The role of incidental variables of time in mood assessment

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* This research has been supported by a grant from the Spanish Ministerio de Ciencia y Innovación (number ECO2009-09834).

ABSTRACT

Determining what influences mood is important for theories of emotion and research on subjective well-being. We consider three sets of factors: activities in which people are engaged; individual differences; and incidental variables that capture when mood is measured, e.g., time-of-day. These three factors were investigated simultaneously in a study involving 168 part-time students who each responded 30 times in an experience sampling study conducted over 10 working days. Respondents assessed mood on a simple bipolar scale – from 1 (very negative) to 10 (very positive). Activities had significant effects but, with the possible exception of variability in the expression of mood, no systematic individual differences were detected. Diurnal effects, similar to those already reported in the literature, were found as was an overall "Friday effect." However, these effects were small. Lastly, the weather had little or no influence. We conclude that simple measures of overall mood are not greatly affected by incidental variables.

Keywords: Affect; mood; experience sampling; diurnal effects; day-of-the-week; weather; multilevel analysis.

JEL codes: C93; I00; I19; I131

Version: July 20, 2010

1. INTRODUCTION

Understanding variability in levels of mood and happiness in daily life is an important topic that has attracted a significant scientific literature (see, e.g., Bradburn, 1969; Csikszentmihayli, 1990; Strack, Argyle, & Schwartz, 1991; Diener & Seligman, 2004; Kahneman, Krueger, Schkade, Schwartz, & Stone, 2004). It is possible to conceive of this variability as being moderated by three classes of variables. First are the activities in which people are involved and specific events that occur (see, e.g., Csikszentmihayli, 1990; Clark & Watson, 1988; Kahneman et al., 2004). Second are variables that are specific to individuals such as age, gender, culture, and personality (see, e.g., Diener, Oishi, & Lucas, 2003; Oishi, Diener, Choi, D.-W., Kim-Prieto, & Choi, T., 2007). And third are time-related factors that are beyond individual control and which form the background against which daily life is lived. We call this third class of variables *incidental.*

The purpose of the present paper is to explore – within the same investigation – the role of three incidental variables on the expression of mood, specifically, time-of-day, day-of-the-week, and the weather. That each might affect mood matches common intuition. Moreover, there is already a growing literature that documents effects, albeit separately (see below).

Our study is motivated by two important issues. The first is to further understanding of the joint effects of different cyclical factors on mood. Are there regularities? On what do these depend? How? Are some incidental variables more important than others? The second has a more practical orientation relating to the measurement of social well-being (or happiness). Does it matter *when* such judgments are elicited? Whereas it is well-known that such assessments can be affected by factors such as question order (see, e.g., Strack, Martin, & Schwartz, 1988) or the occurrence of major events (positive or negative), it is not clear how they are affected by what we have called incidental variables. Moreover, not only is it important to establish whether such variables have reliable influences on mood but also their magnitude.

The data we analyze were originally collected in two studies that used the Experience Sampling Method (ESM) (Hurlburt, 1997; Hektner, Schmidt, & Csikszentmihayli, 2007) to study everyday perceptions of risk (Hogarth, Portell, & Cuxart, 2007; Hogarth, Portell, Cuxart, & Kolev, in press). However, an important feature of both studies was that the first question respondents were asked when prompted at random moments was an assessment of mood. Indeed, the first three questions of both studies were identical across experimental treatments (the second and third questions asked what participants were doing and whether the activity was personal or professional in nature). Thus, since in the analyses reported here we only use the first three responses, it is reasonable to aggregate the two sets of data (see also below).

Unlike much of the recent literature on mood, we used a single bipolar measure. We simply asked respondents "*How would you evaluate your emotional state right now?*" on a scale from 1 (very negative) to 10 (very positive). Whereas this "overall mood" question does not distinguish between negative and positive moods (Watson & Tellegen, 1985; Clark & Watson, 1988) nor different types of moods (see, e.g., Stone, Schwartz, J., Schwartz, N., Schkade, Krueger, & Kahneman, 2006), it does provide a simple overall measure to which our respondents could relate easily in the context of the other questions they were asked. In addition, we note that the use of single questions of "subjective well-being" is quite common in many happiness surveys and has provided meaningful data (see, e.g., Frey & Stutzer, 2002; Diener & Seligman, 2004).[1] As such, answers to our question can be thought of as summary measures of overall mood, possibly equivalent to a ratio of positive to negative moods. Later in this paper, we detail steps we took to assess the validity and reliability of our single mood measure.

We collected data on mood (as defined above) by having respondents complete prepared response sheets when triggered by text messages sent to their cellular telephones at *random* moments during their working days. In short, by using cellular telephones (owned by our respondents), we implemented the ESM and collected *random samples* of mood *in everyday settings*. In addition, we also gathered data on what respondents were actually doing when asked by the ESM to answer questions. The innovative feature of our data collection and analysis is the joint consideration of effects on mood due to the three classes of variables discussed above, namely: activities, individual differences, and incidental factors.

Our main results document the fact that judgments of mood are affected by the three classes of incidental variables we considered and, of course, the activities in which people are engaged. However, although these incidental factors are statistically significant in our study, they are not very predictive of overall assessments of mood, that is, the effects are small.

This paper is organized as follows. In the next section, we describe the study in terms of the participants and procedures used for data collection. This is followed by a review of literature on incidental factors in studies of mood that provides the motivation for

[1] We note here that in our second study (Hogarth et al., in press) we also collected data on emotional reactions (Bradley & Lang, 1994), and thus can use these data to support the appropriateness of our mood measure (see Section 5 below).

the analyses and results that we present in the subsequent section. Next, we outline the steps taken to establish the validity and reliability of our single mood measure. In a final section, we discuss the implications of our findings.

2. THE STUDY

The data were collected in two phases. The first took place in February and May of 2005, the second in October of 2006. Each phase involved a separate ESM study designed to illuminate the perception of risks (Hogarth, et al., 2007; in press) but, as noted above, since the first three questions were identical in both (see below), we have combined the two datasets for the purpose of the present analysis (that only involves these three questions).

Participants

All participants were students recruited from the Universitat Autònoma de Barcelona. A condition of their participation was that they had part-time jobs (defined by at least one third of full working days). There were 168 participants in all – 74 in phase 1 and 94 in phase 2. There were more women than men – 46 vs. 28 in phase 1, and 64 vs. 30 in phase 2. They ranged in age between 17 and 56 with a median of 22 in phase 1, and 19 in phase 2. Those participating in phase 1 were each paid 30 euros. In phase 2, the remuneration was 35 euros. Participants were required to respond to the questions detailed below as well as to some additional questions that are irrelevant to this analysis. In addition, they were required to attend sessions before and after the study for instructions and debriefing (that included some further questions).

