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The relation between valence and arousal in subjective experience varies with personality and culture

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Abstract

Objective: While in general arousal increases with positive or negative valence (a so-called V-shape relation), there are large differences among individuals in how these two fundamental dimensions of affect are related in people's experience. In two studies, we examined two possible sources of this variation: personality and culture.

Method: In Study 1, participants recalled a recent event that was characterised by high or low valence or arousal and reported on their feelings, and reported on their personality in terms of the Five-Factor Model. In Study 2, participants from Canada, China/Hong Kong, Japan, Korea, and Spain reported on their feelings in a thin slice of time and on their personality.

Results: In Study 1, we replicated the V-shape as characterising the relation between valence and arousal, and identified personality correlates of experiencing particular valence-arousal combinations. In Study 2, we documented how the V-shaped relation varied as a function of western versus eastern cultural background and again personality.

Conclusion: The results showed that the steepness of the V-shape relation between valence and arousal increases with extraversion within cultures, and with a west-east distinction between cultures. Implications for the personality-emotion link and research on cultural differences in affect are discussed.

Keywords: valence, arousal, pleasure, activation, structure of affect, structure of emotion, personality, culture

Subjectively experienced affect—how we feel—is a central aspect of the mind, playing a fundamental role in diverse psychological phenomena including perception (Veuillemier, 2005), categorization (Niedenthal, Halberstadt, & Innes-Ker, 1999), decision making (Forgas, 1995), well-being and psychopathology (Watson, 2000). Consequently, understanding how affect is structured in subjective experience is one of the most fundamental and longstanding challenges to the science of psychology (Diener, 1999; Wundt, 1924). To address this challenge, two basic questions need to be answered: What are the fundamental dimensions underlying affect, and how are they interrelated?

Regarding the first question, different answers have been formulated (Fontaine, Scherer, Roesch, & Ellsworth, 2007; Larsen & Diener, 1992; Osgood, May, & Mirron, 1975; Russell, 1980; Thayer, 1989; Watson & Tellegen, 1985), and yet they all converge on identifying valence (pleasure-displeasure or hedonic tone) and arousal (sense of energy or activation) as among the most fundamental properties of subjectively experienced affect (Yik, Russell, & Barrett, 1999). The current study focuses on these two dimensions without assuming valence and arousal are the *only* dimensions of affect.

The second basic question then becomes how valence and arousal are related to each other. Answering this question is important for theoretical (what is the structure of affective experience?), empirical (what is the relation of affect to other psychological phenomena from attention to well-being?), and psychometric reasons (can valence and arousal be measured or manipulated independently?). Several relationships have been suggested, or, more often, assumed, including 1) independence between the two (how pleasant or unpleasant one is feeling conveys no information about how aroused one is feeling and vice versa, e.g., Barrett & Russell, 1999; Carver & Scheier, 1990), 2) a strictly linear relation between valence and arousal (how

pleasant one feels increases (or decreases) how aroused one feels), 3) the equation of arousal with the intensity of positive and of negative valence (the more positive or negative one feels the more aroused one feels—graphically seen as a V-shaped pattern of arousal as a function of valence, e.g., Clore, Ortony, & Foss, 1987; Lang 1994), and 4) an asymmetric V-shaped relationship with a a positivity offset (feelings of arousal are higher at low levels of positive valence as compared to negative valence), and a negativity bias (negative feelings increase more strongly than do positive feelings with increasing arousal) (e.g., Cacioppo & Gardner, 1999). Figure 1 provides a visual depiction of each of these proposed relations.

In addition to the existence of competing proposals, two further limitations preclude us from accepting any such proposal. First, the findings and conclusions from previous research were based exclusively on western samples. Moreover, to our knowledge, no cross-cultural research has addressed these four competing models or indeed the general question of the relation of valence to arousal (e.g., Perunovic, Heller, & Rafaeli, 2007). As a result, we do not know whether any relation found characterizes the structure of affect universally. Second, Kuppens, Tuerlinckx, Russell, and Barrett (2013) observed that these proposals are all aimed at a nomothetic level. Kuppens et al. (2013) demonstrated that a) any relationship between valence and arousal at the nomothetic level accounts for only a small proportion of the total variance, and b) there is sufficient variation at the idiographic (or within-person) level that valence and arousal can in principle show any relationship depending on the person and the situation (e.g., the nomothetic relation accounted for only 1-18% of the total observed variance across studies). In other words, how valence and arousal are related can be markedly different from one individual to another, ranging from V-shaped, to linear, to inverted V-shaped relationships, or even independence. This malleability means that for some individuals, high pleasant and/or unpleasant

affect is habitually experienced in combination with higher levels of arousal, whereas for others it may be experienced with lower levels of arousal, and for some valence and arousal are experienced relatively independently. Large variation at the idiographic level underscores the large malleability of the structure of affect. This variability reflects an important yet understudied source of diversity in subjective emotional experience and thus has important implications for understanding the antecedents and consequences of affective states. For example, idiographic variation in the structure of affect would cast doubt on the existence of a universal neural architecture as the determinant of the relation of valence to arousal. Moreover, idiographic variation in the valence-arousal relation may imply that valence and arousal may not uniformly affect perception, memory, perception, well-being, etc. (for a more elaborate discussion, see Kuppens et al., 2013). Thus, explaining this variation is of critical importance for understanding individual differences in the subjective experience of affect and how affect impacts other phenomena. Furthermore, the existence of reliable and meaningful individual differences in the valence-arousal relationship would be further established by showing that these differences are related to known sources of individual differences in order to explain part of the observed idiographic variation.

The present paper addresses two issues. First, we provide further evidence on the relation between valence and arousal. Our hypothesis is that the relationship is characterized by a weak asymmetric V-shape at the nomothetic level but by large variation at the idiographic level (Kuppens et al., 2013). Second, we aim to contribute to understanding the nature of the idiographic variation by looking into how it correlates with personality (Study 1) and culture (Studies 1 and 2). Indeed, personality is assumed to reflect the most basic individual differences dimensions in how people behave, think, and feel (Larsen & Buss, 2014), and culture is assumed

to have a profound influence on, or is even constituted of, the ways people experience their world emotionally (e.g., Mesquita, De Leersnyder, & Boiger, in press).

