



Splitting the affective atom: Divergence of valence and approach-avoidance motivation during a dynamic emotional experience

Lukasz D. Kaczmarek¹ · Maciej Behnke¹ · Jolanta Enko¹ · Michał Kosakowski¹ · Przemysław Guzik² · Brian M. Hughes³

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Abstract

Valence and approach-avoidance motivation are two distinct but closely related components of affect. However, little is known about how these two processes evolve and covary in a dynamic affective context. We formulated several hypotheses based on the Motivational Dimensional Model of Affect. We expected that anger would be a unique approach-related rather than avoidance-related negative emotion. We also expected that high-approach positive emotions (e.g., desire) would differ from low-approach positive emotions (e.g., amusement) producing a stronger link between valence and approach-avoidance motivation. We also explored other dynamic properties of discrete emotions such as the difference between approach-avoidance motivation and valence as a marker of balance within affective components. We asked 69 participants to provide continuous ratings of valence and approach-avoidance motivation for eight standardized clips representing different discrete emotions. Using multilevel modeling, we established a significant relationship between valence and approach-avoidance motivation with high-approach emotions producing a stronger link between valence and approach-avoidance motivation compared to neutral states and low-approach emotions. Contrary to expectations, we observed that individuals exhibited an avoidance response during anger elicitation. Finally, we found that awe was a distinct positive emotion where approach motivation dominated over valence. These findings are relevant to the theory and research on diverging processes within the core structure of affect.

Keywords Affect · Emotion · Valence · Motivation

Introduction

There seems to be a consensus that valence, arousal, and approach-avoidance motivation are fundamental dimensions that organize emotional responses (Mauss and Robinson 2009). Valence refers to the degree to which an individual feels pleasure or displeasure in response to a stimulus (e.g., object, event, or a possibility). Positive valence is elicited by favorable objects or situations (e.g., smiling people or amusing events) and negative valence is elicited by unfavorable objects or situations (e.g., sad individuals) (Marchewka et al.

2014). Valence ranges from highly negative to highly positive. Arousal reflects a subjective representation of a physiological response to the stimuli, and it ranges from unaroused/relaxed to aroused/excited (Lang et al. 1993). Individuals respond with low arousal to neutral or everyday objects (e.g., a table) and with high arousal to unusual or dangerous objects that might require fast responding (e.g., hostile animals) (Marchewka et al. 2014). Finally, the approach-avoidance motivation pertains to the urge to move toward or away from an object (Harmon-Jones et al. 2013b). This affective dimension ranges from high-avoidance motivation to high-approach motivation. High-approach motivation is elicited by desirable or appetitive objects or situations (e.g., delicious food or sexually attractive individuals) whereas undesirable or aversive objects or situations elicit high-avoidance motivation (e.g., accidents or infected individuals).

Despite the consensus regarding the essential components of affect, there is less agreement regarding how tightly these elements are interrelated. In general, valence and approach motivation are positively correlated, valence and arousal are inversely correlated, and approach motivation and arousal are

✉ Lukasz D. Kaczmarek
lkacz1@gmail.com

¹ Institute of Psychology, Adam Mickiewicz University, 89 Szamarzewskiego Street, PL-60-568 Poznań, Poland

² Poznan University of Medical Science, Poznań, Poland

³ National University of Ireland, Galway, Ireland

inversely correlated (Marchewka et al. 2014). This means that when exposed to negatively valenced stimuli, individuals usually feel aroused and motivated to move away from the object or to avoid the situation. In contrast, when individuals are exposed to positively valenced stimuli, they usually feel less aroused and feel the urge to get closer to the object or engage in the situation. This phenomenon reflects the theory (Gray 1981; Kahneman 1999) as well as the everyday observation that individuals are likely to approach stimuli which elicit positive feelings and likely to avoid stimuli that evoke negative feelings. This fundamental response is hypothesized to be common to humans and much simpler organisms that seek positive and avoid negative circumstances (Bradley and Lang 2000).

In this research, we focused on the relationship between valence and approach-avoidance motivation because the general link between positive valence and approach-avoidance motivation observed across the majority of affective responses (Marchewka et al. 2014) is different for some specific emotions (Shiota et al. 2017). For instance, individuals are motivated to approach objects of anger despite their negative valence, e.g., with the intention to put an end to a situation that aroused anger or to punish the anger-provoking agents (Carver and Harmon-Jones 2009). Furthermore, for some emotions, such as desire, approach motivation is stronger, and for some other emotions, such as amusement, approach motivation is weaker relative to valence (Gable and Harmon-Jones 2008). This indicates that the firm bounding between affective components may be weaker for specific stimuli. This observation is important because the motivational intensity influences subsequent functioning. For instance, positive emotions characterized by high approach intensity facilitate proactive control, whereas low-approach positive emotions that facilitate reactive control (Li et al. 2018).

There is, however, little systematic evidence that describes how valence and approach-avoidance motivation diverge or converge producing different experiential qualities. Moreover, no research examined how valence and approach-avoidance motivation evolve in dynamic affective experience. Accounting for the interplay between valence and approach-avoidance motivation is essential to explain the primary affective differences between discrete emotions that stem from different evolutionary processes and engage different biological systems (Harmon-Jones 2018; Shiota et al. 2017). A meta-analytical study revealed that the valence-approach models have mixed support from the empirical evidence in predicting differences between discrete emotions (Lench et al. 2011). In particular, differences between effect sizes associated with emotions of different motivational directions (i.e., happiness or anger vs. fear or sadness) were not higher than those associated with emotions of the same motivational direction. Moreover, small differences were observed between high-approach vs low-approach positive emotions in their influence on cardiovascular, electrodermal, and respiratory responses during stress (Kaczmarek et al. 2019). This

suggests that more nuanced studies are needed to provide a fine-grained analysis of the interplay between valence and approach-avoidance motivation across discrete emotions. Furthermore, given that the majority of literature has been focused on happiness as the most representative positive emotion (e.g., Lench et al. 2011), it is essential to account for more numerous discrete positive emotions in testing how the valence and approach-avoidance motivation produce different experiential qualities.