Procedure

We sent text messages to participants between 8 am and 10 pm over a two-week period that excluded week-ends, i.e., for 10 consecutive working days. Depending on their working hours, some participants received their messages between 8 am and 3 pm and the others between 3 pm and 10 pm (43 and 125 participants, respectively).[2] To determine when messages should be sent, we divided time into segments of 15 minutes and chose six segments at random each day (three for each group of participants).

When they received a message, participants were required to note the date and time and to answer a series of questions.[3] The first three questions and types of scale used were:

1. *How would you evaluate your emotional state right now?* Scale from 1 (very negative) to 10 (very positive)
2. *What are you doing right now?* Open-ended and subsequently referred to as ACT.
3. *Is ACT professional or personal in nature?* Binary response, coded (0/1)

There were up to five additional questions after this that varied by phase and experimental conditions within phases (Hogarth et al., 2007; in press).

After completing the task, participants were thanked, debriefed, and paid in a post-experimental session in which they also answered demographic and other questions. Phase 1 participants also completed Rotter's (1966) Internal-External "Locus of Control" questionnaire (IE).

[2] The objective was to send participants messages during the part of the day in which they were mainly at work.
[3] All questions were asked in Spanish.

3. THE ROLE OF INCIDENTAL FACTORS

Prior studies have specifically and directly investigated factors that we classify as incidental. Of particular importance are the possible impacts of the timing of mood questions which can be classified as being due to the time-of-day (diurnal), day-of-the-week, or seasonal. However, since our data does not contain sufficient samples of seasonal observations, we exclude the latter from consideration.[4]

Diurnal effects. Investigators have considered the existence of mood cycles for several types of mood (not just positive and negative) using a variety of different methods from simple rating methods to ESM to the more comprehensive Daily Reconstruction Method (DRM) pioneered by Kahneman et al. (2004).

A priori, this is not a simple area of investigation in that "natural" biological cycles might well be masked by factors such as the social organization of the day as well as specific events (cf., Clark & Watson, 1988). Thus, in an especially interesting study where a heterogeneous sample of 18 adults were kept in isolation over five days, Monk, Fookson, Moline, and Pollak (1985) measured several moods and activities at frequent intervals. Their measures of "happy" (or positive mood) and overall "wellbeing" showed inverted-U patterns with the maxima being achieved some 4.1 hours after waking. "Sad" (or negative mood) had no temporal pattern.

Wood and Magnello (1992) had several different groups of respondents (students and non-students) assess moods and energy levels at different points in the day. Their conclusions were, in brief, that positive mood had a diurnal effect but negative mood did

[4] Seasonal effects of weather on moods and behavior have been documented (see, e.g., Smith, 1979; Harmatz, Well, Overtree, Kawamura, Rosal, & Ockene, 2000).

not. Second, moods with cycles reached their peaks between 10 a.m. and noon, and although energy levels dipped after lunch, they rose late at night for students. Third, they speculated that whereas positive moods might have a biological component, negative moods might reflect environmental factors to a greater extent. In a related study of chronic fatigue syndrome patients and a control group, Wood, Magnello, and Sharpe (1992) again found that diurnal patterns of energy were highly correlated with positive mood and reached their peaks between 10 a.m. and noon but measures of negative affect showed no diurnal pattern.

Further evidence for the inverted-U shaped curve across the day for positive affect – and yet no relation for negative affect – can be found in several other studies (Thayer, 1987; Clark, Watson, & Leeka, 1989; Watson, Wiese, Vaidya, & Tellegen, 1999; Murray, Allen, & Trinder, 2002; Peeters, Berkhof, Delespaul, Rottenberg, & Nicolson, 2006).

Stone, Smyth, Pickering, and Schwartz (1996) made a detailed study of the moods experienced by 94 employees of a large insurance company in New York. They collected data every 15 minutes over the course of most of one day using a diary method. They found that moods were quite influenced by specific activities or location that were correlated with times in the day (such as commuting in early morning/late afternoon or lunch at noon), but that nonetheless other diurnal cycles were not dependent on such factors (in particular, “rushed,” “ sad,” and “tired”).

Stone et al. (2006) analyzed a large dataset involving responses by 909 working women in Texas using the DRM (Kahneman et al., 2004). They were able to tabulate changes in twelve moods (assessed by adjectives) across one working day and noted several distinctive diurnal patterns. There were peaks for positive emotions at noon and in the evening and peaks for negative emotions in mid-morning and mid-afternoon. Other moods had V and inverted-U shaped patterns ("tired" and "competent," respectively). The advantage of the methodology used by Stone et al. (2006) was its ability to capture a large amount of relevant data. However, this was limited to the activities of a single day and thus, by itself, could not capture variation in factors such as the weather. Nonetheless, as the authors themselves state:

> With regard to the diurnal cycles observed in this sample of Texas women, not only were several findings based on smaller scale studies replicated, we detected diurnal rhythms that to our knowledge have not previously been reported. A consistent and strong bimodal pattern was found for positive and negative emotions. For the three positive adjectives, emotion levels during the work day had a peak at noon and a second peak starting at about 7 p.m. and the higher level lasted the rest of the evening. Conversely, peaks for the six negative adjectives were at about 10 a.m. and then at 4 or 5 p.m., although this pattern was relatively weak for some of the adjectives. One interpretation of this bipolarity is that the elevation of negative emotions was due to work and that lunchtime provided a respite from the demands of the work environment, reducing negative emotions (and increasing positive emotions)…. (Stone et al., 2006, p. 145).

Finally, we note an interesting implication of diurnal mood fluctuations on behavior. Kramer (2001) found that stock returns (resulting from trading) tend to be higher in the morning than in the afternoon, a finding she attributed to people suffering more from depression earlier rather than later in the day, i.e., negative mood is less in the afternoon than in the morning.

Day-of-the-week effects. Most people are familiar with feelings of "blue Mondays" and "happy Fridays" (TGIF) as markers of starting and ending the work week. However, what evidence exists to support these notions?

Rossi and Rossi (1977) reported a study of daily moods of university students over a 40-day period. Using a measure of the ratio of the endorsements of positive to negative mood adjectives, they found an increasing trend in mood from Monday through Friday with a stronger slope for men (n=15) than women (n=67). They explain this gender effect by noting that women's daily moods are confounded by effects of menstrual cycles that do not match days of the week. However, they also show that there are day-of-the-week effects for women controlling for effects of menstrual cycles.