Study 1: Personality correlates of variation in the relation between valence and arousal

The large individual differences in the valence-arousal relation raises the important question of the extent to which this idiographic variation is meaningful: Is the variation in the habitual occurrence of particular valence-arousal combinations simply random sampling error, or can it be explained in terms of relationships with well-established, independently defined sources of individual differences? An answer to this question would contribute to building a nomological network around the observed idiographic variation in valence-arousal relations and would highlight the emotional concomitants of important established dimensions of individual differences.

In this study, we examined the associations between idiographic variability in experiencing valence-arousal combinations and individual differences in the personality dimensions defined by the Five Factor Model of Personality (FFM; McCrae & Costa, 1987). A large literature has documented how personality dimensions, particularly extraversion and neuroticism, predict the habitual experience of specific affective states (e.g., DeNeve & Cooper, 1998; Kuppens et al, 2008; Larsen & Ketelaar, 1991; Watson & Clark, 1984; Yik, Russell, Ahn, Fernández Dols, & Suzuki, 2002).

Extraversion has consistently been found to be related to increased experience of positive emotions (see Lucas, Ly, & Dyrenforth, 2008 for a meta-analysis). Perhaps because of its specific responsivity to appetitive stimuli that involve the possibility of reward, extraversion is particularly related to the experience of high arousal positive affect (Smillie, Cooper, Wilt, & Revelle, 2012). In other words, when aroused or when feeling pleasant, it is more likely for

extraverts compared to introverts to also experience high levels of positive feelings and arousal, respectively.

Neuroticism, in turn, is considered to reflect the dispositional tendency to experience negative emotions (Larsen & Buss, 2015). Unlike extraversion, which seems to be particularly geared to the experience of high arousal states, neuroticism has equally been related to the habitual experience of both low arousal negative feelings, such as sadness and depression, as to the experience of high arousal negative feelings, such as stress and anxiety (Matthews & Deary, 1989; Watson, Gamez, & Simms, 2005).

Based on this literature, we hypothesized that extraversion would be positively related to individual differences in valence when people experience high arousal (e.g., extraverts gravitate towards feeling pleasant when feeling active) and to higher arousal when feeling positive (e.g., extraverts gravitate towards feeling active when feeling pleasant). In other words, people who are high on extraversion would experience more positive feelings accompanied by higher levels of arousal. In addition, we hypothesized that neuroticism would be negatively related to valence whether arousal is low or high (i.e., neurotics gravitate towards feeling unpleasant).

To test these hypotheses, we conducted a study in which participants completed a personality questionnaire assessing the FFM dimensions and recalled four recent events: one highly activated, one low in activation, one highly pleasant, and one highly unpleasant, and reported their experienced levels of valence and arousal in those events. This event-recall study allowed for idiographic variability in experiencing valence in relation to high versus low levels of arousal (events 1 and 2), and variability in experiencing arousal in relation to positive versus negative valence (events 3 and 4), and enabled us to examine how this variability was related to personality.

Method

Participants. 482 first-year Belgian, Dutch speaking university students (398 females, mean age = 19 yrs.) participated in return for course credit.

Materials and procedure. In a Dutch-language computerized task, participants first read short descriptions of the pleasure and arousal dimensions. Next, participants were asked to recall four different events: the last time they had felt "echt actief" (translated as "really active"; high arousal condition), "echt inactief" ("really inactive"; low arousal condition), "echt goed" ("very good"; positive valence condition), and "echt slecht" ("very bad"; negative valence condition).

The four event descriptions were presented in a separate random order for each participant. When trying to recall each event, participants were instructed to close their eyes, relive the experience, and remember exactly how they felt at the time. They next typed a short description of the event into a textbox. Next, their feelings of arousal and pleasure were assessed using multiple measures (while their description of the event remained on top of the screen). All ratings were made on 9-point scales. The first measure was the Self-Assessment-Manikin (SAM; Bradley & Lang, 2007), which consists of two bipolar ratings scales with pictorial manikins representing varying values of pleasure (ranging from unpleasant to pleasant) and arousal (ranging from low to high arousal), which were recoded to range from –4 to +4. The second measure consisted of two semantic differential items ranging from "very bad" to "very good" (valence) and from "very passive" to "very active" (arousal), again recoded to range from -4 to +4. The third set of measures consisted of 16 unipolar adjective scales, two items for each of

eight combinations arousal and valence (*high arousal-positive*: "enthusiastic", "peppy"; *neutral arousal-positive*: "pleasant", "good"; *low arousal-positive*: "calm", "relaxed"; *low arousal-neutral valence*: "passive", "sleepy'; *low arousal-negative*: "bored", "sad"; *neutral*

arousal-negative: “bad”, “unpleasant”; *high arousal-negative*: “nervous”, “stressed”; *high arousal-neutral valence*: “active”, “activated”). On the basis of these items, a valence score was calculated by subtracting the mean negative valence composite score from the mean positive valence composite score (intercorrelation between both = -.90, $p<.001$ across conditions, and ranging between -.48 to -.84 per condition); and an arousal score by substracting a mean low arousal composite score from the mean high arousal score (intercorrelation between both = -.77, $p<.001$ across conditions, and ranging between -.44 to -.58 per condition). The final score for valence was the mean of three scores: the bipolar SAM valence ratings, the bipolar verbal scale valence score, and the valence score based on the unipolar items. The final arousal score was similarly defined. The reliability of these multi-source compound scores was good (Cronbach alphas for valence ranged from .68 to .95 across conditions; those for arousal ranged from .63 to .79).

Finally, participants completed a computerized version of the Dutch translation of the Ten Item Personality Inventory (TIPI; Hofmans, Kuppens & Allik, 2008), which measures each of the five personality dimensions by means of two (opposite) items, to be scored on a 7-point scale ranging from 1 (*describes me not at all*) to 7 (*describes me very well*).

Results

Nomothetic Relationship. While the design of this study was primarily intended to explain idiographic variation in the experience of particular valence-arousal combinations, the data can nevertheless be used to verify whether they conform to predictions that follow from the hypothesis that a nomothetic V-shaped relation between valence and arousal fits the data better than other models suggested in the literature. To this end, we examined the nomothetic relation between valence and arousal in each condition. We fit different statistical regression models in

which arousal was predicted by valence in ways reflecting the different theoretical models. For the high and low arousal conditions, we tested models involving 1) independence (Model 1: predicting arousal by an intercept only; see equation with Figure 1a), 2) a linear relation (Model 2: predicting arousal by valence; see equation with Figure 1b), 3) a symmetrical V-shaped relation (Model 3: predicting arousal by the absolute value of valence; see equation with Figure 1c), and 4) various instances of asymmetrical V-shaped relations (Models 4-6: predicting arousal by the absolute value of valence and allowing for differences in intercept and/or slope for positive and negative valence – models that reflect positivity offset and/or negativity bias; see equation with Figure 1d). Finally, Model 7 tests a non-parametric relation between valence and arousal, where arousal is modeled as a free function of valence, in order to detect possible shapes not seen in the previous models.