Elementary Components of Affect

Most theorists agree that a person's current emotions influence motivation to act in a certain way (Fredrickson 2001; Frijda 1986; Izard 2007; Loewenstein et al. 2001). However, there has been an ongoing debate regarding structural and functional differences between emotions (Harmon-Jones 2018; Shiota et al. 2017). The functional differences pertain to the question of how specific emotions influence behavior. The structural differences pertain to the questions what elementary building blocks are necessary to explain the diversity of affective experience, and how these blocks are interrelated. Theorists have discussed the functional value of emotions for over a century starting with the works of Darwin on emotions (emotional expressions in particular) and their relation to specific action readiness (e.g., Darwin, 1872/1965). The evolutionary perspective was elaborated by Tooby and Cosmides (1990) who argued that emotions evolved to facilitate adaptive behaviors and reflect ancestral environments. Frijda and colleagues (Frijda et al. 1989) proposed that emotions can be regarded both as experiences of situational appraisals and as states of specific action readiness.

Among more recent theories, Levenson (1994) emphasized that emotions serve to establish an individual's position towards the environment pulling towards certain objects and pushing away from others. This author emphasizes that the terms "emotion" and "motivation" come from the same Latin word source: to set in motion (emotion) and to serve to move (motivation). Finally, Fredrickson (2001) proposed the broaden-and-build model of positive emotions which stipulates that positive emotions broaden the thought-action repertoire and motivate individuals to build their physiological, psychological, and social resources (Fredrickson 2001). In summary, these theories are congruent in establishing a strong functional link between emotions and behavioral motivations.

More recently, the debate regarding functions of emotions has been revived by experimental findings on anger and desire that resulted in the Motivational Dimensional Model of Affect (MDMA) (Gable and Harmon-Jones 2010a). MDMA emphasized the structural perspective indicating that different components of affect are differentially related to functional outcomes. MDMA posits that besides valence and arousal that have been often studied together, comprehensive models of affect should account for approach-avoidance motivational

intensity because this component provides additional explanatory power (Harmon-Jones et al. 2013b). MDMA has been increasingly focused on the fact that emotions of the same valence can vary in approach-avoidance motivation (Gable and Harmon-Jones 2008). Some positive stimuli (e.g., leading to amusement) can elicit positive valence but weaker approach motivation relative to stimuli that elicit desire. For instance, individuals can be amused by situations that are funny but somewhat dangerous (Kreibig et al. 2013). In such situations, individuals are likely to feel pleasure despite little motivation to approach the scene. Other positive stimuli (e.g., leading to enthusiasm) result in positive valence and intense approach motivation. For instance, when an object elicits pleasure that is accompanied by a strong urge to approach the object (e.g., a delicious dessert), individuals are likely to experience desire or enthusiasm (Gable and Harmon-Jones 2010a).

Experimental research supported the validity of MDMA and its contribution to the development of theory. For example, the broaden-and-build theory proposed that all positive emotions increase the breadth of attention (Fredrickson and Brannigan 2005). The broadening effect of positive emotions was replicated using diverse experimental methods (Rowe et al. 2007; Stanko-Kaczmarek and Kaczmarek 2016; Wadlinger and Isaacowitz 2006). Research on MDMA limited this general claim indicating that the broadening effect does not occur for high-approach positive emotion, e.g., desire (Gable and Harmon-Jones 2008). Furthermore, the relative independence of motivational direction and valence is observed in anger, which is classified as a negative affective state and is associated with approach motivation measured on a neural and cognitive level (Carver and Harmon-Jones 2009; Harmon-Jones et al. 2013a). This perspective challenges previous conceptualizations that linked positive valence with approach motivation and negative valence with withdrawal motivation with little further elaboration regarding the stability of this link (Watson et al. 1999).

The relationship between valence and approach-avoidance motivation is the cornerstone of the MDMA. Despite the abundance of experimental studies on the MDMA where the stimuli were carefully selected to fit the MDMA assumptions (Harmon-Jones 2018), we know little whether the strength of valence and approach-avoidance motivation is the same across a variety of high-approach vs. low-approach positive emotions. Addressing this problem is essential to present data-based arguments that the link between valence and approach-avoidance motivation is flexible rather than fixed.

Moreover, MDMA predicts that approach-avoidance motivation is weakly related to arousal, because motivational intensity, in contrast to arousal, always has action implications (Gable and Harmon-Jones 2010a). For instance, when individuals feel aroused by an amusing situation, they can feel no urge to approach anything in the environment. The independence of approach-avoidance motivation from arousal was documented by an experimental study

where manipulated arousal did not influence cognitive effects of motivational intensity on cognitive processes and affective neural responses to high-approach positive affect (Gable and Harmon-Jones 2013).

The Present Study

In the current study, we aimed to examine the relationship between valence and approach-avoidance motivation in several discrete emotions as well as affective categories, i.e., high-approach and low-approach emotions. We focused on discrepancies between valence and approach-avoidance because these two dimensions of affect are the most strongly related conceptually, yet the stability of their link has been questioned (Harmon-Jones 2018).

