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Semantic and affective manifestations of ambi (valence)

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ABSTRACT

People sometimes report both pleasant and unpleasant feelings when presented with affective stimuli. However, what is reported as "mixed emotions" might reflect semantic knowledge about the stimulus (Russell, J. A. (2017). Mixed emotions viewed from the psychological constructionist perspective. *Emotion Review*, *9*(2), 111–117). The following research examines to what degree self-reported mixed emotions represent actual feelings compared to knowledge about the stimulus. In a series of three experiments, participants reported either their feelings or their knowledge in response to affective stimuli. In Experiment 1, we sampled the entire IAPS pictorial space and examined the proportion of mixed emotion ratings using feelings-focused and knowledge-focused self-reports. We found a higher degree of mixed emotions under knowledge-focused than feelings-focused self-reports. In Experiment 2, we used a priori selected pictures to elicit mixed emotions. The proportion of mixed emotions was again higher under knowledge-focused instructions. In Experiment 3, we used movie clips that were previously used to elicit mixed emotions. In contrast to Experiments 1 and 2, there was no difference between feelings-focused and knowledge-focused self-reports. The results suggest a strong semantic component and a weak experiential component of self-reports in the case of pictorial stimuli. However, ambivalent movie clips elicited a stronger experiential component, thus supporting the existence of mixed emotions at the level of feelings.

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Mixed emotions; ambivalence; valence

The term ambivalence (from Latin *ambo*, "both") suggests that the emotional response is not restricted to being either bitter or sweet. The potential bittersweet response has a special theoretical importance as it can unveil the underlying structure of the valence system. If pleasure and displeasure can be activated at the same time, it suggests the existence of two independent systems – one for pleasure and another for displeasure. However, if pleasure and displeasure are forced into reciprocal activation, the evidence supports a bipolar structure of the valence system. Evidence for the co-activation of pleasure and displeasure comes mainly from self-reports of feelings. The reliance on self-reports raises an important question, namely, to what degree do self-reports about mixed emotions reflect the participants' actual feelings and not semantic knowledge or cognitive reasoning (Itkes, Kimchi, Haj-Ali, Shpiro, & Kron, 2017; Russell, 2017)?

The structure of valence

Valence, the ability to represent external and internal events as positive and/or negative, is considered a cross-cultural, primary dimension of human emotions (Barrett, 2006). The representation of pleasure and displeasure within mixed emotional states bears special theoretical significance since it can reveal the underlying architecture of the valence system (Barrett & Bliss-Moreau, 2009; Larsen & McGraw, 2011). Two models of valence are traditionally discussed in the literature: bipolar and dual unipolar. An assumption of the bipolar model is that pleasure and displeasure are two polar opposites of the same dimension.

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Therefore, pleasure and displeasure cannot be activated simultaneously (e.g. Barrett & Russell, 1999; Lang, Greenwald, Bradley, & Hamm, 1993; Russell, 1980, 2003). Conversely, the dual unipolar valence structure (also known as the bivariate valence model) assumes that pleasure and displeasure are represented by two independent dimensions and therefore enable simultaneous activation (e.g. Cacioppo, Gardner, & Berntson, 1999; Kron, Goldstein, Lee, Gardhouse, & Anderson, 2013; Kron, Pilkiw, Banaei, Goldstein, & Anderson, 2015; Larsen, McGraw, & Cacioppo, 2001).

Providing initial support for a dual unipolar account of valence, studies have shown that participants rate certain stimuli as both positive and negative (e.g. Ersner-Hershfield, Mikels, Sullivan, & Carstensen, 2008; Hunter, Schellenberg, & Schimmack, 2008; Kron et al., 2013; Larsen et al., 2001; Stanley & Meyer, 2009; Williams & Aaker, 2002). One limitation of this initial evidence is its ability to exclude the alternative explanation of serial activation – a rapid vacillation between pleasure and displeasure (Barrett & Bliss-Moreau, 2009; Larsen & McGraw, 2011). If the serial activation hypothesis is correct, mixed emotions represent temporal shifts between pleasant and unpleasant emotions rather than a simultaneous activation of the two. In a creative line of studies designed to address this alternative explanation of vacillation (Larsen & McGraw, 2011), participants watched emotional and control video clips and were asked to press a key with one finger when feeling happy, another key with another finger when feeling sad, and both keys when feeling happy and sad at the same time. Evaluations in Larsen and McGraw were given online (and not post-stimulus as in previous research), and as such, provide support for the simultaneous activation of pleasure and displeasure.