However, the positive and negative valence conditions allowed us to test only part of the nomothetic V-shape prediction, namely the increase of arousal with increasing positive and negative valence, respectively. Indeed, due to the event-recall manipulation, valence scores were negatively skewed in the positive valence condition and positively skewed in the negative valence condition. As a result, it does not make sense to fit V-shaped models in these conditions. Therefore, only models involving independence (Model 1), a linear relation (Model 2; which would detect one leg of a V-shape), and a non-parametric relation (Model 7) were fitted to the data involved positive and negative valence scores under these instructions, respectively.

Subsequently, we applied model-selection procedures to select the best-fitting model, relying on the BIC, a model selection criterion that balances model fit with parsimony, and posterior probability estimates of model fit, which provide a quantification of uncertainty as a

probability statement (i.e., after having seen the data, what is the probability that the model is true?) (Raftery, 1995).

The results can be found in Table 1. In the high and low arousal conditions, both the BIC and the posterior probability statistics favored a V-shaped relationship (Model 3). In the positive valence condition, independence was favored, and in the negative valence condition, a linear relationship was favored. The selected models for the different conditions are graphically illustrated in Figure 2, along with the non-parametric model to illustrate the relation between valence and arousal when no linear restrictions are imposed. These figures clearly show that feeling more positive or negative is on average accompanied by feeling more arousal in almost all conditions, essentially confirming the V-shape relation between valence and arousal. Figure 2c, reflecting the positive valence condition, in which an independence model was favored, is an exception to this relation, although the non-parametric function again goes in the direction of a (one-armed) V-shape.

Idiographic variation. The wide scattering of the plotted data in the Figure 2 panels clearly illustrates, however, that participants strongly differed in how aroused they felt when they felt very good or very bad, and in how positive or negative they felt when they felt very high or low arousal, showcasing the large idiographic variation in valence-arousal combinations. The size of the idiographic deviation from the overall relation is also illustrated by the very low R-squared values (ranging from .00 to .05) reported in Table 1 (see also Kuppens et al., 2013 reporting values between .01 and .34 with a median of .08) that indicate how much of the variance in the data of each condition is explained by the selected nomothetic model.

To examine how much of the variation could be explained by personality, we took two approaches. First, we examined to what extent variation in the slope of the entire V-shape or the

positive or negative leg of the V-shape separately (in the arousal conditions), or in one leg of the V-shape (the positive leg in the positive valence condition and the negative leg in the negative valence condition) was moderated by personality. To this end, we performed 20 separate regression analyses across participants in which arousal was predicted by a V-shaped function of valence (in case of the high and low arousal conditions) or a linear function (in case of the positive and negative valence conditions) in interaction with each of the five personality dimensions (separately for each personality dimension). In none of these analyses, however, was the V-shape or one leg of it moderated by personality (all *p*s>.05).

Second, we examined the extent to which personality was related to the experience of each particular valence-arousal combination. Specifically, we regressed the valence scores on all five personality dimensions separately for the high and low arousal conditions, and the arousal scores on the same five dimensions separately for the high and low valence conditions. These analyses inform us how individual differences in the personality dimensions uniquely relate to idiographic variation in valence when feeling highly active or passive, and to arousal when feeling very positive or negative. By providing this information about the valence-arousal combinations people with certain personality traits tend to experience, we can infer how personality shapes the relation between valence and arousal.

In the high arousal condition, extraversion predicted more positive valence (β = .19, SE = .06, $p < .01$; the other four personality dimensions failed to make a significant contribution, *p*s>.05). In the low arousal condition, only neuroticism predicted more negative valence (β = -.16, SE = .08, $p < .05$; all other *p*s>.05).[2] In the positive valence condition, extraversion (β = .20, SE = .05, $p < .001$) and agreeableness (β = .30, SE = .08, $p < .001$) each predicted higher arousal; all other *p*s>.05). In the negative valence condition, neuroticism (β = .15, SE = .06, $p < .05$) and

extraversion (β = .15, SE = .06, $p < .05$) predicted higher arousal, whereas agreeableness (β = -.21, SE = .09, $p < .05$) predicted lower arousal; all other *p*s>.05).

Discussion

As expected, valence and arousal were found to be related to one another at the nomothetic level. There were reliable tendencies for certain combinations of valence and arousal to occur more frequently than other combinations. This valence-arousal relationship was not simply linear. On average, as people felt more intensely positive or more intensely negative, they felt more aroused: intensity in either valence direction was accompanied by more arousal.

However, as can be observed from the data in Figure 2, this relationship was by no means true for all individuals. The magnitude of the relation was small at the nomothetic level, and any combination of valence and arousal is possible, and indeed frequent. Contrary to the overall V-shaped relation at the nomothetic level, some individuals reported feeling low arousal levels in combination with highly positive or highly negative valence. Similarly, when participants were instructed to remember instances when they felt high or low arousal, they reported a wide range of valence scores. However, this was less the case in the high arousal condition, in which participants predominantly reported positive experiences (see Figure 2a). Thus, the instruction to remember a highly active experience seemed to prime primarily positive memories, at least in a Western European cultural context.

The observed idiographic variation in scores was related to established dimensions of personality. Extraverts tended to experience higher arousal compared to introverts in combination with positive and negative valence, and higher positive valence in combination with high arousal. Individuals scoring high on neuroticism tended to experience high arousal in combination with negative valence and negative valence in combination with low arousal. In

addition, agreeable individuals tended to experience high arousal in combination with positive valence, but low arousal in combination with negative valence. These results showed that individual differences in experiencing particular valence-arousal combinations are meaningfully related to broad personality dimensions in ways consistent with previous findings on these personality traits. Regarding extraversion, early theories already linked this personality dimension with the seeking of high arousal states (Eysenck, 1967); neuroticism is a strong predictor of negative emotionality both in the high and low arousal realm (Barlow, Sauer-Zavala, Carl, Bullis, & Ellard, 2014); the low anger-proneness associated with agreeableness (e.g., Kuppens, 2005) may predispose individuals to experience low rather than high arousal negative states.