First, we aimed to provide replicative evidence expecting that anger would be related to stronger approach motivation relative to the neutral conditions (H1) (Harmon-Jones and Allen 1998). Second, we expected to replicate prior studies with static stimuli by showing that that valence and approach motivation would be positively correlated in a dynamic material (H2). We also expected that approach-avoidance motivation would be stronger for high-approach positive emotions (such as awe, desire, enthusiasm, tenderness) than compared to other low-approach emotions (H3). As explorative aims, we examined differences between approach-avoidance motivation and valence to provide more information about the balance between the components of affect (intraaffective balance). We examined whether specific emotions or group of emotions are over-motivated (approach-avoidance motivation levels significantly higher than valence), undermotivated (approach-avoidance motivation lower than valence) or balanced. We analyzed a temporally dynamic emotional experience (continuous ratings on two dimensions while watching a movie clip), rather than an emotional response to a static stimulus, e.g., a photo, because continuous ratings provide more measurement points, and thus allow for more robust testing of relationships and differences. Consequently, we also aimed to present descriptive data with the dynamics of valence and approach-avoidance motivation.

Method

Participants

This study involved 69 student volunteers (59.5% female) between the ages of 18 and 40 ($M = 22.47$, $SD = 3.10$). Each participant signed informed consent for their participation and received a cinema ticket for their involvement. The Institutional Ethics Committee approved the study.

Procedure

Upon arrival, volunteers signed informed consent and reported their age and gender. We tested participants in groups of up to five persons. Each person was seated in a cubicle in front of a separate PC. Participants received instructions and rated the video clips for valence or approach motivation first, depending on randomization. After a short break, they completed the second session when they rated the other dimension of affect (valence or approach motivation). Half of the participants evaluated valence first and approach motivation later.

Measures

A Continuous Measure of Affect Participant used arrow keys on a PC keyboard to report valence and approach-avoidance motivation continuously. The signal was sampled at 4 Hz with the CARMA software (Girard 2014). Participants were asked to adjust the scale position as often as necessary so that it always reflected how they felt at a given moment. For the valence rating the scale was from -6 (“Extremely negative”) to 6 (“Extremely positive”). For the approach motivation the scale was from -6 (“Motivated to avoid”) to 6 (“Motivated to approach”). Rating scales provide reliable and valid emotion measurement (Ruef and Levenson 2007).

Affective Stimuli We used stimuli from a validated emotion-eliciting video clips database (Schaefer et al. 2010): “There is something about Mary” (The protagonist fights with a pet dog) for amusement, “The Dead Poets Society” (Students climb on their desks to manifest their solidarity with their teacher) for tenderness, “Seven” (A man apparently dead unexpectedly wakes up) for fear, “Leaving Las Vegas (A woman is raped and beaten by young men) for anger, and “Three Colours: Blue” (People in everyday situations) for neutral. For the remaining categories (enthusiasm, desire, and awe), we performed additional pilot testing of 52 video clips that were viewed by at least 12 raters. We selected a montage from The Summer Olympic Games for enthusiasm ($N = 18$, valence $M = 6.44$, $SD = 2.14$, arousal $M = 4.61$, $SD = 2.63$, approach-avoidance motivation $M = 6.44$, $SD = 2.14$), and a montage of architecture in a modern city for awe ($N = 36$, valence $M = 6.54$, $SD = 1.38$, arousal $M = 4.78$, $SD = 2.24$, approach-avoidance motivation $M = 6.65$, $SD = 1.89$). Based on previous static affective stimuli for desire (Desmet and Schifferstein 2008; Gable and Harmon-Jones 2008), we pilot tested several other clips and selected a clip with desserts presentation for desire ($N = 16$, valence $M = 7.38$, $SD = 1.41$, arousal $M = 3.94$, $SD = 2.24$, approach-avoidance motivation $M = 8.00$, $SD = 1.89$). The clips in each session were presented in a counterbalanced order using a Latin square so that each clip was presented as the first at least in one group. The order of clips presentation was determined with randomizer.org. A

15-s neutral video preceded each affective clip with geometric figures (Gross and Levenson 1995).

Despite several well-established databases that provided affective ratings for movie clips (e.g., Carvalho et al. 2012; Gross and Levenson 1995; Hagemann et al. 1999; Samson et al. 2016; Schaefer et al. 2010), little is known how different components of affect evolve throughout these clips. Movie clips usually tell a story that needs a relatively neutral introduction before delivering the emotional message. Thus, movie clips are adequate for the study of the temporal dynamics of affective responses. This is important because emotional experiences seldom comprise a single emotion (Samson et al. 2016). It is crucial to provide continuous online ratings in validation studies because retrospective affective evaluations are often biased, e.g., by the influence of the peak and the final moments of the experience on the overall rating (Kahneman et al. 1993). It is worthwhile to ascertain that the affective active ingredients of a clip occur in specific moments, e.g., at the beginning of the clip rather than at the middle or the end. Such temporal precision is essential when the affective material is used to influence ongoing processes, e.g., in studies on cardiovascular recovery (e.g., Fredrickson and Levenson 1998). Relying solely on the retrospective ratings is likely to decrease the validity of experimental research in affective science.

Analytical Strategy

We analyzed the data using multilevel modeling in the *R* 3.0.2 environment (R Development Core Team 2014) using *R* packages nlme (Pinheiro et al. 2007) and lme4 (Bates et al. 2015). The data was conceptualized as a two-level structure in which repeated ratings of valence and approach motivation were nested in individuals. We used valence and approach-avoidance ratings binned into 10-s blocks. Clips for discrete emotions were grouped into three affective categories: low-approach, high-approach, and neutral. We also used amusement as a prototypical low-approach positive affect (Harmon-Jones et al. 2013a).