It was recently suggested that what is reported as feelings of mixed emotions may reflect not only the affective state of the participant (i.e. the actual feelings of pleasure and displeasure), but also semantic judgments of stimuli (Russell, 2017). That is, self-reported pleasure and displeasure might reflect not (merely) the feelings in response to stimulus X, but also the participant's knowledge that stimulus X can be, or is, negative and positive. In light of this recent argument, the question about the nature of the human valence system still left open is: to what degree does the evaluation of stimuli as both pleasant and unpleasant (mixed) represent the actual emotional experience of mixed emotions as opposed to the semantic judgment of the stimulus?

The distinction between emotional experience and semantic judgment of stimuli

Many models of emotions make a distinction between "emotion" and "cognition about emotions". For example, terms such as cold versus hot emotions (Schaefer et al., 2003), cognitive appraisal versus feelings (Lazarus & Smith, 1988; Roseman & Smith, 2001), core affect versus affective quality (Russell, 2003), evaluative versus signal learning (Baeyens, Eelen, Van den Bergh, & Crombez, 1992), and experiential knowledge versus non-experiential knowledge Robinson and Clore (2002a, 2002b). A similar distinction is also prevalent in the attitude literature. For example, the definition of ambivalence varies, so that while some models define ambivalence as a state that can be described as both pleasant and unpleasant, other models emphasise the "cognitive" aspects or the conflict that arises in response to having both positive and negative evaluations to the same object (Harreveld, Nohlen, & Schneider, 2015; Schneider & Schwarz, 2017).

Inspired by the abovementioned literature, we previously suggested and empirically demonstrated a distinction between *affective* and *semantic* modes of valence (Itkes et al., 2017). Affective valence is defined as a short-term, object-oriented valence of emotional response (Barrett, 2006; Beedie, Terry, & Lane, 2005). For example, when a person notices a snake in the yard, an array of emotion-related changes might occur, such as change in heart rate, facial expression, and experienced feelings. However, people are also able to *know* that snakes are negative and potentially dangerous without having an emotional response. For example, passing by a terrarium of venomous snakes might activate categorical knowledge of snakes and their features (e.g. that they belong to conceptual categories of dangerous animals, reptiles, and negative things), but not necessarily an emotional response. That is, *semantic valence* is stored as conceptual knowledge about the valence of an object (e.g. Schacter, Wagner, & Buckner, 2000; Tulving, 1984; 1993; Wheeler, Stuss, & Tulving, 1997). Compatible with the taxonomy of semantic memory (e.g. Schacter et al., 2000; Tulving, 1984; 1993; Wheeler et al., 1997), the valence of an object or an event can be represented in a general, non-episodic manner. Thus, current taxonomy

focuses on the distinction between the valence of the *emotional response* and semantic knowledge about the valence of *stimuli*. In respect to ambivalent stimuli, the question is to what extent self-reports on mixed emotions reflect semantic knowledge about the stimuli or the participant's actual affective state. In this work, we use the term "ambivalence" to refer to the content or properties of the stimulus and "mixed" when referring to the emotional state elicited by the stimulus.

The present study

The aim of the following study is to apply our suggested theoretical and empirical distinction between affective and semantic valence to examine Russell's question about the involvement of non-affective aspects in self-reported mixed emotions (Russell, 2017). Specifically, the current line of experiments examines the degree to which self-reported mixed emotions are influenced by semantic knowledge about the stimulus or that they reflect actual feelings. We have developed two types of self-report instruction sets: the first is feelings-focused instructions that encourage participants to report about their feelings (and not semantic knowledge). The second is knowledge-focused instructions that encourage participants to report about their conceptual knowledge about the valence of the stimulus (Itkes et al., 2017). Next, we examine the proportion of self-reported ambivalence under feelings-focused and knowledge-focused instructions. In Experiment 1, participants provided feelings-focused and knowledge-focused self-reports in response to pictures from the IAPS picture pool (Lang, 1995), which is widely used in emotion research. In Experiment 2, we used pictures that were a priori selected to elicit mixed emotions. In Experiment 3, we used clips from the movie "Life Is Beautiful" that were used to study mixed emotions (Larsen et al., 2001; Larsen & McGraw, 2011).