In a further study involving undergraduate students (39 females and 35 males) who completed mood reports for 84 consecutive days, Larsen and Kasimatis (1990) found a strong weekly pattern of data similar to that of Rossi and Rossi (1977). Moreover, they detected a systematic personality difference in that extraverts exhibited more variability in daily moods than introverts.

Replication of these effects with larger and more representative samples has, however, not proven successful. For example, Stone, Hedges, Neale, and Satin (1985) carried out several studies with substantial samples of married men. Their findings can be summarized by stating that although their respondents believed that Mondays were "blue" and Fridays "happy," this was not the case when mood was actually measured on those days. (At week-ends, however, positive mood was generally higher and negative mood lower.) In a diary study involving 166 married couples over six weeks, Bolger, De Longis, Kessler, and Schilling (1989) found no day-of-the-week effects. However, from their study one might also infer that these could be perturbed by other more impactful events.

Weather conditions. Most people have an intuitive feeling that mood levels vary with weather. However, both mood and weather conditions can be classified on several dimensions and the empirical research does not present a clear picture.

Several studies clearly show effects of weather on human actions where it is assumed that mood, as a reaction to changes in weather, affects behavior. For example, Hirshleifer and Shumway (2003) showed that the amount of sunshine is significantly correlated (positively) with stock returns. Moreover they documented this effect across 26 countries (national exchanges) from 1982 to 1997 thereby providing support for an earlier study by Saunders (1993) in the US (see also Trombley, 1997).[5] Further evidence has been provided by Rind (1996) and Rind and Strohmetz, (2001) who documented how beliefs concerning good weather increased tips given in restaurants. Finally, Simonsohn (2007) reported that university admissions officers change the weights of their selection criteria according to weather patterns. In the presence of cloud cover (i.e., lack of direct sunshine), academic attributes of candidates are weighted more heavily.

There is, however, some evidence that sunshine has a direct affect on mood (broadly defined). High levels of sunlight have been seen to increase self-reports of happiness (Schwartz & Clore, 1983) and other similar effects on mood have been reported by Cunningham (1979) and Parrott and Sabini (1990). On the other hand, when Schkade and Kahneman (1998) investigated life satisfaction in large samples of students in two regions in the US that differ in desirable weather (the Midwest and Southern California), they found no differences. But, when respondents were asked to rate life satisfaction of a similar other in the other region, Midwesterners gave higher ratings to Californians than themselves, a difference that Schkade and Kahneman (1998) referred to as a focusing illusion.

Studies conducted some time ago had relatively few observations (participants and times of measurement) but produced some interesting results. Thus, K. M. Goldstein (1972)

[5] Unfortunately, Hirshleifer and Shumway (2002) point out that trading using a sunshine strategy would not be profitable because it would require so many trades that the transaction costs of trading would not be compensated by the expected benefits.

reported that better mood was associated with high barometric pressure on some measures but low on others. In addition, his results suggested that gender and being an external (on Rotter's 1966 IE scale) might mediate reactions between mood and weather. Looking at these results a decade later, Sanders and Brizzolara (1982) conducted a study using a larger sample and came to the overall conclusion that the effect of weather on mood is most marked by levels of humidity (better moods beings associated with low humidity). This result was replicated by Howarth and Hoffman (1984) who conducted a study relating measures of ten mood variables to eight weather variables collected from 24 male respondents over eleven days. Humidity, temperature, and hours of sunshine were found to have the greatest effects on mood. However, humidity was the most significant "predictor" (in a regression and canonical correlation analysis).

Recently, Denissen, Butalid, Penke, and van Aken (2008) conducted a comprehensive online diary study (N=1,233) that examined possible effects of six weather parameters (temperature, wind power, sunlight, precipitation, air pressure, and photoperiod) on three measures of mood (positive affect, negative affect, and tiredness). Using multilevel analysis they found no significant effects of daily weather on positive affect. There were main effects of temperature, wind power and sunlight on negative affect, and sunlight also affected tiredness. However, overall weather fluctuations accounted for very little variance in people's day-to-day mood. Interestingly, through their multilevel analysis Denissen et al. (2008) reported individual effects but these could not be explained by either personality (the Five Factor model) or gender.

In a study by Keller, Fredrickson, Ybarra, Côté, Johnson, Mikels, Conway, and Wager (2005), no relation was found between weather and mood at different times of the year except that pleasant weather (high temperature or barometric pressure) was related to higher mood during the spring as time spent outdoors increased. In short, these investigators posit a post-winter contrast effect due to time spent outdoors in more pleasant conditions.

At one level, it might seem surprising that the literature does not demonstrate “simpler” effects of weather on mood. However, as noted, both weather and mood are multidimensional and, in addition to the fact that the studies reviewed used a variety of different methodologies, there is also the fact the sampling of weather took place at different moments in the year and in different geographical locations. Also, people who have experienced different weather conditions across their lives might well react in different ways. Clearly, future research will need to control for all these kinds of factors and the work to date can only be suggestive.

Non-incidental factors. As noted above, the second and third questions asked our respondents what they were doing when asked to assess their mood. Thus, we can also investigate to what extent current activities impact mood. Three types of variables are of interest: (1) the kind of tasks participants were performing (recall they were part-time students questioned mainly while at work); (2) whether participants were doing something that was effectively personal or professional in nature. The literature, for example, shows that people involved in “desirable” events exhibit better moods than those who are not so involved (David, Green, Martin, & Suls, 1997); and (3) whether they were doing something on their own or in the company of one or more others (the latter has been shown to be associated with better moods, Clark & Watson, 1988).

4. RESULTS

Response rates

From the 5,040 (= 168 x 10 x 3) messages sent, 5,022 were received (99.6%). For various reasons, people might not receive text messages when they are sent (e.g., cell telephones may have been turned off). We therefore checked the extent to which messages were received when they were sent. For phase 1, participants reported receiving messages between zero and 22 minutes after they were sent with an overall mean (median) of 3 (2) minutes. For phase 2, the range was between zero and ten minutes after reception (overall mean of one minute). We deem both response rates and reported times of receiving messages satisfactory.