To test our hypotheses we created nine two-level models. First, we checked whether the clips elicited expected levels of affect in absolute terms (significant differences from zero) and relative terms, i.e., compared to the neutral category. We tested whether valence levels differ for discrete emotions (Model 1) affective categories (high-approach, low-approach, and neutral material), (Model 2) or within positive emotions (Model 3). We also checked if approach-avoidance motivation levels differ for discrete emotions (Model 4), affective categories (model 5) or within positive emotions (Model 6). Next, we tested whether the relationship between approach-avoidance motivation and valence is significant and differs for discrete emotions (Model 4) for affective categories among all emotions (Model 5), and only for positive emotions (Model 6). Finally, to test which emotions are over-motivated, balanced

or undermotivated, we examined the difference between approach-avoidance motivation and valence for discrete emotions (Model 7), affective categories among all emotions (Model 8) and only for positive emotions (Model 9).

All predictors were group-centered because our interest was in the relationship between Level 1 variables, i.e., valence and approach-avoidance motivation relationship and difference (Enders and Tofghi 2007). In all four models, each affective category or each discrete emotion were factor-coded with the neutral clip coded as 0 as the reference category. To provide descriptive statistics (mean levels of approach motivation or coefficient for each category), we run the analysis on subsets of data.

We tested whether the models required multilevel modeling by comparing models with fixed intercept and slope, random intercept and fixed slope, and random intercept and slope (Field et al. 2012; Nezlek 2011). Classical regression analysis assumes that the score of each participant is represented by the same intercept (i.e., the point where the regression line crosses the Y-axis) and the same slope (i.e., the gradient of the regression line). In contrast, models with random intercept and/or slope account for the fact that subgroups of participants within the sample may differ in their intercepts and the slopes, and consequently, intercepts and slopes may vary around the overall model. In such instances, multilevel models that account for the lack of homogeneity are recommended (Field et al. 2012).

To test whether there was a need to account for random slopes and/or intercepts in our data, we compared random slope and/or random intercept models against the fixed slope and intercept model. The fit of each model (null, random intercept, random slope) was assessed using the Akaike information criterion (AIC), the Bayesian information criterion (BIC) with lower values representing better fit. We also used the log-likelihood ratio (Vrieze 2012) to examine if the difference between the models' fit was significant.

Valence Levels We regressed valence on discrete emotions (Model 1), affective categories for all emotions (model 2), and positive emotions only (Model 3) as predictors with the following structure:

$$\text{Level 1 } (\text{valence})_{ij} = \beta_{0j} + \beta_{1j}(\text{emotion}) + r_{ij}$$

$$\text{Level 2 } \begin{aligned} \beta_{0j} &= \gamma_{00} + u_{0j} \\ \beta_{1j} &= \gamma_{10} + u_{1j} \end{aligned}$$

Approach-Avoidance Motivation Intensity and the Valence and Approach-Avoidance Motivation Relationship To test if emotions categories differ in the approach-avoidance motivation intensity, we built three models with discrete emotions

(model 4), with affective categories for all emotions (model 5), and with positive emotions only (model 6) as predictors and approach-avoidance motivation as the outcome. First, we examined the regression of each independent variable (i.e., valence and emotion factor) on the outcome, that presented the 1) approach-avoidance motivation intensity for each emotional category 2) overall relationship between approach-avoidance motivation and valence. Next, we analyzed the interaction of the independent variables on the outcome, that showed the difference in approach-avoidance motivation and valence relationship across emotional categories.

$$\text{Level 3 } (\text{approach})_{ij} = \beta_{0j} + \beta_{1j}(\text{valence}) + \beta_{2j}(\text{emotion}) + \beta_{3j}(\text{valence} * \text{emotion}) + r_{ij}$$

$$\text{Level 4 } \begin{aligned} \beta_{0j} &= \gamma_{00} + u_{0j} \\ \beta_{1j} &= \gamma_{10} + u_{1j} \end{aligned}$$

Approach-Avoidance Motivation and Valence Difference We regressed the outcome (difference between approach-avoidance motivation and valence) on discrete emotions (Model 7), affective categories for all emotions (Model 8), and positive emotions only (Model 9) as predictors with the following structure:

$$\text{Level 5 } (\text{approach} - \text{valence})_{ij} = \beta_{0j} + \beta_{1j}(\text{emotion}) + r_{ij}$$

$$\text{Level 6 } \begin{aligned} \beta_{0j} &= \gamma_{00} + u_{0j} \\ \beta_{1j} &= \gamma_{10} + u_{1j} \end{aligned}$$

Results

Descriptive statistics (means and standard errors) are presented in Fig. 1. For each model, we found that adding the multilevel structure provided a better fit (Table 1).

Valence and Approach-Avoidance Motivation Levels for Discrete Emotions and Affective Categories

Before testing relationships between approach-avoidance motivation and valence, we tested whether the clips elicited expected levels of affect in absolute terms (significant differences from zero) and relative terms, i.e., compared to the neutral category (Table 2). First, we observed that amusement, awe, desire, enthusiasm, and tenderness produced positive valence, the neutral clip produced neutral valence, and anger and fear produced negative valence in absolute terms. In