The current study design focused on particular regions of the affective space. Hence, it was not designed to establish personality moderation of global patterns of valence and arousal across the entire affective space (such as a V-shape). For this purpose, data are needed that potentially range across the entire affective realm (such as based on uninstructed self-reported affect in a thin slice of time).

Study 2: Cultural correlates of variation in the relation between valence and arousal

Most data reported in the literature (including our Study 1) on the relation between valence and arousal originated from western samples. As a result, the question remains whether the conclusions drawn could be generalized to non-western samples. Perhaps the relations found, such as the shallow V-shape, reflect a culture-specific feature of the structure of affect stemming from a western liking of high arousal affective states.

There are good reasons to contemplate this latter possibility. Tsai and colleagues (e.g., Tsai, Knutson, & Fung, 2006) convincingly demonstrated that members from western cultures

prefer high arousal positive affect (such as feeling excited and enthusiastic), whereas members of eastern cultures instead prefer low arousal positive states (such as relaxed and peaceful feelings). Such differences in ideal affect are thought to originate from cultural differences in interpersonal goals. In western societies, the emphasis lies on independence, influencing the environment, and personal achievement, while in eastern societies, the focus more lies on interdependence, adjustment to the environment, and interpersonal harmony (Markus and Kitayama, 1991; Tsai, 2007).

Although ideal affect is not always achieved in actual experienced affect, cultural differences in the two certainly align (Tsai, 2007). As a consequence, people from different cultures might differ in their nomothetic experience of valence-arousal combinations: people might succeed in achieving their ideal. In western societies, the preference for high arousal positive affect would create a higher prevalence of high (vs. low) arousal positive states; in eastern societies, the preference for low arousal positive affect would create a higher prevalence for low (vs. high) arousal positive states. Combined with a reasonably anticipated preponderance of average arousal levels experienced at low positive and negative valence, these preferences could translate into more or less steep, or even negative positive valence-arousal relations across cultures.

Predictions regarding negative affect are less straightforward as ideal affect is understandably situated on the positive rather than negative side, and less research on ideal negative affect exists. Still, people do on occasion seek out and achieve negative affect (Tamir, 2009). An intriguing question, therefore, is whether a cultural proneness for experiencing high or low arousal affect on the positive side also generalises to the negatively-valenced realm of feeling states. There are several theoretical reasons why this may be so. High arousal negative

states such as anger and anxiety arise, in part, to mobilise energy for influencing the environment, and the motivation to exert influence on events is considered to be more dominant in western than in eastern cultures, which are more concerned with adjustment (Tsai, 2007). The opposite holds for low arousal negative states such as sadness and depression, which reflect passive compliance rather than active interaction with ongoing events. Empirically, cultural differences in the valence-arousal relation remain unexplored.

In Study 2, we examined possible cultural differences in the nomothetic relation between valence and arousal by analyzing existing data collected by Yik et al. (2002) in five distinct cultural contexts: Canada, China/Hong Kong, Japan, Korea, and Spain. These countries were selected as they represent five different language groups (see Yik, et al., 2002), and show significant variation on basic cross-cultural dimensions (with for instance Spain being more collectivistic than most other western countries, but more individualistic than eastern countries; Hofstede, 2001). Participants recalled a moment from the preceding day, based on which they provided affect ratings that were then used to calculate compound scores of valence and arousal. These data also contained scores on the FFM personality dimensions, thereby allowing us to examine further the personality correlates of the valence-arousal relationship based on data for which participants were not instructed to report on particular restricted regions of the affective space.

Method

Participants. Participants were undergraduate student volunteers. The Canadian (Vancouver) data came from 535 participants (294 females, mean age = 20 years); the Chinese/Hong Kong data from 487 participants (323 females; mean age = 20 years); the Japanese (Kyoto) data from 450 participants (222 females; mean age = 20 years); the Korean

(Busan) data from 365 participants (189 females; mean age = 21 years); and the Spanish (Madrid) data from 233 participants (37 females, mean age = 20 years). They participated in the study in return for course credit.

Materials and procedure. To measure momentary affect, we relied on the "remembered moments method" in which participants were asked to describe their affect in a moment that they remembered well during the preceding day.[4] They were asked to report their affect using four questionnaires, each in a different format. The rationale for the inclusion of multiple formats was to obtain scores that are not dependent on a particular scale format, and capture emotional responses independent of assessment method (see also Yik, et al., 2002). A first format used visual analogue scales with opposing emotion terms at either end, a second format involved indicating to what extent they experienced a number of emotions termed as adjectives ranging from 1 (*not at all*) to 5 (*extremely*), a third format involved indicating their agreement ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) with a number of statements regarding their feeling state, a fourth format asked how well a number of statements describe their feeling at the time ranging from 1 (*not at all*) to 4 (*very well*). Each format except for the first one, contained items that could be used to compute scale scores for positive valence (adjectives: *happy, pleasant, content, satisfied*), negative valence (adjectives: *miserable, troubled, unhappy, dissatisfied*), activation (adjectives: *aroused, hyperactivated, activated*), and deactivation (adjectives: *sleepy, still, quiet*). Next the study authors identified the items that were culturally and theoretically appropriate to indicate positive and negative valence, activated and deactivated arousal in each culture. Measurement invariance of the resulting item groups was tested using multigroup confirmatory factor analyses (Brown, 2015) with corresponding item parcels for each response format serving as indicators for positive valence, negative valence, activation, and

deactivation. Model selection (based on BIC) indicated weak invariance (CFI = .946, RMSEA = .094), suggesting that the factor loadings of the parcels can be considered to be equal across groups. Because positive and negative valence scores were strongly negatively correlated (intercorrelation between both = -.81, $p<.001$ across countries, and ranging between -.73 to -.87 per country), we created a valence score by subtracting negative from positive valence scores for each of the three formats. Similarly, an arousal score was calculated by subtracting deactived from activated scores (intercorrelation between both = -.51, $p<.001$ across countries, and ranging between -.35 to -.63 per country). Next, valence arousal scores were averaged across the three formats to obtain a final valence and arousal score for each subject. Cronbach's alphas from the five samples ranged from .95 to .97 for valence, and from .75 to .91 for arousal, indicating reliable scales.