An overview

The design of our study involved data that can be thought of as being collected at two levels. One of these levels – termed level 1 – is represented by participants' responses to the 30 occasions on which they received text messages (i.e., at the level of occasions). The other – level 2 – is at that of the participants themselves (i.e., characteristics of the participants that do not change across the 30 occasions). Thus, for example, it is of interest to know whether, say, mood at the moment judgments are elicited (question 1) is associated with what participants were doing (question 2) – i.e., at level 1 – and also whether such judgments reflect differences between the participants in, say, gender – i.e., at level 2. As such, our data can be efficiently modeled using the techniques of hierarchical linear models (Byrk & Raudenbush, 2002; H. Goldstein, 1995; Longford, 1993).

(Insert Table 1 about here)

Table 1 presents the outcomes of the analysis of such a hierarchical model and provides an overview of our findings. In fact, we show six models to demonstrate the additional effects of different classes of variables.

Model 1 simply estimates the overall mean of mood without accounting for any other factors and the residual variance at level 2 and at level 1 (between and within individuals, respectively). The estimate for overall mood is 6.76 on a scale of from 1 ("very negative") to 10 ("very positive"). The intraclass correlation is 0.20, meaning that 20% of the total variance in mood is accounted for by individual differences. Model 2 shows a statistically significant and fairly large increase in mood (0.46 points) of being involved in personal as opposed to professional activities. In Model 3, significant effects of different types of activities, and the extent to which they involve interaction with other people, are estimated. Model 4 introduces diurnal effects. Model 5 adds those due to the days of the week, and Model 6 captures the effects due to weather.

It is important to emphasize that Table 1 provides an overview of all of our data and that all the models have been estimated assuming fixed effects. We have also estimated models assuming random effects and, in our discussion of results for each class of variables below, we comment on implications of different ways of analyzing the data.

Level-2/personal variables

There are two kinds of level-2 variables: methodological and personal. For the former, we recall that the study was conducted in two phases and, within phases, participants answered questions either mainly in the morning or in the afternoon. As shown in Table 1, the dummy variable for phase 2 is not significant thereby implying that it is reasonable to aggregate the data from both phases for analysis. Nor is there a main effect for responding in the morning or the afternoon but this distinction does interact with level 1 variables as we will explain further below.

No effects for gender are shown in Table 1 because there were none. As to possible effects of personality, we did have measures of Rotter's (1966) IE scale ("Locus of Control") for the 74 participants in phase 1. Interestingly, whereas the correlation between IE scores and mean mood was not statistically significant ($r = -0.16$), the correlation between IE scores and the standard deviation of mood was ($r= 0.34$, $p = .003$), and especially for women ($r = 0.42$, $p = .004$). The interpretation is that variability in expressions of mood is associated with more externally-oriented personalities (and particularly for women). It is not clear how this squares with previous work on locus of control (see, e.g., Blair et al., 1999; Klonowicz, 2001) but it is suggestive of some systematic effects.

Table A1 in the Appendix shows the effect of including IE scores in a Model 6 analysis limited to phase 1 data. IE score has no main effect at level 2 but does interact with weather (sunshine hours). Increased sunshine has a greater positive effect on the mood of our more internally-oriented participants. We are unsure of the meaning of this interaction. However, since IE score and the standard deviation of mood are correlated in the phase 1 data, we created a proxy personality measure of variability in mood by using the standard deviation of each participant's mood measures. We included this as a level 2 variable in a re-analysis of Model 6. Although one might legitimately question this statistical manipulation, the result – shown on the right hand side of Table A1 in the Appendix – is that the standard deviation of mood has a significant negative relation with mood at level 2 (coefficient = -0.61, t = -4.68, p< .001). In other words, variability in expressions of mood is associated with lower levels of the same variable (cf., Beal & Ghandour, 2010). Finally, there is also a significant interaction concerning the positive effects of Fridays that are disproportionately greater if people exhibit less variability in mood. We have no explanation for this interaction.

Activity effects

In our study, activities were reported by respondents in their own words in response to the second question they received (i.e., after reporting mood). We classified these data as follows. First, for data from phase 1 we established definitions of categories for the activities. Then, two researchers independently allocated responses to categories (Kappa = 0.65). Disagreements between the two coders were resolved by having them discuss until they reached consensus. Second, for data from phase 2, two coders were trained in the use of the categories employed in phase 1. Then, they independently allocated responses to categories and discussed disagreements with a third person (overall Kappa = 0.95). As a third step, all the data for professional activities (phases 1 and 2) were submitted to an additional analysis to determine more specific categories.

As will be no surprise to those familiar with the literature, our data show variation in mood by the activities in which respondents were engaged (cf., Kahneman et al., 2004). First, as shown by Model 2, being involved in personal as opposed to professional activities has a positive impact (cf., David et al., 1997). Furthermore, several activities have significant coefficients in Model 3 of Table 1 – in particular “Eating and drinking,” “Entertainment,” and “Personal care/rest/sleep” – that are over and above the effect of the dummy variable for "personal/professional."[6] In addition, there is a strong effect (0.81) for interacting with family/friends (see also Clark & Watson, 1988). Further insight is provided by Figure 1 that shows 95% confidence intervals of mean z-scores for mood broken down by the categories of activities that we established and highlights the distinction between personal and professional types of activity.[7] These show that, relative to each respondent's average mood state, professional activities were generally associated with negative (i.e., below average) mood whereas most personal activities were (with a couple of exceptions) above average.

(Figures 1 through 3 about here)

A more detailed analysis of the Table 1 data broken down by whether participants were working mornings or afternoons reveals an interaction with type of activity (not shown in Table 1). Specifically, whereas the pattern of significant effects for different activities for afternoon workers is the same as the whole sample, this is not true of morning workers. For the latter, the coefficients for "Eating and Drinking" and "Entertainment" are not statistically significant nor are the coefficients for interacting with "family/friends" and "children". On the other hand, the coefficient for "Personal care/rest/sleep" is significant (-0.64, $p < .001$).[8] A plausible interpretation of these results lies in the fact that the nature of activities differed for participants in the morning and afternoon groups.

[6] The reference category used as a base for coding the dummy variables for different activities was "Housework, personal time organization, and managing funds."

[7] We calculated z-scores for each individual respondent such that the mean of each person's mood judgments is 0 with a standard deviation of 1. This allows us to categorize all observations/occasions as being positive or negative, i.e., whether they are above or below each individual's mean mood score.

[8] These results are robust to analyses assuming fixed or random coefficients.

Diurnal effects

Model 4 of Table 1 shows effects of time of day on mood relative to the period between 8 and 10:20 am. As can be seen, there are significant effects above this base level between 10:21 to 12:40 and 12.41 to 15:00. Thereafter, there is a significant effect at the end of the day, i.e., from 19:41 and after. This pattern is illustrated in Figure 2 that shows 95% confidence intervals for mood at different times of the day. As noted, mood starts low in the morning, rises to the period between 12:41 to 15:00, and then falls sharply in the afternoon before rising again in the evening.