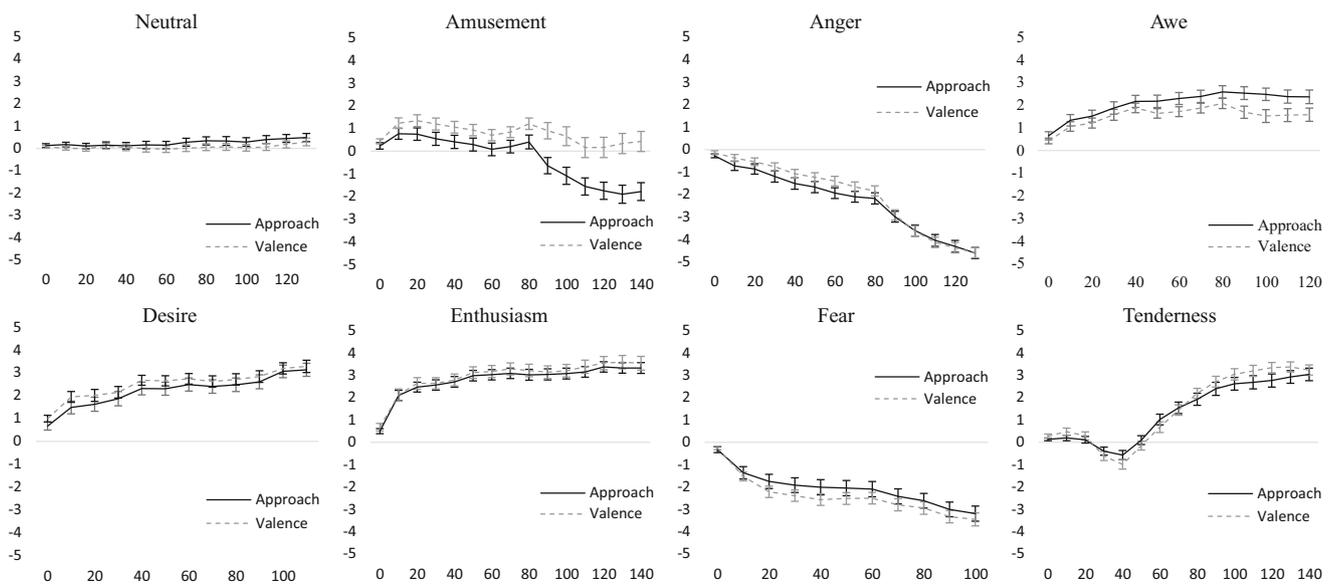


Fig. 1 Approach-avoidance motivation (solid line) and valence (dashed line) in affective clips. Note. Error bars present standard errors. X-axis represents time in seconds

relative terms, each affective clip significantly differed in valence from the neutral conditions.

Second, we observed positive approach-avoidance intensity for awe, desire, enthusiasm, and tenderness, neutral approach-avoidance intensity for amusement and neutral conditions, and negative approach-avoidance intensity for fear and anger (Table 3). Moreover, we found that awe, desire, enthusiasm, and tenderness produced higher levels of approach-avoidance motivation relative to the neutral conditions. In contrast, amusement, anger, and fear produced lower levels of approach-avoidance motivation relative to the neutral conditions. Thus, contrary to H1, we found that anger was related to avoidance motivation rather than the approach motivation.

These findings indicate that each clip produced expected responses in valence. Moreover, each clip except for anger produced expected responses in the approach-avoidance motivation. Consequently, we moved anger from the high-approach group to the low-approach group in further analyses. Moreover, after removing anger from the high-approach affect group, the high-approach group represented high-approach positive emotions rather than high-approach positive and negative emotions in general.

We binned the clips into categories based on their approach-avoidance intensity to formulate high-approach positive affect (awe, desire, enthusiasm, tenderness), low-approach positive affect (represented by amusement), and low-approach affect (amusement, anger, fear). We found that the approach-avoidance motivation was highest for high-approach clips, middle for neutral clips, and the lowest for the low-approach clips. Furthermore, high-approach clips produced higher levels of approach-avoidance motivation, and low-approach clips produced lower levels of approach-

avoidance motivation relative to the neutral clip. High-approach positive affect produced higher levels of approach-avoidance motivation than low-approach positive affect (amusement). Additionally, high-approach clips produced higher levels of valence relative to low-approach clips, low-approach positive clip, and neutral clip.

Relationship between Valence and Approach-Avoidance Motivation

As expected (H2), the relationship between valence and approach-avoidance motivation was positive for each emotion group and for each discrete emotion as well as the neutral conditions (Table 4). We found that the relationship between valence and approach-avoidance motivation was stronger for anger, desire, enthusiasm, fear, and tenderness relative to the neutral conditions. Amusement and awe the relationship between valence and approach-avoidance motivation did not differ relative to the neutral conditions.

Moreover, supporting H3, the relationship between valence and approach-avoidance motivation was stronger for high-approach positive emotions relative to low-approach emotions, the neutral conditions, and low-approach positive emotion. The strength of the link between the valence-approach/avoidance motivation was equal for low-approach emotions and neutral conditions.

Difference between Approach-Avoidance Motivation and Valence

For this type of analysis, we subtracted scores for valence from the scores for approach-avoidance motivation. In

Table 1 Model fit for multilevel structures

Model	<i>df</i>	AIC	BIC	χ^2
Model 1				
Fixed intercept and slope	17	30472.75	30590.48	
Random intercept and fixed slope	18	29166.17	29290.82	1308.58***
Random intercept and slope	20	28063.93	28202.44	1106.24***
Model 2				
Fixed intercept and slope	7	31392.35	31440.83	
Random intercept and fixed slope	8	30306.86	30362.26	1087.50***
Random intercept and slope	10	29126.41	29195.67	1184.44***
Model 3				
Fixed intercept and slope	7	23588.8	23635.45	
Random intercept and fixed slope	8	22322.3	22375.62	1268.50***
Random intercept and slope	10	21321.99	21388.64	1004.31***
Model 4				
Fixed intercept and slope	17	31800.24	31917.98	
Random intercept and fixed slope	18	30976.38	31101.04	825.86***
Random intercept and slope	20	29848.00	29986.51	1132.37***
Model 5				
Fixed intercept and slope	7	31892.46	31940.94	
Random intercept and fixed slope	8	31105.33	31160.73	789.13***
Random intercept and slope	10	30020.93	30090.18	1088.40***
Model 6				
Fixed intercept and slope	7	24407.06	24453.71	
Random intercept and fixed slope	8	23372.14	23425.46	1036.92***
Random intercept and slope	10	22734.98	22801.63	641.159***
Model 7				
Fixed intercept and slope	2	32828.70	32842.55	
Random intercept and fixed slope	10	32071.52	32140.78	773.17***
Random intercept and slope	45	27319.22	27630.86	4822.30***
Model 8				
Fixed intercept and slope	2	33147.41	33161.26	
Random intercept and fixed slope	5	32411.34	32445.97	742.07***
Random intercept and slope	10	30881.86	30951.11	1539.49***
Model 9				
Fixed intercept and slope	2	25396.85	25410.18	
Random intercept and fixed slope	5	24378.72	24412.05	1024.13***
Random intercept and slope	10	23055.97	23122.62	1332.76***