In addition, personality was measured with the NEO FFI (Costa & McCrae, 1992), a 60-item questionnaire designed to measure the FFM dimensions of personality. Each of the five factors is represented by 12 items. Responses are made on a 5-point rating scale ranging from "strongly disagree" through "neutral" to "strongly agree." Cronbach's alphas from the five samples ranged from .62 to .83, indicating that the scales were internally consistent, similar to the original English scales (McCrae et al., 1998). Model selection (based on BIC) testing different types of measurement invariance using multigroup confirmatory factor analyses pointed to weak invariance, indicating that factor loadings can be considered to be equal across groups (both for models involving 12 individual items per scale, CFI = .602, RMSEA = .063, or parcels consisting of 3 or 4 items per scale, CFI = .832, RMSEA = .094, and CFI = .825, RMSEA = .080, respectively).

Results

First, we examined the nomothetic relationship between valence and arousal per country. As in Study 1, the best fitting of seven models was selected based on the associated BIC and posterior probability estimates, separately for each country. The results of this model selection can be found in Table 1. In all cultures but one (China/Hong Kong), a symmetric V-shape (Model 3) was the most dominant pattern in the data. The order of countries, from largest to smallest, based on the size of the slope (steepness of the V-shape) in those models was Canada (B = .32, SE = .06, p<.001), Spain (B = .27, SE = .11, p=.013), Japan (B = .25, SE = .06, p<.001), and Korea (B = .18, SE = .06, p=.004). For the data from China/Hong Kong, independence between valence and arousal (Model 1) fit the data best.

We next fit a multiple regression model assuming a symmetric V-shape on all data combined, allowing for separate intercept and slope values per country. As seen in Figure 3, Canada, Spain, and Japan were characterised by a steeper V-shaped relationship, whereas the V-shape was weaker in Korea, and almost absent in China/Hong Kong. The interaction between slope and country was significant (F(4)=3.58, p=.006), indicating that the country differences in steepness of the V-shape were reliable. A comparison of the BIC of a joint model with (BIC=6710) and without (BIC=6694) this interaction favored a model without the interaction, however.

Finally, we examined how the shape of the V-shape is a function of personality across data combined from all cultures. The results from Study 1 provide the basis for a clear prediction in this respect. As extraversion predicted higher arousal in case of both positive and negative valence, we expected that the steepness of the V-shape would be predicted by extraversion. To test this hypothesis, we estimated a regression model across all data predicting arousal from valence in which country-centered extraversion interacted with the intercept (level of arousal at

neutral valence) and absolute value of the slope (steepness of the V-shape).[5] The results indeed showed that higher scores for extraversion were related to a more steep V-shape (slope) (*B*=.12, *SE* = .05, *p*=.016; extraversion did not relate to the intercept, however, *B*=.01, *SE* = .10, *p*=.943). In addition, we also examined how country-centered extraversion moderated the steepness of the slope separate for positive and negative valence (to examine whether extraversion indeed relates to a steeper V-shape overall, or perhaps particularly to a steeper slope for positive or negative valence). The result showed that extraversion only positively moderated the steepness of the positive valence-arousal slope (*B*=.13, *SE* = .06, *p*=.038), but not of the negative valence-arousal slope (*B*=-.07, *SE* = .08, *p*=.398). To visualise the moderation by extraversion, Figure 4 displays the V-shape relationship between valence and arousal for participants with high and low levels of extraversion. While in the model underlying this Figure extraversion is allowed to moderate the intercept and slope of the positive and negative leg of the V-shape separately (based on median split), it is important to point out that again only the moderation of the positive slope reaches statistical significance.[6]

Second, although no clear-cut predictions could be formulated based on the results from Study 1, we examined in two similar models how neuroticism (again country-centered) related to the intercept and slope(s) of the V-shape. The first model showed that neuroticism predicted a higher level of arousal at neutral valence (intercept: *B*=.20, *SE* = .09, *p*=.027) and a slightly less steep slope overall (*B*=-.08, *SE* = .04, *p*=.046). However, the second model did not show that neuroticism moderated the steepness of the separate positive and negative valence-arousal slopes (*B*=-.06, *SE* = .05, *p*=.283; *B*=.10, *SE* = .07, *p*=.189).

Agreeableness, openness to experience and conscientiousness (country-centered) were not related to the intercept, V-shape or separate slopes in similar models (all ps>.10).

In a combined model in which all five personality dimensions were included in interaction with the intercept and slope of the V-shape, only neuroticism significantly predicted the intercept, with higher neuroticism being related to a higher level of arousal at neutral valence (*B*=.21, *SE* = .10, *p*=.033), and extraversion remained the only predictor of the slope, with higher extraversion being related to a steeper slope of the V-shape (*B*=.12, *SE* = .06, *p*=.036; all other *p*s>.05). Finally, in a combined model in which all personality dimensions were entered as predictors of the intercept and separate positive and negative slopes, the only significant moderation that emerged was extraversion being positively related to the positive valence-arousal slope (*B*=.15, *SE* = .07, *p*=.027).

Discussion

The findings from this study again replicated the previously documented relation between valence and arousal, while at the same time demonstrating that cultural and individual variability in that relationship is predictable and therefore meaningful. Specifically, all but one country showed a V-shaped relation between valence and arousal, the exception being China/Hong Kong in which valence and arousal were independent. Moreover, the steepness of the V-shape varied by country. The V-shape was steepest in Canada, then Spain, then Japan, moderate in Korea and almost absent (i.e., flat) in China/Hong Kong. These findings attest to the malleability of the structure of affect (see also e.g., Feldman, 1995; Kuppens, 2008). In addition, they strongly resonate with the documented preference for high arousal positive affect in western cultures and lower arousal positive affect in eastern cultures (Tsai et al., 2006). Indeed, Figure 3 and the accompanying reported V-shape slopes illustrate that the five samples can be ordered in terms of their arousal levels at both high positive and high negative valence in line with an East-West cultural distinction. This indicates that differences in ideal affect extend to experienced affect

(see also, Tsai, et al., 2006), and also demonstrate that cultural differences in preference for higher or lower levels of arousal extend to negative affect. The largest exception to this was Japan, however, which was characterised by lower levels of arousal at neutral valence, but did showcase a relatively stronger V-shape compared to the other eastern countries (although we note that the average arousal level at neutral valence was quite low in Japan). A possible explanation for this may be differences in scale use when reporting emotions between cultures. Also, the data from Hong-Kong, while displaying a flat relation between valence and arousal, was characterised by relatively high arousal levels overall. Especially at neutral valence, the arousal level of Hong-Kong participants exceeded that of participants from other nations. More research is needed to pinpoint the exact interpretation of these findings, however.