Although this figure shows variations across the day, it is important to recall that the data are comprised of morning and afternoon groups such that the three earlier estimates are based predominantly on the morning group and the three later estimates on the afternoon group. Nonetheless, the pattern of data is remarkably similar to results reported by other researchers – for positive but not negative mood. (Reports of negative mood are that it is almost "flat" or "unpredictable" across the day.) Several studies discussed in our review of the literature provide evidence of a similar inverted-U pattern prior to the evening when there is a late upturn (see, e.g., Monk et al., 1985; Wood & Magnello, 1992; Wood et al., 1992; Peeters et al., 2006; Stone et al., 2006). One difference with our data, however, is that the mid-day peak appears later than in the other, mainly US, studies. There is a plausible cultural explanation. Whereas lunch usually starts at around 12 noon in the US, it is much later in Spain, starting at 2 or even 3 pm. This external event appears then to displace the diurnal pattern.

In short, we find a diurnal pattern in our data that is consistent with data from other studies involving positive mood as well as energy levels. This suggests that our single mood measure taps into either positive mood or the ratio of positive to negative mood (since negative mood has been found to be flat across the day).

Day-of-the-week effects

Model 5 of Table 1 shows one day-of-the-week effect – a higher level of mood on Fridays. This is also presented graphically in Figure 3. As noted in our review of literature, when one excludes week-ends, effects for day-of-the-week are not a consistent finding although our data do support the findings by Rossi and Rossi (1977) for a Friday effect in a student population. Comparing the morning and afternoon groups, the patterns of day-of-the-week effects are remarkably similar except that the Friday effect was marginally greater for the morning group as compared with the afternoon group (not shown in Figure 3).

Weather conditions

We examined meteorological conditions for the dates when our data were collected and identified 10 different measures.[9] Of these, only one variable – daily sunshine (total number of hours) – was statistically significant as shown by Model 6 of Table 1 ($t = 2.13$, $p < .05$). However, when the same coefficient is estimated with robust standard errors, its significance can be questioned ($t = 1.56$, $p = .12$). More importantly, whether statistically significant or not, the effect is quite small.

[9] These included: daily average temperature (ºC); precipitation (liter per square meter); rain (dummy variable, 1:yes; 0:not); daily sunshine (total number of hours); relative daily sunshine (percentage out of expected total hours); degree of cloudy at 7am (scale from 0 to 8); degree of cloudy at 1pm (scale from 0 to 8); daily solar radiation (watts per square meter); daily average of relative humidity (%); and daily average of barometric pressure(in hectoPascals, hPa). The data were obtained from the Servei Meteorològic de Catalunya , Xarxa d'Estacions Meteorològiques Automàtiques (XEMA) del Vallès Occidental and Observatori Fabra (Barcelona).

Overall then, our data do not show effects of variation in weather on mood. This therefore adds to the confusion on this topic in the literature. One explanation for the lack of effects in our data could be the nature of the generally pleasant Mediterranean climate enjoyed in the Barcelona area. Although the data collection took place in different months, February, May, and October, the latter two months are typically characterized by comfortable weather and February is rarely very cold. If data collection had also taken place in July and August, it is possible that discomfort from humidity could have been a factor as reported in other studies (Sanders & Brizzolara, 1982; Howarth & Hoffman, 1984).

5. USING A SINGLE MEASURE OF MOOD

For a recent investigation of mood, our study is unusual in its use of a single measure. This therefore calls for some justification. We present four arguments.

First, recall that we elicited self-reported mood in an ESM study where, to avoid reactivity, we limited the number of questions (Hektner et al., 2007). The fact that only a first, single question was used to elicit mood argues in its favor for dealing with one of the more troubling issues in emotion research, namely, the need to synchronize the timing and context of participants' responses (Larsen & Fredrickson, 1999).

Second, we can ask whether the results we obtained with the measure have face validity or, more precisely, what Hektner et al. (2007) refer to as *situational validity*. In other words, are participants' reports of mood coherent with other more "objective" findings and data in the study? The answer is undoubtedly "Yes." Consider, for example, the findings reported above about better moods being associated with personal as opposed to professional activities as well as the diurnal and day-of-the-week effects.

Our third argument is that we do, in fact, have some data for phase 2 of the study that could be considered complementary to mood. Specifically, after completing the three questions defined above (see Procedure), participants in this second phase were also required to report feelings of their emotional states using the method of self-assessment manikins (SAMs, Bradley & Lang, 1994). The SAMs represent visually three basic dimensions of emotions in reactions to events or situations. These are (a) valence (or pleasure), (b) arousal, and (c) dominance. Each emotion is captured by five "cartoon" impressions, going from one extreme to the other. For example, valence is shown in the form of five different figures (mainly faces) going from happy smiling to unhappy. For each of the three emotions, participants simply checked the figure—or between adjacent figures—that corresponded most to their feelings (thereby implicitly using nine-point scales). Conceptually, one would expect valence to have some relation with our measure of mood given that it taps into an intuitive sense of happiness. On the other hand, no relation would be expected between mood and arousal although there might be a relation with dominance (better mood being associated with more control).

(Insert Table 2 about here)

Table 2 reports correlations between our mood measure and the SAMs – both between individuals (A) and within individuals (B). First note that there are appropriate and significant correlations between mood and valence (happier valence being associated with more positive mood). There is no significant relation between mood and arousal; and there is a positive relation between mood and dominance (better mood, more dominance). However, note that dominance and valence are also correlated in these data.

We realize, of course, that mood at a particular point in time is not the same thing as emotional reactions to a situation. However, to the extent that these are simultaneous expressions of affective states, we would expect coherence among different measures of mood and emotions. Thus, the pattern of correlations in Table 2 supports the notion that our mood measure has an appropriate level of reliability as well as demonstrating convergent and discriminant validity.

Finally, our fourth point relates to a question the participants of phase 1 answered in their post-experimental session. This was to assess their "emotional state over the last two weeks" using the same 1 to 10 scale ("very negative" to "very positive") as in the main study. Whereas people's memories of their past average mood states might be biased, significant correlations between the stated average and estimates of actual experience would provide further evidence of reliability of the mood scale. In fact, this correlation, i.e., between estimates of average mood over the two preceding weeks (the means of 30 judgments per individual) and participants' remembered estimates, is 0.69 ($n = 74$, $p < .001$).

