multiple measurements of the constructs at each time moment. Other models, like the trait-state-error model for multiwave data of Kenny and Zautra (1995), may be considered when only a single measurement of a construct is available at each time moment.

From the last equation, it can be seen that emotion h of person k at time j is predicted from the overall intercept of emotion h (β_{oh}), the disposition of person k for emotion h (V_{hk}), the emotional state h at time j of person k (U_{hjk}) and an error term (E_{hijk}). The between-subjects and within-subject correlations between each pair of emotions can be estimated—free of measurement error—on the basis of the variance/covariance matrices of the V_{hk} and U_{hjk} terms. The analyses were done using the program Mlwin (Rabash, Browne, Goldstein, Yang et al., 2002).

3. Results

In Table 1, the different estimates for the fixed and random parts of the multivariate MRCM are presented together with their standard errors. In the first row of this table, the intercepts for the different emotions are displayed. These coefficients (which are essentially estimates of means) indicate that positive emotions are experienced more intensely than negative emotions. Under the intercepts, the between-subjects and within-subject (co)variances between all pairs of emotions are presented, and at the bottom line of the table, the error variance (E_{hijk}) for each emotion is shown.

On the basis of the between-subjects and within-subject (co)variances, it is possible to estimate the between-subjects and within-subject correlations between all pairs of emotions. In Table 2, the resulting estimated between-subjects correlations among all six emotions are displayed above the diagonal and the corresponding within-subject correlations below the diagonal. Examining the between-subjects correlations, it can be seen that all negative emotions are clearly positively correlated, with correlations ranging from .64, for anger–disgust and sadness, to .76, for shame–guilt and fear, the average correlation being .69. The between-subjects correlation between joy and love is .65, whereas the between-subjects correlations among emotions of different valence range from −.24 to .15 with an average of −.03. On the basis of these results, it can be concluded that the between-subjects correlations among emotions of the same valence are high whereas between-subjects correlations among emotions of different valence are close to zero, in line with our hypotheses.

Within-subject correlations among negative emotions varied between .38, for anger–disgust and sadness, to .60, for anger–disgust and fear, with an average of .44; the within-subject correlation between the two positive emotions, however, was .69. We must conclude that, although the within-subject correlations among the negative emotions are clearly lower than their between-subjects counterparts, they are still meaningfully different from zero. Moreover, the within-subject correlation between joy and love was slightly higher than the corresponding between-subjects correlation. Further, it is striking that all within-subject correlations among emotions of different valence were negative, ranging from −.58, between anger–disgust and joy, to −.13, for shame–guilt and love with an average of −.29. As a whole, these results suggest that emotions of different valence tend to be experienced as separate, discrete

Table 1
Multivariate multilevel model with emotions as criteria and random intercepts as predictors: Parameter estimates and standard errors

	Anger–disgust (h = 1) Par. (SE)	Shame–guilt (h = 2) Par. (SE)	Fear (h = 3) Par. (SE)	Sadness (h = 4) Par. (SE)	Joy (h = 5) Par. (SE)	Love (h = 6) Par. (SE)
Fixed effects						
β_{ho} = Intercept	1.08(.13)	.43(.09)	.97(.14)	.83(.14)	5.14(.22)	3.61(.31)
Random Effects						
Between-subjects variance–covariance matrix						
Anger–disgust	.56(.14)					
Shame–guilt	.28(.08)	.28(.07)				
Fear	.42(.13)	.34(.10)	.71(.17)			
Sadness	.38(.12)	.28(.09)	.46(.14)	.64(.16)		
Joy	−.23(.17)	−.06(.12)	−.13(.19)	−.12(.18)	1.70(.41)	
Love	.07(.23)	.09(.16)	.08(.26)	.22(.25)	1.54(.48)	3.29(.79)
Within-subject variance–covariance matrix						
Anger–disgust	1.97(.07)					
Shame–guilt	.31(.02)	.39(.02)				
Fear	.80(.04)	.28(.02)	.89(.05)			
Sadness	.72(.04)	.36(.02)	.54(.03)	1.86(.05)		
Joy	−1.78(.07)	−.36(.03)	−.68(.05)	−.97(.06)	4.79(.12)	
Love	−1.27(.07)	−.19(.04)	−.44(.06)	−.49(.06)	3.56(.11)	5.60(.15)
Error terms	1.54(.04)	.60(.01)	1.73(.04)	.31(.01)	.66(.02)	1.83(.04)
−2∗loglikelihood(IGLS) = 156275.9						

Note. par., parameter; SE, standard error, n, 44,556.