Experiment 1

Participants

40 undergraduate students (32 women) from the University of Haifa, ranging in age from 18 to 36 ($M = 25.4$, $SD = 3.7$), participated in this study. The sample size was a priori determined based on effect sizes of previous experiments using a similar design (Kron et al., 2013; Kron et al., 2014). The participants received either course credits or monetary compensation for their participation. All participants had normal or corrected-to-normal vision. The participants were randomly assigned into one of the two instruction groups: (a) instructions that tap affective feelings ($n = 20$) and (b) instructions that tap semantic knowledge ($n = 20$).

Self-report

Feelings-focused

Self-report instructions were developed to reflect the participant's internal feelings, as opposed to evaluations based on semantic knowledge, expectations, or beliefs (for a complete description of the self-report procedure see Itkes et al., 2017). To achieve this goal, we used three rating scales presented as volume graphs ranging from 0 (none) to 8 (high). The scales rated "general" emotional feelings (participants were instructed to rate the maximum value of any type of emotions that they experienced, such as arousal, pleasure, displeasure, or any other feeling), pleasure (happiness, and/or any other pleasant feelings), and displeasure (sadness, unpleasantness, etc.).

We began by explaining the distinction between "feeling" and "knowing" to the participants. We emphasised two possibilities in particular: (a) confusing the evaluation of feelings with the evaluation of the content of the picture (e.g. experiencing an unpleasant/negative feeling vs. the content of the picture is unpleasant/negative), and (b) confusing feelings with beliefs or expectations about what "one should feel" while looking at a picture.

Next, participants were familiarised with the three scales. We used the first scale (emotional feelings) to frame the task as an "emotion detection task". Participants were told to think of this scale as a volume knob that indicates the intensity of their emotions and the question as whether or not they detected ANY emotion at all (e.g. pleasant and unpleasant, arousal, etc.). If no feelings were detected, they were instructed to press [0]. If the participants did detect emotional feelings, they were asked to rate the intensity of those feelings. The purpose of this scale was to reduce the accessibility bias (e.g. reports about semantic knowledge in the absence of strong feelings) by legitimising cases of no emotional feelings. If a participant detected feelings, the next two scales asked how positive/negative those feelings were.

Knowledge-focused

These instructions were developed to reflect the participants' semantic knowledge about the event conveyed by the image. To achieve that, we used the same pleasure and displeasure scales as in the self-report about feelings, but this time participants were instructed to rate how positive/negative the picture was. Participants were told that they were being asked about the valence of the picture, not about their own internal feelings.

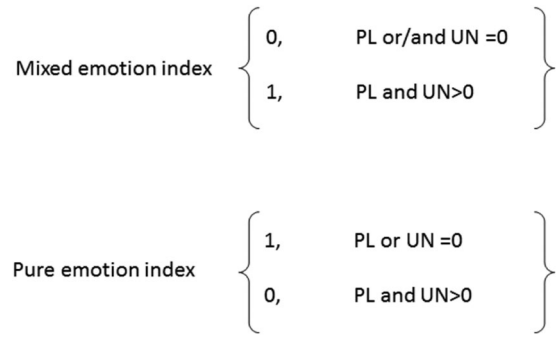

Figure 1. Mixed emotion index – a binary measure with a score of 0 if the report on the pleasant and/or unpleasant scale is zero and a score of 1 if the reports on both the pleasant and unpleasant scales are higher than zero. Pure emotion index – a binary measure with a score of 1 if the pleasant or unpleasant scale is 0 and a score of 0 if both the pleasant and the unpleasant scales are higher than or equal to zero.

Stimuli

Images for the current experiment were selected from the IAPS picture pool (Lang, 1995) in such a way that all possible combinations of arousal and valence of the IAPS were represented. To ensure that the stimuli were randomly chosen and equally distributed across the arousal-valence IAPS space, we used an in-house algorithm. The algorithm randomly selected a sample of 72 images[1] so that the resulting two-dimensional shape of the selected sample was the same as the original shape of the IAPS set, and all of the images were distributed across this shape in a uniform manner.

Design and procedure

Participants were tested individually in a quiet room. Upon arrival, they were asked to sign a consent form and given specific verbal instructions[2]; either feelings-focused or knowledge-focused instructions. They were instructed to keep their eyes on the screen during the experiment and to focus on the pictures shown on the computer screen. During each trial, a picture was randomly presented on a black background for six seconds, with an average 10-second blank screen interval between pictures. All experiments were designed using E-Prime 2 Professional Software (Schneider, Eschman, & Zuccolotto, 2002). Data analysis was performed using SPSS and SAS software.