Parenthetically, this empirical result also speaks to the literature on the so-called "peak-end" rule where it has been found that memory of the experience of sequential events is better modeled by averaging the "peak" (i.e., most extreme) and "end" (i.e., last) stimulus as opposed to the average of *all* stimuli experienced (see, e.g., Fredrickson & Kahneman, 1993). However, when we calculated the corresponding peak-end rule for our data, the correlation with recalled experience was lower than for the mean (i.e., 0.35 vs. 0.69). There are alternative explanations. One is that, for whatever reason, the peak-end rule result does not apply to our data (see also, Kemp, Burt, & Furneaux, 2008). The second is that whereas taking the mean of 30 randomly selected moments of experience provides an unbiased estimate of average mood state, estimating the peak-end rule from our available data might be biased. This is because there is no guarantee that the sequence of stimuli sampled actually includes the most extreme experience (mood state) during the relevant period or, indeed, the most recent mood state. Finally, we take heart from analytical results of Cojuharenco and Ryvkin (2008) who showed that, under many conditions, peak-end and average experience are quite highly correlated.

6. DISCUSSION

We used the experience sampling method to investigate assessments of mood made during working hours by 168 part-time students on a simple bipolar scale – from 1 (very negative) to 10 (very positive) – on 30 different occasions across a period of 10 working days. We considered three classes of explanatory variables: types of activities; individual differences; and incidental variables related to the times that measurements took place.

Participants also reported what they were doing on the occasions mood was assessed and we used these self-report data to classify their activities. There was a strong effect if the participants considered that their activities were personal as opposed to professional in nature (personal activities being rated on average almost one-half point higher on the mood scale). Moreover, if personal activities involved eating and drinking, entertainment, or interaction with friends and family, assessments were even higher. These effects are similar to other studies that have looked at everyday activities (e.g., Clark &

Watson, 1988; Kahneman et al., 2004).[10] We also analyzed our data to look for possible effects in the types of part-time work being done by our participants but, with the exception of a small positive effect for those involved in professional childcare (i.e., babysitting), we found no differences. A disadvantage of our methodology, of course, is that is ill-suited to capturing possible systematic effects of unusual events or activities that occurred rarely.

With the exception of gender, our participants were quite homogeneous with respect to age and other demographic characteristics typical of a part-time student population. As such, one would not expect to find many effects due to individual differences. Moreover, except for Rotter's (1966) IE ("locus of control") scores for 74 of the 168 participants, we had no measures of personality. Nonetheless, two points were highlighted by our analysis. First, there were no main effects for gender or even interactions involving gender. Second, whereas IE scores did not correlate with mood, they did correlate with variability in mood with more externally oriented participants having larger standard deviations of mood scores. Building on this finding, we used standard deviations of mood as a proxy measure of individual difference (i.e., for variability in mood) and identified an inverse relation between levels of mood and variability across our whole sample. Whereas only suggestive, this result highlights the potential importance of individual variability (Beal & Ghandour, 2010).

We investigated three types of incidental variables: diurnal, day-of-the-week, and weather. Moreover, an important advantage or our methodology was that we could estimate the potential effects of all from the same data. Our results are largely consistent with findings in the literature.

[10] We do not consider that the types of part-time work in which our respondents were engaged would have allowed for the type of "flow" experiences described by Csikszentmihayli (1990).

First, the diurnal pattern of our data suggests an inverted-U shape from morning until the early evening followed by a rise in the later evening – see Figure 2. Such patterns have also been observed in other studies that have examined feelings of positive mood (e.g., Stone et al., 2006). Moreover, since negative mood appears to be unrelated to time across the day, the argument can be made that total mood (as either the sum or ratio of positive and negative mood) should also follow pattern that we observed. Finally, we note that some studies have identified diurnal mood levels (and energy) to differ by age of participants with older people starting high (in the morning) and ending low at night and younger people having the reverse pattern (see, e.g., Wood & Magnello, 1992). The pattern of data of our young, part-time student population clearly followed that of younger people.

Second, we identified a Friday effect – see Figure 3. As pointed out above, this is both consistent (Rossi & Rossi, 1977) and inconsistent (Stone et al., 1985) with previous findings of day-of-the-week effects.

Third, we essentially found little or no effects due to the weather. This is consistent with recent findings concerning positive affect in the extensive, recent study by Denissen et al., 2008). However, we are acutely aware that our sample of Mediterranean weather may not have provided sufficient variation for effects to have been observed. Specifically, our review of the literature suggested two variables that might be particularly relevant to mood changes, namely; hours of sunshine, and humidity.[11] We are intrigued by the possibility that weather-related mood changes might interact with individual differences in a way that needs to be specified in future research (cf., K. Goldstein, 1972).

[11] In fact, our data suggest a small, "questionable" effect due to hours of sunshine.

Finally, whereas our analyses did identify some statistically reliable effects of incidental variables on assessments of mood, it is important to emphasize that the effects we found were not large in the sense that their incorporation would make much difference in a predictive model. Often such a statement might be considered the “death knell” of a scientific investigation. However, we do not believe that to be the case here. As stated at the beginning of this paper, not only is it important to establish that effects exist (to confront theories and intuitions), but sizes of effect are also important from a practical perspective. For example, from the viewpoint of research on subjective well-being, it is essential to establish the boundary conditions under which assessments of happiness are and are not subject to systematic influences. Thus it is important to know that the main effects of incidental effects are small. Whether their interactions with other variables – and especially individual differences – are small provides another and open set of questions for future research.