In addition, the current results allowed us to fine-tune insights from the first study in that extraversion was found to be the most consistent independent personality predictor of the arousal-valence relationship. Specifically, the findings showed that extraversion is related to a steeper V-shape in the relation between valence and arousal, which is particularly driven by extraversion being related to increasing positive valence with increasing arousal.

A notable limitation of this study however is that it is difficult to rule out the possibility that personality and/or culture may partly have driven the specific events people recall when asked to report on a particularly memorable event from the previous day (cf. Robinson & Clore, 2002), and that this may partly account for the findings. While this would reflect a different way personality or culture may bias people affectively, experimental methods are needed to dissociate this possibility from the hypothesis that personality and culture predispose people to respond affectively to events in particular ways.

General Discussion

The present studies replicated Kuppens et al.'s (2013) findings, in 6 new samples in both western and eastern cultures, regarding an overall nomothetic V-shaped association between valence and arousal, with arousal increasing as positive or negative valence increases. Yet, at the same time, the current studies highlight significant and meaningful variation in this association across individuals and cultures. One of the main objectives of the two reported studies was to identify correlates of these differences.

In terms of personality, the most consistent finding was that extraversion was associated with how much arousal increases with increasing valence, particularly positive valence, underscoring the crucial role of extraversion in emotional experience. Extraversion has been associated with the habitual experience of positive high arousal affective states, but not much with positive low arousal or negative states (Yik, 2009; Yik, Russell, & Steiger, 2011). As such, extraversion can be regarded as a general arousal-infusing factor for positive feelings. The approach motivation and reward sensitivity that is considered to underlie extraversion (e.g., Smillie, 2013) may be the driving force behind the larger surge in arousal in reaction to positive events.

Other personality dimensions were also related to more specific aspects of idiographic variation in the structure of affect. Neuroticism was generally related to higher levels of arousal, particularly of negative affect. Neuroticism has indeed been associated with negative emotionality in numerous studies, although it must be said that this dimension is considered to make individuals prone to experiencing both high arousal negative states (e.g., stress, anxiety) as well as low arousal negative states (e.g., sadness, depression). This duality is perhaps also reflected in the findings from Study 1 that, on the one hand, individuals high in neuroticism tend to feel more negative when experiencing low arousal (corresponding to sadness and depression),

while at the same time also reporting increased arousal when feeling negative (corresponding to stress and anxiety). The combination of these findings may help to understand the role of neuroticism in, for instance, the reported high comorbidity between depression and anxiety (Barlow, et al., 2014; Mineka, Watson, & Clarke, 1998).

In terms of culture, the first important aspect to highlight is that despite the observed cultural variation, the V-shape between valence and arousal still remains the dominant pattern across cultures, albeit to varying degrees, ranging from positive to totally flat. Our data did not indicate a culture in which the V-shape was reversed, or made thoroughly asymmetric, as could perhaps be expected on the basis of research on ideal affect (which would predict decreasing arousal with positive valence in eastern culture). The observed differences more or less did align, however, with the distinction between Western/independent versus Eastern/interdependent cultures that are considered to lie at the base of differences in ideal affect. Also, while experienced and ideal affect follow each other's course, they are certainly not identical. One way to interpret this set of findings is that although experienced affect does not coincide with ideal affect, cultural preferences for high or low arousal states seem to pull at the overall nomothetic V-shape in one direction or another, creating cultural differences in how valence and arousal relate to one another. An additional finding was that the cultural ordering in experienced arousal levels at higher levels of positive and negative valence was similar, suggesting that habitual experience of high versus low arousal feeling states generalise across valence.

Combining the findings from both studies, it is striking to note that cultural differences in extraversion (e.g., McCrae, 2004; McCrae & Terraccioano, 2005) seem to align with the observed cultural differences in the V-shaped relation between valence and arousal, which showed a steeper slope in western compared to eastern samples. This observation ties the

findings of both studies together, in a way, in that extraversion seems to shape the valence-arousal-relation both at the level of individuals and at the level of nations.

A number of limitations should be noted. First, both studies relied on recalled affective experiences, which may be subject to memory biases (see also the limitation mentioned in Study 2). In a related vein, personality could play a role not only in how people respond to or remember situations, but also in how they actively select or avoid situations in their lives, and our method does not allow to disentangle those. It is therefore important to replicate the findings using more momentary affective ratings, such as collected for instance in experience sampling studies (Stone et al., 2006), and in settings where the (choice of) situation can be controlled, such as in lab settings. Second, the items used in both studies may not have equally covered all quadrants of the affective space equally. In particular, negative high arousal affect involves nervousness and stress but also fear, anger, and associated states, and the current selection may have impacted the results. Third, in our cultural comparisons, we relied on a distinction between cultures in terms of levels of ideal affect. It would be useful in follow-up studies to measure these attributes directly, in order to shed light on how exactly they relate to structural characteristics of affect. Also, such cultural differences align with other differences in cultural tendencies, such as, for instance, self-affirmation (Heine, Lehman, Markus, & Kitayama, 1999), moderacy bias (Chen, Lee, & Stevenson, 1995), or dialectical worldview (Spencer-Rodgers, Williams, & Peng, 2010), and additional research is needed to ascertain their role in shaping valence-arousal relation.

There is no doubt that subjectively experienced affect occupies a central aspect of the mind and that understanding how affect is structured is one of the longstanding challenges to the science of psychology. The present studies sought to fill the vacuum by examining the relationship between two of the main pillars of affect in five different languages and establishing

sources of variance in the relation between valence and arousal. First, primarily extraversion was found to be a personality correlate of this relation across a diverse set of nations, with higher levels of extraversion translating into higher levels of arousal with increasing positive valence. Second, we observed national differences in this relation that more or less aligned with the distinction between more western and more eastern cultures showcasing a steeper versus less steep V-shaped relation between valence and arousal.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article

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Footnotes

[1] Some examples are 'participating in a swimming contest 1500m' 'accident on a speed boat, friend could not breath, panic'(high arousal condition); 'at my dorm, sitting in comfortable couch, sipping tea', 'a few days ago, total boredom' (low arousal condition); 'when I lost a relative', 'when my boyfriend told me he kissed with my friend when drunk' (negative valence condition); 'watching the sunset from a mountaintop on holiday', 'party, birthday, friends'(positive valence condition).