*** $p < .001$

Model 1, Model 2 and Model 3 tested valence level, Model 4, Model 5 and Model 6 tested the approach-avoidance motivation intensity and the approach-avoidance motivation and valence relationship, Model 7, Model 8 and Model 9 tested the approach-avoidance motivation and valence difference. Models were created for discrete emotions (Model 1, Model 4, Model 7), affective categories (Model 2, Model 5, Model 8), and for affective categories for positive emotions only (Model 3, Model 6, Model 9)

absolute terms, we found that a significant difference above zero (approach-avoidance motivation higher than valence, i.e., over-motivated affect) was observed for awe (Table 5). A significant difference below zero (approach-avoidance motivation lower than valence, i.e., undermotivated affect), was observed for amusement and low-approach emotions. In relative terms, amusement, and

anger tended to be undermotivated (the negative difference between approach-avoidance affect and valence) compared to neutral conditions. Low-approach emotions were also more undermotivated than neutral conditions. Finally, high-approach positive emotions were significantly more balanced than low-approach positive affect observed in amusement.

Table 2 Levels of valence for affective categories and discrete emotions

	Levels and differences from zero					Comparisons			
	<i>B</i>	<i>SE B</i>	<i>t</i>	<i>df</i>		<i>B</i>	<i>SE B</i>	<i>t</i>	<i>df</i>
Neutral	0.06	0.12	0.54	897	Intercept	0.57	0.10	5.30**	7437
Amusement	0.77	0.27	2.88**	966	Amusement vs. Neutral	1.04	0.07	14.44**	7437
Anger	-2.04	0.16	-12.63**	897	Anger vs. Neutral	-0.66	0.09	-7.18**	7437
Awe	1.52	0.19	7.90**	828	Awe vs. Neutral	0.73	0.08	8.94**	7437
Desire	2.48	0.20	12.45**	759	Desire vs. Neutral	1.45	0.08	17.19**	7437
Enthusiasm	2.94	0.21	14.30**	966	Enthusiasm vs. Neutral	1.53	0.08	17.42**	7437
Fear	-2.41	0.23	-10.60**	690	Fear vs. Neutral	-0.99	0.09	-10.63**	7437
Tenderness	1.50	0.16	9.59**	966	Tenderness vs. Neutral	0.81	0.07	11.36**	7437
High-Approach PE	2.11	0.13	16.27**	3726	High-Approach PE vs. Neutral	1.01	0.06	15.86**	7447
Low-Approach	-1.09	0.16	-7.00**	2691	Low-Approach vs. Neutral	0.10	0.07	1.42	7447
					High-Approach PE vs. Low-Approach	0.91	0.04	17.41**	7447
					High-Approach PE vs. Amusement	0.07	0.02	2.84**	5722

$p^* < .05$, ** $p < .01$

Testing for mean levels of parameters and comparisons to neutral condition. PE – positive emotions

Discussion

The present study examined absolute levels, relationships, and relative differences between valence and approach-avoidance motivation intensity in dynamic affective experience. Building upon prior research (Gable and Harmon-Jones 2008; Marchewka et al. 2014), we expected that these two dimensions of affect would be closely related, yet there would be meaningful differentiation across specific discrete emotions, e.g., high-approach positive emotions vs. low-approach positive emotions. As the secondary aim, we

examined other dynamic properties of the valence and approach motivation.

Continuous ratings for each clip revealed a significant positive relationship between valence and approach intensity. It means that in more pleasant moments individuals were more likely to feel the urge to approach, and in more negative moments, they felt the urge to withdraw. Although this finding is intuitive, we provided evidence for its validity in a dynamic context and across multiple discrete emotions that differed in their valence and approach-avoidance levels. It extends prior analyses regarding static material (Marchewka et al. 2014).

Table 3 Levels of approach-avoidance motivation for affective categories and discrete emotions

	Levels and differences from zero					Comparisons			
	<i>B</i>	<i>SE B</i>	<i>t</i>	<i>df</i>		<i>B</i>	<i>SE B</i>	<i>t</i>	<i>df</i>
Neutral	0.25	0.13	1.93	897	Intercept	0.57	0.10	5.30**	7437
Amusement	-0.33	0.27	-1.25	966	Amusement vs. Neutral	-1.00	0.08	-12.00**	7437
Anger	-2.28	0.20	-11.55**	897	Anger vs. Neutral	-1.10	0.11	-9.97**	7437
Awe	2.06	0.24	8.65**	828	Awe vs. Neutral	1.01	0.09	11.28**	7437
Desire	2.20	0.24	9.13**	759	Desire vs. Neutral	0.46	0.11	4.32**	7437
Enthusiasm	2.78	0.25	11.15**	966	Enthusiasm vs. Neutral	0.57	0.11	5.28**	7437
Fear	-2.07	0.28	-7.24**	690	Fear vs. Neutral	-0.32	0.13	-2.61**	7437
Tenderness	1.37	0.17	7.86**	966	Tenderness vs. Neutral	0.25	0.09	2.97**	7437
High-Approach PE	2.10	0.16	13.37**	3726	High-Approach PE vs. Neutral	0.58	0.07	8.02**	7447
Low-Approach	-1.49	0.17	-8.89**	2691	Low-Approach vs. Neutral	-1.02	0.08	-13.42**	7447
					High-Approach PE vs. Low-Approach	1.61	0.05	30.24**	7447
					High-Approach PE vs. Amusement	1.51	0.06	23.34**	5722