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Table 1: Reported mood, activities, and incidental variables

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	RANOVA for mood		Type of activity		Different activities		Time of day		Day of the week		Weather	
Fixed effects	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Level 2 variables												
Intercept	**6.76**	68.97	**6.48**	62.74	**6.47**	62,22	**6.19**	41.80	**6.13**	39.36	**6.10**	35.45
Phase 2	-0.11	-0.84	-0.16	-1.18	-0.21	-1.62	-0.23	-1.68	-0.23	-1.63	-0.12	-0.80
Level 1 variables												
Personal (personal=1, professional=0)			**0.46**	9.10	**0.33**	5.61	**0.31**	5.18	**0.32**	5.33	**0.32**	5.16
Eating and drinking					**0.34**	4.41	**0.33**	4.32	**0.32**	4.15	**0.34**	4.26
Entertainment					**0.31**	3.72	**0.30**	3.61	**0.31**	3.70	**0.30**	3.54
Personal care/rest/sleep					<u>-0.17</u>	-1.97	-0.12	-1.32	-0.13	-1.49	-0.11	-1.20
Interacting with												
Family/friends					**0.81**	9.15	**0.79**	9.00	**0.76**	8.65	**0.76**	8.53
Children (professional)					<u>0.36</u>	2.57	<u>0.35</u>	2.45	<u>0.36</u>	2.53	<u>0.34</u>	2.35
Time of the day (ref. 8:00-10:20)												
10:21-12:40							<u>0.30</u>	2.75	<u>0.31</u>	2.80	<u>0.26</u>	2.32
12:41-15:00							**0.40**	3.70	**0.44**	3.99	<u>0.35</u>	3.02
15:01-17:20							0.25	1.61	0.28	1.75	0.08	0.50
17:21-19:40							0.30	1.87	0.29	1.78	0.09	0.53
19:41 and after							<u>0.38</u>	2.39	<u>0.36</u>	2.28	0.18	1.07
Day of the week (ref. Monday)												
Tuesday									-0.00	-0.02	-0.02	-0.34
Wednesday									-0.08	-1.13	-0.08	-1.07
Thursday									0.09	1.30	0.04	0.51
Friday									**0.28**	3.95	**0.25**	3.42
Weather (Sunshine hours)											<u>0.02</u>	2.13
Random effects												
Level 2 (individuals)												
Intercept variance	**0.633**		**0.641**		**0.646**		**0.649**		**0.649**		**0.670**	
Level 1 (occasions) variance	**2.458**		**2.417**		**2.351**		**2.344**		**2.330**		**2.344**	

Note: Coefficients/variance components significant at p<.001 are in **bold**, significant at p <.05 are <u>underlined</u> using t-tests or chi^2 as appropriate.

Table 2. Correlations of mood with SAM measures

A. Correlations between individuals (n=94)

		Valence[1]	Arousal[2]	Dominance[3]	Mood[4]
SAMs:	Valence	1.00			
	Arousal	0.07	1.00		
	Dominance	-0.21	0.32	1.00	
Mood		**-0.66**	-0.03	**0.41**	1.00

B. Correlations within individuals ($n \geq 2{,}779$)

		Valence[1]	Arousal[2]	Dominance[3]	Mood[4]
SAMs:	Valence	1.00			
	Arousal	0.07	1.00		
	Dominance	**-0.37**	0.01	1.00	
Mood		**-0.57**	-0.11	**0.33**	1.00

Note: figures in **bold** indicate $p < 0.001$

[1] Scale "happy" (1) left to "unhappy" right (9)
[2] Scale: "aroused" (1) left to "quiet" (9) right
[3] Scale: "lack of control" (1) left to "dominating" (9) right
[4] Scale: "very negative" (1) to "very positive" (10).