[2] Additional analyses performed separately on the positive and negative subscales calculated from the unipolar adjectives yielded largely similar results: In the high arousal condition, extraversion marginally predicted higher positive valence ($\beta = .08$, SE = .04, $p = .09$) and predicted lower negative valence ($\beta = -.11$, SE = .05, $p < .05$); in the low arousal condition, neuroticism predicted lower positive ($\beta = -.12$, SE = .06, $p < .05$) and higher negative valence ($\beta = .21$, SE = .06, $p < .001$).

[3] The current research question is different from the question pursued in Yik et al. (2002), which focused on the entirety of the circumplex model and its relation to personality.

[4] Original English versions of the affect scales were translated into the target language through a translation/back-translation procedure. For each target language, the materials were first translated by a native speaker. Next, a second translator (blind to the original English version) back-translated the questionnaire into English. Discrepancies between the back-translated original version were reviewed revised after consultation with the translators.

[5] In these and the following analyses, we centered the Five-Factor dimension and arousal scores per country to avoid cross-country differences in personality influencing results. Hence, the findings of these analyses present overall within-country interactions between the characteristics of the valence-arousal relation and personality. Valence scores were not centered because of the substantive importance of the neutral midpoint.

[6] The associated regression model of this figure (in which arousal across all participants was predicted by separate intercepts and slopes for both positive and negative valence, a dummy based on the median split of extraversion scores, and the interaction between personality and the

intercepts and slopes) again confirmed that extraversion predicts a steeper positive leg of the V-shape (B=.16, SE = .07, p=.022).

Table 1

Summary of model selection statistics when arousal is modeled as a function of valence for each Study

Study	Model 1 Independence		Model 2 Linear relation		Model 3 Symmetric V		Model 4 Asymmetric V positivity offset		Model 5 Asymmetric V negativity bias		Model 6 Asymmetric V positivity offset + negativity bias		Model 7 Non-parametric		
	BIC	PostP	BIC	PostP	BIC	PostP	BIC	PostP	BIC	PostP	BIC	PostP	BIC	PostP	R^{2a}
Study 1															
High arousal condition	1449	.11	1453	.02	**1446**	**.78**	1452	.04	1451	.05	1456	.00	1459	.00	**.02**
Low arousal condition	1618	.00	1623	.00	**1601**	**.57**	1602	.33	1605	.07	1608	.02	1611	.00	**.05**
Positive valence condition	**1861**	**.91**	1866	.08	-	-	-	-	-	-	-	-	1867	.01	**.00**
Negative valence condition	2010	.01	**2001**	**.99**	-	-	-	-	-	-	-	-	2022	.00	**.03**
Study 2															
Canada	1878	.00	1881	.00	**1857**	**.88**	1863	.04	1862	.05	1864	.03	1870	.00	**.05**
China/Hong Kong	**1347**	**.87**	1353	.04	1353	.05	1355	.02	1358	.00	1358	.00	1359	.00	**.00**
Japan	1464	.00	1469	.00	**1452**	**.84**	1456	.09	1457	.05	1462	.01	1463	.00	**.04**
Korea	1101	.18	1106	.01	**1098**	**.61**	1102	.10	1102	.09	1108	.01	1111	.00	**.02**
Spain	847	.34	852	.02	**846**	**.49**	850	.07	850	.06	855	.00	853	.01	**.03**

Note. BIC: Bayesian Information Criterion (lower values reflect better fit); PostP: posterior probability of each model given the data among the set of seven models. The values of the best fitting model are displayed in bold.

[a] R^2 of the best fitting model.

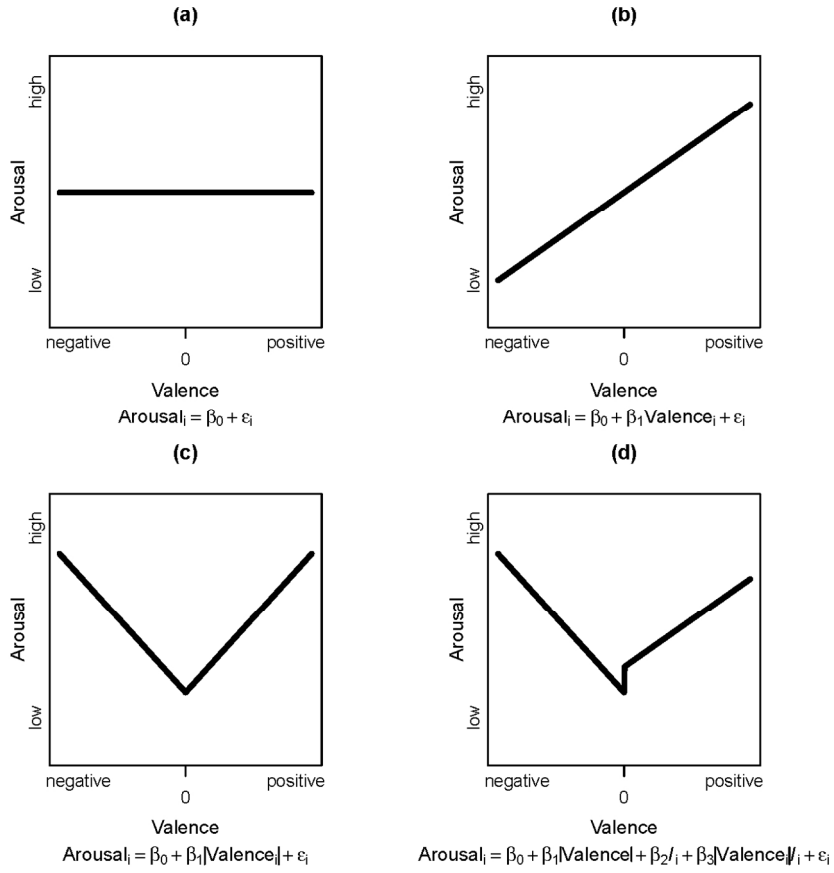

Figure 1. Overview of possible relations and associated model equations between valence and arousal: (a) independence, (b) (positive) linear relation, (d) symmetric V-shaped relation, and (e) asymmetric V-shaped relation including both positivity offset and negativity bias.