Table 2
Between-subjects (above diagonal in bold) and within-subject (below diagonal) correlations between emotions

	Anger–disgust	Shame–guilt	Fear	Sadness	Joy	Love
Anger–disgust		**.71**	**.66**	**.64**	**−.24**	**.05**
Shame–guilt	.36		**.76**	**.68**	**−.09**	**.10**
Fear	.60	.47		**.68**	**−.12**	**.05**
Sadness	.38	.42	.42		**−.12**	**.15**
Joy	−.58	−.26	−.33	−.32		**.65**
Love	−.38	−.13	−.20	−.15	.69	

emotional states. However, in contrast with our hypotheses, the results also suggest that persons may experience different emotions of the same valence, and especially positively valenced emotions, at the same time.

4. Discussion

The results of our study indicate that between-subjects correlations among emotions of the same valence are positive, whereas the same correlations for emotions of different valence are close to zero. As a result, individual differences in emotional traits may be captured by a dimensional model. With regard to emotional states, our within-subject correlations provide evidence for emotional blending of emotions of the same valence whereas they suggest that a discrete model applies to emotional states of different valence.

Despite the fact that emotional states were assessed as momentary experiences in this study, emotional states of the same valence do not seem to be separate and unique experiences. An explanation for this finding may be derived from a theory of Feldman Barrett (1998). This theory starts from the common assumption that all emotional states can be characterized in terms of two qualities (Feldman Barrett, 1998; Russell & Feldman Barrett, 1999): valence (positive vs. negative emotional states) and arousal (bodily activation). According to Feldman Barrett (1998), individuals may differ in terms of focus on those characteristics. For example, there may be individuals who focus more on the valence than on the arousal aspect of their emotional states; such individuals should evidence large positive correlations among subjective emotional states of the same valence (because they are not attending to information that would distinguish the same valence states from one another).

Viewed from the perspective of this theory, a possible explanation for the high within-subject correlations among like-valenced emotions and for the negative within-subject correlations among emotions of different valence as found in our study may be that the majority of participants in our sample was high on valence focus and low on arousal focus. Such an explanation is consistent with the results of Feldman (1995) who found that the majority of her participants focused more on valence than arousal.

Further, it is striking that all the mean correlations in our study are larger (apart from the between-subjects correlations among emotions of different valence which are approximately zero in both studies) in comparison to the study of Zelenski and Larsen (2000). This result may be due to the fact that both kinds of correlations are corrected for attenuation in the MRCM.

Future research would benefit from the selection of a larger sample of emotions that should be carefully selected and well-balanced with respect to their position on the arousal and valence dimensions. On the other hand, using more emotions (which would be accompanied by the need for more participants to estimate between-subjects and within-subject correlations reliably) is not without drawbacks. An experience sampling protocol that requests too many judgments may overwhelm participants and reduce the validity of their responses.

We believe that the present study makes a valuable contribution in two domains. First, it extends our understanding of emotional states. Blending may be a tendency when considering states of the same valence, whereas emotional states of different valences seem to follow a more discrete model. Second, this paper provides an example of how to use multilevel modeling to examine between- and within-person relationships among psychological states. As studies of within-person phenomena become more common, researchers need to be certain to use analytic techniques whose properties are well-understood, and whose assumptions correspond to the characteristics of their data structures. Non-standard, idiosyncratic, and ad-hoc procedures may appear to provide valid descriptions of relationships; however, because such procedures may not be based on statistical models with well-understood properties, their use allows for the possibility that results may reflect the idiosyncrasies of the specific data structure and technique more than they reflect population parameters.

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