Figure 1. Mood as a function of personal and professional activities

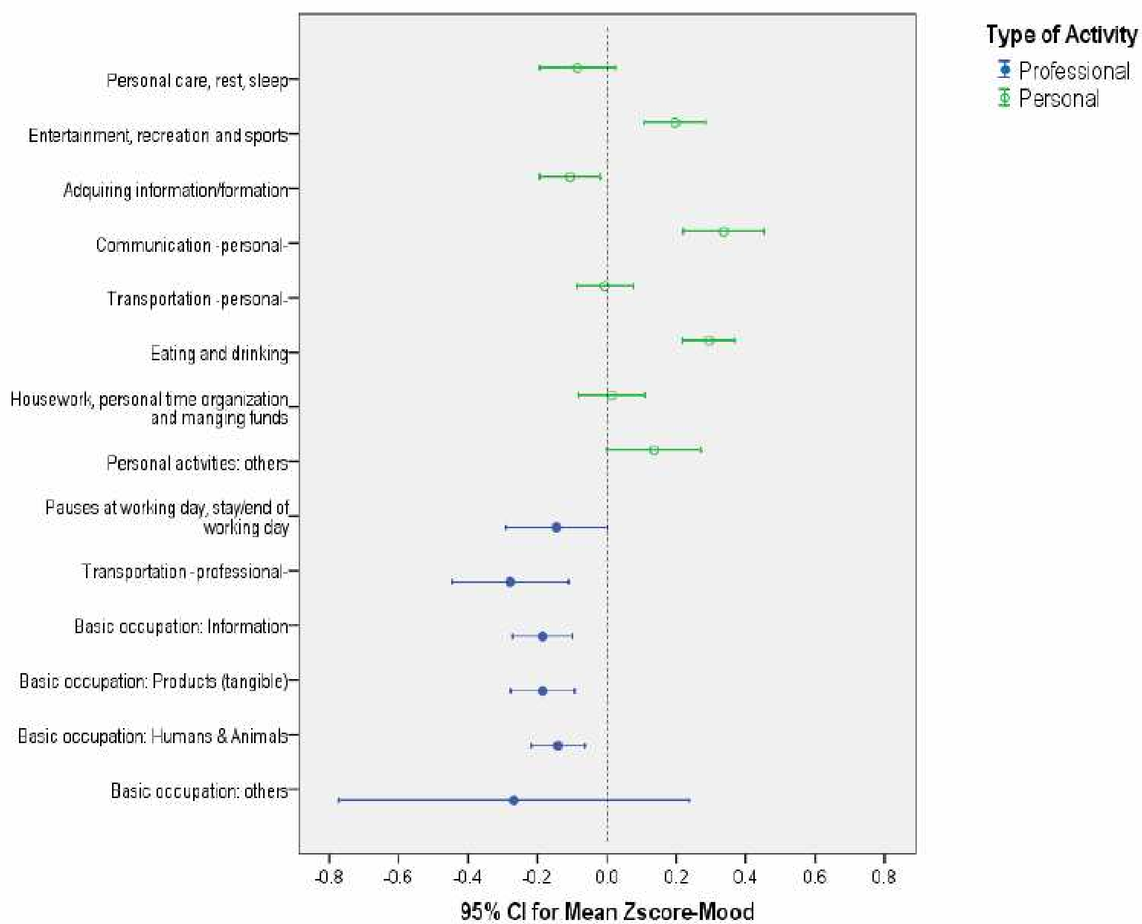


Figure 2. Diurnal effects – mood as function of time of day

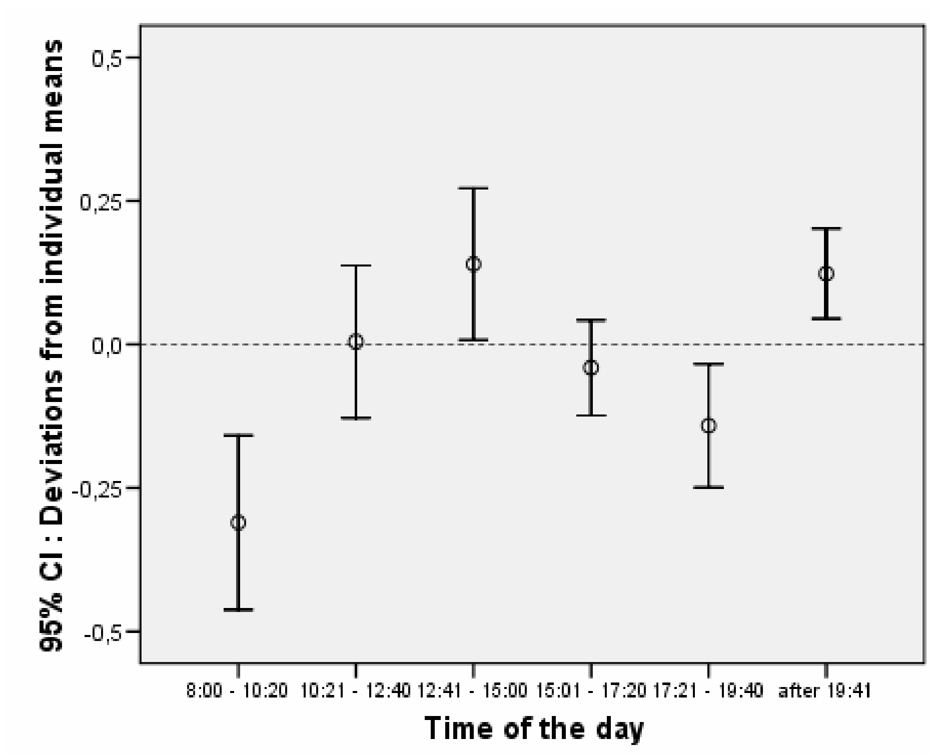
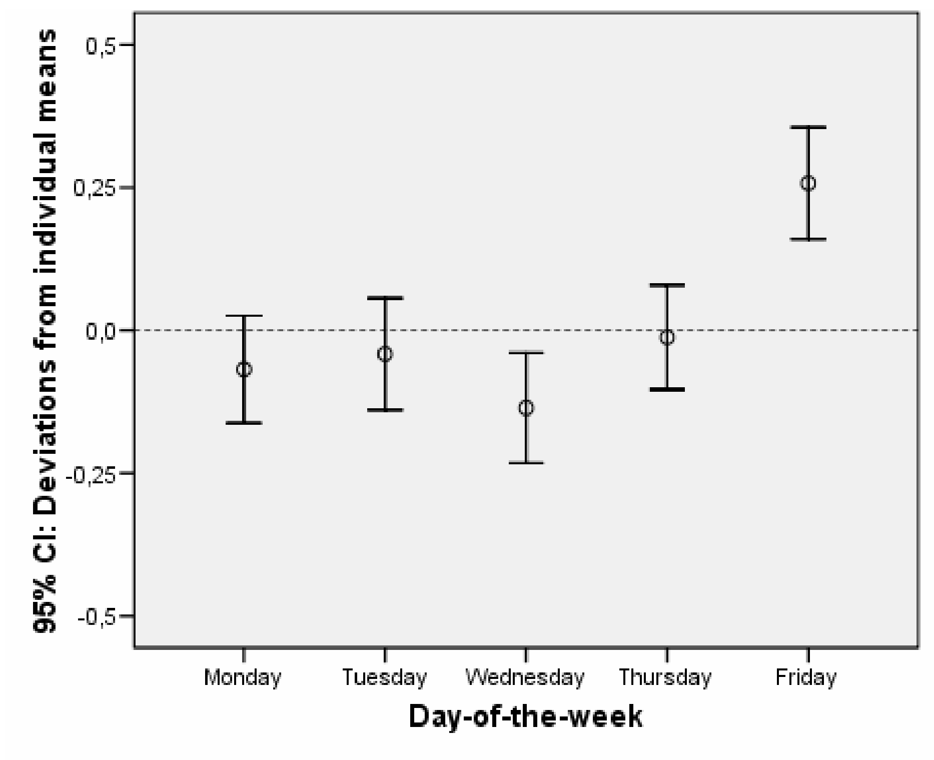


Figure 3. Day of the week – mood as a function of day-of-the-week



APPENDIX

Table A1: Additional analyses

Dependent variable:	Mood (only phase 1)		Mood (all data)	
Fixed effects	Coefficient	t-ratio	Coefficient	t-ratio
Level 2 variables				
Intercept	**5.68**	12.73	**6.98**	27.82
IE Control	0.03	0.83	x	
Phase 2	x		-0.13	-0.98
Mood standard deviation (SD)	x		**-0.61**	-4.68
Level 1 variables				
Personal (personal=1, professional=0)	**0.38**	4.04	**0.32**	5.20
Eating and drinking	0.17	1.31	**0.35**	4.41
Entertainment	0.14	1.07	**0.30**	3.57
Personal care/rest/sleep	-0.22	-1.46	-0.11	-1.24
Interacting with				
Family/friends	0.54	2.68	**0.77**	8.62
Children (professional)	0.25	0.89	0.33	2.32
Time of the day (ref. 8:00-10:20)				
10:21-12:40	0.21	1.46	0.27	2.32
12:41-15:00	0.33	2.24	0.35	3.04
15:01-17:20	0.19	0.90	0.14	0.85
17:21-19:40	0.15	0.66	0.15	0.88
19:41 and after	0.24	1.09	0.24	1.47
Day of the week (ref. Monday)				
Tuesday	-0.04	-0.38	-0.03	-0.36
Wednesday	-0.09	-0.79	-0.08	-1.06
Thursday	-0.08	-0.61	0.04	0.50
Friday	0.13	1.03	**0.80**	4.21
Interaction: Friday x Mood SD	x		-0.37	-3.12
Weather (Sunshine hours)	**0.14**	4.16	0.02	2.19
Interaction: Sunshine x IE Control	**-0.01**	-3.45	x	
Random effects				
Level 2 (individuals)				
Intercept variance	**0.727**		**0.551**	
Level 1 (occasions) variance	**2.396**		**2.331**	

Note: Coefficients/variance components significant at p<.001 are in **bold**, significant at p <.05 are underlined using t-tests or chi^2 as appropriate.