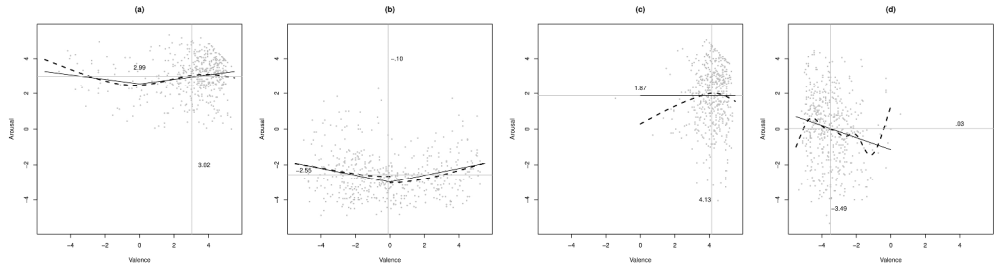

Figure 2. Relationship between valence and arousal in the (2a) high arousal (based on all data), (2b) low arousal (based on all data), (2c) positive valence (based on positive valence data only), and (2d) negative valence (based on negative valence data only) conditions. For illustrative purposes, the dashed line reflects the non-parametric relationship. The points are the plotted raw data (Study 1).
1270x352mm (72 x 72 DPI)

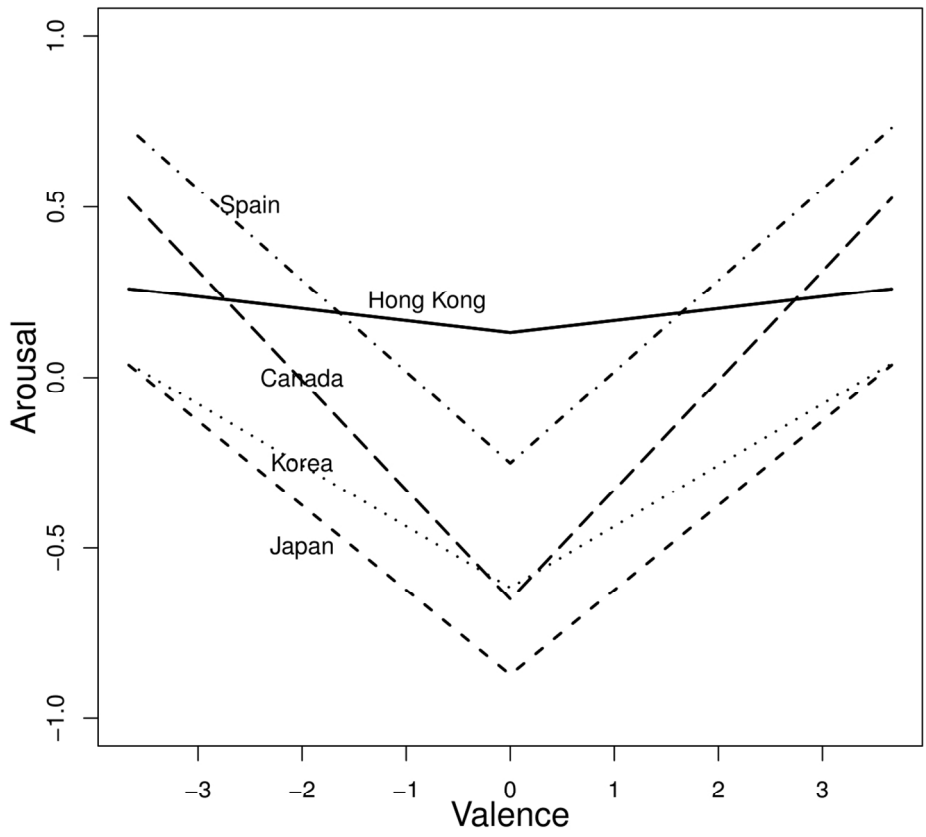

Figure 3. Relationship between valence and arousal per country according to a model that assumes a symmetric V-shape relation (Study 2).
493x493mm (72 x 72 DPI)

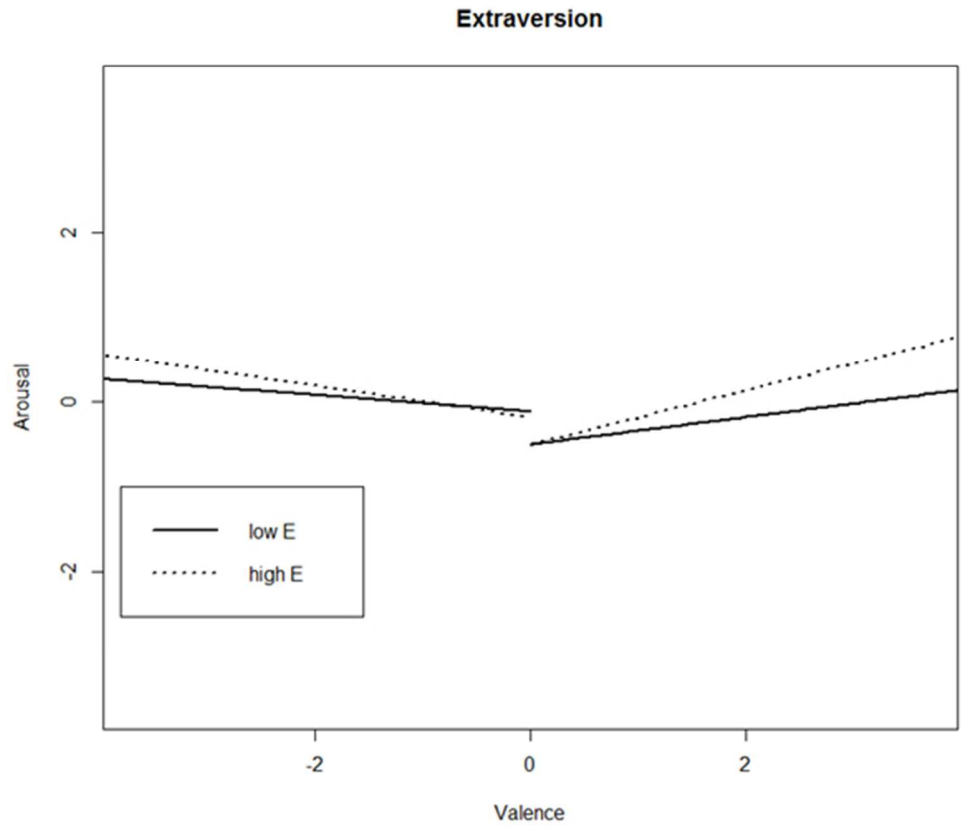

Figure 4. Relationship between valence and arousal for people scoring high versus low (based on median split) on Extraversion (E) (Study 2).