Data reduction

For each trial, we computed three scores: a valence score, a binary mixed emotions index, and a binary pure emotion index. The valence score was computed by subtracting the negative from the positive scale (i.e. PL minus UN). The mixed emotion index evaluates the frequency of mixed emotions reports (contains both positive and negative reports) in each instruction group; the mixed emotion index was given the value "1" if both pleasant and unpleasant scores were above 0, and the value "0" if pleasant and/or unpleasant scores were equal to 0 (see Figure 1). The pure emotion index evaluates the frequency of pure emotion reports (contains only negative or positive reports); the pure emotion index was given the value "1" if pleasant or unpleasant are equal to 0, and the value "0" if pleasant and unpleasant scores are higher than 0 (see Figure 1).

Analytical strategy

The main analysis was set to examine two hypotheses: firstly, whether there is a difference in the proportion of mixed emotions between feelings-focused and knowledge-focused self-reports. Secondly, whether this difference was greater than the difference between feelings-focused and knowledge-focused self-reports in pure positive and negative indexes. To test the first hypothesis, we used a Generalized Linear Mixed Model (GLMM) with the instruction condition as a between participants variable, mixed emotion index as a dependent variable, and participants as a random variable. To test the second hypothesis, we carried out two analyses. In the first, we compared the difference between feelings-focused and knowledge-focused instructions in the proportions of the pure positive index and the mixed emotion index using a GLMM with instruction condition as a between participants variable, type of index (mixed and positive) as a dependent variable,

and participants as a random variable. In the second analysis, we compared the difference between feelings-focused and knowledge-focused instructions in the proportions of the pure negative index and the mixed emotion index using a GLMM with instruction condition as a between participants variable, type of index (mixed and negative) as a dependent variable, and participants as a random variable.

Results

We first examined the proportion of mixed emotions with feelings-focused and knowledge-focused instructions. The proportions of the mixed emotion index for both feelings-focused and knowledge-focused instructions were significantly greater than 0 (95% CI [.15, .19]), (95% CI [.36, .46]), respectively. Next, we directly examined whether the mixed emotion index changes based on whether participants received feelings-focused or knowledge-focused instructions. To verify that the proportion result is unique to self-reports of mixed emotion (and not characteristic of self-reports of pure states as well), we compared the effect of instructions (affective vs. semantic) between different valence ratings (mixed vs. pure pleasant or pure unpleasant). The proportion of the mixed emotion index (=1) was higher for the knowledge-focused ($M = .41$, $SD = .49$) than the feelings-focused ($M = .17$, $SD = .25$) conditions, F (1, 2911) = 11.94, $p < .0001$. The proportion of the pure positive emotion index did not show a significant difference between feelings-focused ($M = .28$, $SD = .14$) and knowledge-focused ($M = .31$, $SD = .14$) instructions, F (1, 2911) = .55, $p < .46$. The interaction ([mixed semantic vs. mixed affective] vs. [pure positive semantic vs. pure positive affective]) was significant F (1, 5822) = 8.08, $p < .0004$ (see Figure 2). Similar to the case of positive ratings, there was no difference in the pure negative emotion index between the feelings-focused ($M = .29$, $SD = .25$) and the knowledge-focused ($M = .24$, $SD = .11$) group, F(1, 2911) = 2.50, $p < .12$ with significant interaction ([mixed semantic vs. mixed affective] vs. [pure negative semantic vs. pure negative affective]) F (1, 5822) = 14.21, $p < .01$ (see Figure 2).

Discussion

The results of Experiment 1 suggest that participants do report about having mixed emotions even when specifically asked to report their feelings (and not semantic evaluation). Yet, the proportion of reported mixed emotions is substantially higher when participants report about the valence of the stimulus (semantic valence) than when participants report about their own feelings. The higher proportion of mixed reports in the