$p^* < .05$, ** $p < .01$

Testing for mean levels of parameters and comparisons to neutral condition. PE – positive emotions

Table 4 Relationship between valence and approach-avoidance motivation for affective categories and discrete emotions

	Levels					Comparisons			
	<i>B</i>	<i>SE B</i>	<i>t</i>	<i>df</i>		<i>B</i>	<i>SE B</i>	<i>t</i>	<i>df</i>
Neutral	0.41	0.09	4.77**	896	Intercept	0.58	0.11	5.29	7447
Amusement	0.47	0.08	6.02**	965	Amusement vs. Neutral	-0.09	0.06	-1.46	7437
Anger	0.78	0.05	15.50**	896	Anger vs. Neutral	0.12	0.06	2.05*	7437
Awe	0.62	0.07	9.46**	827	Awe vs. Neutral	-0.04	0.06	-0.70	7437
Desire	0.74	0.06	12.00**	758	Desire vs. Neutral	0.16	0.06	2.62**	7437
Enthusiasm	0.72	0.06	13.30**	965	Enthusiasm vs. Neutral	0.15	0.06	2.40*	7437
Fear	0.68	0.07	9.44**	689	Fear vs. Neutral	0.18	0.06	2.94**	7437
Tenderness	0.62	0.05	12.05**	965	Tenderness vs. Neutral	0.11	0.06	1.97*	7437
High-Approach	0.70	0.04	15.96**	3725	High-Approach PE vs. Neutral	0.12	0.06	2.18*	7447
Low-Approach	0.63	0.04	14.21**	2690	Low-Approach vs. Neutral	0.06	0.05	1.14	7447
					High-Approach PE vs. Low-Approach	0.06	0.02	2.91**	7447
					High-Approach PE vs. Amusement	0.20	0.03	7.12**	5722

p * < .05, ** *p* < .01

Testing for mean levels of parameters and comparisons to neutral condition. PE – positive emotions

We demonstrated that the relationship between valence and approach-avoidance motivation differed between discrete emotions and groups of emotions. For individuals who experienced high-approach positive emotions, the congruence between valence and approach motivation was higher compared to low-approach emotions, low-approach positive emotions, and neutral conditions. In contrast, low-approach emotions and neutral conditions had the same strength of the relationship between valence and the approach-avoidance intensity. Thus, the relationship between valence and the approach-avoidance motivation seemed to be enhanced

for high-approach emotions. This indicated that it was easier to predict approach-avoidance motivation from valence when individuals experienced high-approach emotions. Moreover, we found that low-approach positive emotions were undermotivated, whereas high-approach emotions were motivationally balanced.

We found only one instance of over-motivation, i.e., an experience where approach-avoidance motivation was significantly stronger than valence. Individuals who experienced awe while watching a clip presenting a large, modern city, reported more motivation to approach than pleasantness. A

Table 5 Differences between approach-avoidance motivation and valence for affective categories and discrete emotions

	Levels					Comparisons			
	<i>B</i>	<i>SE B</i>	<i>t</i>	<i>df</i>		<i>B</i>	<i>SE B</i>	<i>t</i>	<i>df</i>
Neutral	0.18	0.14	1.34	897	Intercept	0.86	0.15	5.67	7450
Amusement	-1.11	0.23	-4.81**	966	Amusement vs. Neutral	-1.30	0.26	-4.95**	7445
Anger	-0.23	0.22	-1.09	897	Anger vs. Neutral	-0.42	0.21	-2.02*	7445
Awe	0.53	0.20	2.62**	828	Awe vs. Neutral	0.34	0.35	1.40	7445
Desire	-0.28	0.22	-1.28	759	Desire vs. Neutral	-0.47	0.28	-1.67	7445
Enthusiasm	-0.15	0.19	-0.83	966	Enthusiasm vs. Neutral	-0.34	0.26	-1.34	7445
Fear	0.33	0.23	1.51	690	Fear vs. Neutral	0.15	0.20	0.74	7445
Tenderness	-0.13	0.16	-0.86	966	Tenderness vs. Neutral	-0.33	0.22	-1.46	7445
High-Approach PE	-0.01	0.12	-0.12	3726	High-Approach PE vs. Neutral	-0.20	0.20	-1.01	7450
Low-Approach	-0.41	0.16	-2.49**	2691	Low-Approach vs. Neutral	-0.59	0.17	-3.51**	7450
					High-Approach PE vs. Low-Approach	0.39	0.24	1.65	7450
					High-Approach PE vs. Amusement	1.10	0.27	4.11**	5725

p * < .05, ** *p* < .01

Testing for mean levels of parameters and comparisons to neutral condition. PE – positive emotions

previous study on awe provided a similar result with awe as an emotion with little positive expressiveness compared to other positive emotions (Campos et al. 2013). These findings seem to be in line with theories that associate awe with attractive information-rich stimuli that prioritize cognitive accommodation (Keltner and Haidt 2003). Awe motivates individuals to elaborate detailed representations of the world and build informational resources (Shiota et al. 2007). This approach emphasizes the cognitive aspect of awe. This is congruent with the diminished response in valence observed in our study. Moreover, unlike other positive emotions, awe directs attention away from the self and toward the environment (Shiota et al. 2007). If this was the case for individuals in our study, they might have allocated attention in the attractive material and, in turn, had less cognitive resources for the monitoring of their hedonic experience. However, this is the first study to report over-motivation in awe. Thus, this potentially unique feature of awe should be replicated.