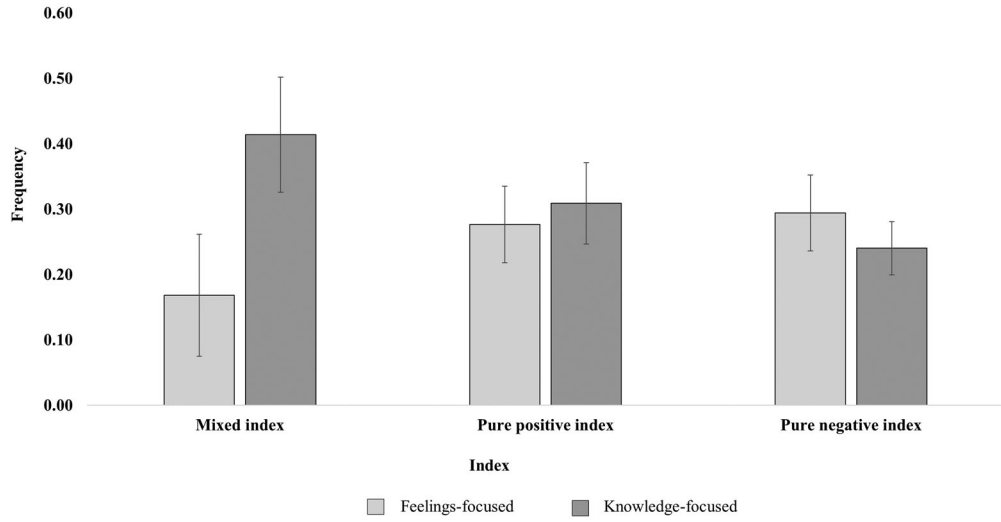

Figure 2. The proportion of mixed emotion, pure positive and pure negative indexes under feelings-focused and knowledge-focused instruction conditions. Error bars denote standard errors.

knowledge-focused condition indicates that a larger semantic component characterises self-reports of mixed feelings. The stronger semantic component is specific to mixed emotion reports as no such pattern was found for reports about pure positive and negative ratings.

Together, the results of Experiment 1 suggest that self-reports about mixed emotions are not simply semantic judgments of the stimulus, but at least in some cases represent the participants' affective responses (Russell, 2017). At the same time, the results suggest a higher proportion of reported mixed emotions with knowledge-focused reports. Consequently, it seems that the IAPS pool is a less than ideal source of stimuli for use in mixed emotion research – especially when traditional instructions for self-reports might involve both semantic and affective components. In Experiment 2, we examine if the higher proportion for semantic evaluation of mixed emotions is unique to the IAPS stimuli. It might be that the low proportion of mixed affective reports is because pictures in the IAPS pool were not a priori selected to elicit mixed states. In Experiment 2, we examined the proportions of semantic vs. affective evaluation using in-house samples of pictorial stimuli that were a priori selected to be positive, negative, and ambivalent.

Experiment 2

Similar to Experiment 1, in Experiment 2 participants viewed pictures and were asked to report either about their feelings (feelings-focused condition) or about semantic knowledge about the content of the stimulus (knowledge-focused condition). Contrary to Experiment 1, here pictures were a priori selected to elicit four valence categories: pleasant, unpleasant, neutral, and mixed feelings.

Participants

50 undergraduate students (43 women) from the University of Haifa, ranging in age from 18 to 34 ($M = 22$, $SD = 3.5$), participated in this study. The sample size was a priori determined based on effect sizes of previous experiments with similar design (Kron et al., 2013; Kron et al., 2014). The participants received either course credit or monetary compensation for their participation. All participants had normal or corrected-to-normal vision.

Stimuli

In the absence of a standardised stimuli pool to study the nature of mixed emotions, 56 pictures were selected from an in-house collection based on a pilot study – 14 pictures for each valence condition (pleasant, unpleasant, ambivalent, and neutral). The pictures from the in-house pool were rated according to the feelings-focused instructions described above.

Ambivalent pictures contained both pleasant and unpleasant content such as disabled puppies in a wheelchair (mixed index, $M = 1.24$, $SD = .31$; pleasant, $M = 2.74$, $SD = .75$; unpleasant, $M = 2.47$, $SD = .36$). Pleasant, unpleasant, and neutral pictures were matched to the ambivalent pictures so that, for example, pleasant pictures contained cute puppies and children (mixed index, $M = .04$. $SD = .07$; pleasant, $M = 4.97$, $SD = .39$; unpleasant, $M = .16$, $SD = .16$); unpleasant pictures contained abused animals and injuries (mixed index, $M = .09$. $SD = .10$; pleasant, $M = .06$, $SD = .08$; unpleasant, $M = 5.09$, $SD = .60$); and neutral pictures contained people and animals with minimal affective content (mixed index, $M = .12$, $SD = .12$; pleasant, $M = 1.12$, $SD = .58$; unpleasant, $M = .26$, $SD = .29$). Similar to Experiment 1, we computed indexes for pleasant, unpleasant, ambivalent, and neutral valence (see Figure 1).