These findings document how high-approach positive emotions differ from low-approach emotions in the strength of bindings between affective components. It provides a novel argument for the MDMA model that high-approach should be distinguished from low-approach emotions not only because of their different functions (Gable and Harmon-Jones 2008; Li et al. 2018) and neural correlates (Harmon-Jones et al. 2011) but also because of the way these two core elements interact with each other. This approach supports the notion that accounting for the motivational intensity improves differentiation within the family of positive emotions (Griskevicius et al. 2010; Gable and Harmon-Jones 2008; Shiota et al. 2017). Notably, observation of this phenomenon was possible because we used samples of continuous materials (different emotions) rather than discrete affective stimuli (e.g., photos). This allowed us to estimate the strength or relationship within one emotion or groups of emotions and compare it with other emotions or groups of emotions.

The examination approach-avoidance motivation levels in discrete emotions revealed that individuals who experienced awe, enthusiasm, desire, and tenderness (or high-approach positive affect in general) increased their approach-avoidance motivation compared to the neutral condition. Individuals decreased their approach-avoidance motivation while experiencing amusement, fear, and anger. This finding regarding anger was against our hypotheses. First, anger produced a significant decrease rather than an increase in the approach motivation. This finding is puzzling because the MDMA literature has provided neural evidence that anger is an approach-related emotion (Harmon-Jones and Allen 1998). Our ad hoc hypothesis is that the clip that we used to elicit anger (a rape scene) (Schaefer et al. 2010) produced comparable levels of other negative emotions such as fear or moral disgust. This hypothesis is supported by the fact that anger produced avoidance motivation intensity levels compared to

fear. More fine-tuned methods that control for other concurrent emotions within one situation might be necessary to corroborate this finding. For instance, scenes, where the anger-provoking agent is more powerful than the victim but less powerful than the witness (i.e., the research participant), might be less likely to commingle anger with fear.

Besides testing the research hypotheses regarding relationships, this study provided substantial descriptive material of dynamic affective stimuli. First, the affective ratings for valence and approach-avoidance motivation need at least several seconds to be effective compared to the neutral condition. It suggests that individuals need a considerable amount of time to develop the psychological meaning of a scene. This is important for experiments where timing is prioritized. Second, we observed that the emotional punchline of each clip is located at different moments throughout the clip. Thus, the effects of the clip can differ not only due to the overall amount of affect it generates but also due to the temporal distribution of the affective content (Kahneman et al. 1993). For instance, a clear separation between the valence and approach-avoidance motivations is visible for the amusement after ca. 100 s and the enthusiasm after 120 s. There is also an early and transient separation between effects of both types of affective clips for the fear – this separation starts ca. 30 s after the beginning and disappears within the next 30 s. It suggests that the effects of this fear-eliciting clip are short-lasting, whereas for amusement and enthusiasm they amplify in time. Third, there can be different punchlines within one clip, as it was the case with the tenderness clip that generated a negative valley first, and a positive peak later (Schaefer et al. 2010). Such composite clips can be used for the study of sequentially mixed emotions (Oceja and Carrera 2009). In sum, this study indicated that movie clips should be used with caution for emotion elicitation when the exact timing of emotions elicitation is essential. Moreover, researchers need more validation of clips with continuous methods on multiple dimensions for affective science to progress in accuracy.

There are limitations to this study. First, although we used several clips in each category (i.e., high-approach emotions, and low-approach emotions), we used only one clip for each specific emotion (e.g., anger). Thus, our analyses for specific affective stimuli are likely to capture uncontrolled affective and motivational influences that are specific for the clip but not for the emotion. Second, participants in this study watched the clips only twice. Thus, we did not account for the dynamics of arousal, the third component of affect (Gable and Harmon-Jones 2010a) that would require the third session. Third, rather than multiple viewing of the same clip, we might have used a biaxial psychometric tool that is capable of capturing two dimensions at the same time (Girard and Wright 2017). Despite more cognitive burden on the participant during biaxial reporting, such measurements might eliminate the problem of priming approach motivation by valence in half of the participants and vice versa.

These findings have a practical implication. First, we provide evidence that some positive emotions may be particularly relevant to enhance approach-motivation. Elicitation of these emotions might be considered for individuals where addressing the approach intensity is the target of interventions. For instance, abnormal approach motivation has been discussed in the context of clinical psychology (Trew 2011). In particular, decreased approach motivation has been linked to depression (Bijttebier et al. 2009) and anxiety (Coplan et al. 2006; Movius and Allen 2005). Further applied studies, might focus on how individuals with depression and social anxiety respond to high-approach vs. low-approach positive stimuli and whether affective stimulation with different approach intensity material contributes to the reduction of clinical symptoms and improves the quality of daily life.

The strength of this study is that we presented a detailed examination of the relationship between valence and approach-avoidance motivation as well as their relative magnitudes in a dynamic affective situation. Furthermore, we accounted for several positive emotions and provided further evidence for the diversity within this family of psychological phenomena. We present the first systematic evidence of how valence and approach-avoidance motivation converge and diverge in dynamic material. The current project is another step towards a better understanding of the basic structure of affect and how different elementary processes within this structure interact to produce distinct qualities of experience.

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Compliance with Ethical Standards

Conflict of Interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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