Design and procedure

Participants were tested individually in a quiet room. Upon arrival, they were allocated to either the feelings-focused or knowledge-focused instructions group and asked to sign a consent form. All participants were instructed to keep their eyes on the screen during the experiment and to focus on pictures shown on the computer screen. During each trial, a picture with mixed, pleasant, unpleasant, or neutral valence was randomly presented on a black background for six seconds (i.e. a within participant condition). After each picture, the ratings scales appeared in counterbalanced order (in the feelings-focused group, the general feelings scale always appeared first). The average interval between pictures was 10 s.

Analytical strategy

In Experiments 2 and 3, continuous variables are analyzed in the statistical context of ANOVA. Analysis of frequencies (e.g. of mixed emotion index) involves a binary measure and a Generalized Linear Mixed Model (GLMM) was used. The manipulation check was set to examine the utility of the emotion

elicitation manipulation by comparing self-reports across the four valence conditions (i.e. pleasant, unpleasant, ambivalent, and neutral) and the two instruction conditions (feelings-focused and knowledge-focused). The analysis was performed separately for both the feelings-focused and knowledge-focused instructions using a within-participant ANOVA, with valence condition (pleasant, unpleasant, ambivalent, and neutral) as a within-participant variable, and positive/negative ratings as a dependent variable. In addition, we compared the proportion of mixed emotions between the four valence conditions using a GLMM, with valence condition as a within-participant variable, mixed emotion index as a dependent variable, and participants as a random variable.

Similar to Experiment 1, the main analysis was set to examine two hypotheses. Firstly, whether there is a difference in the proportion of mixed emotions between feelings-focused and knowledge-focused self-reports and, secondly, whether this difference was greater than the difference between feelings-focused and knowledge-focused self-reports in pure positive and pure negative indexes. To test the first hypothesis, we examined the difference in the proportion of mixed emotions between feelings-focused and knowledge-focused self-reports for the ambivalent condition only. This analysis was done using a GLMM with instruction condition as a between-participants variable, mixed emotion index as a dependent variable, and participants as a random variable. To test the second hypothesis, we performed two analyses. In the first, we examined if the proportion of the pure positive index between feelings-focused and knowledge-focused instructions is different from the proportion of the mixed emotion index. In the second, we examined if the proportion of the pure negative index between feelings-focused and knowledge-focused instructions is different from the proportion of the mixed emotion index. To this aim, we used a GLMM with instruction condition as a between-participants variable, pure positive/negative/ambivalent index[3] as a dependent variable, and participants as a random variable.

Results

Manipulation check

Feelings-focused negative scale

Comparing the four valence conditions for the feelings-focused negative scale (i.e. participants reporting about the degree of unpleasant feelings), the omnibus test was significant, F (3, 72) = 110.27, $p < .0001$, $\eta_p^2 = .821$. Specifically and supporting the emotion manipulation, pictures in the unpleasant condition were rated as more unpleasant ($M = 4.19$, $SD = 1.80$) than pleasant pictures ($M = .23$, $SD = .40$), t (24) = 11.50, $p < .0001$, Cohen's d = 3.078, and more unpleasant than neutral pictures ($M = .18$, $SD = .03$), t (24) = 11.57, $p < .0001$, Cohen's d = 3.153. In addition, pictures in the unpleasant condition were rated as more unpleasant than pictures in the ambivalent condition ($M = 1.44$, $SD = 1.11$), t (24) = 11.45, $p < .0001$, Cohen's d = 1.872. Pictures in the ambivalent condition were rated as more unpleasant than pleasant and neutral pictures (t (24) = 6.29, $p < .0001$, Cohen's d = 1.483, t(24) = 6.07, $p < .0001$, Cohen's d = 1.593, respectively).

Feelings-focused positive scale

Comparing the four valence conditions for the feelings-focused positive scale (i.e. participants reporting about the degree of pleasant feelings), the omnibus test was significant, F (3, 72) = 49.86, $p < .0001$, $\eta_p^2 = .675$. Pictures in the pleasant condition were rated as more pleasant ($M = 2.87$, $SD = 1.60$) than unpleasant pictures ($M = .20$, SD =.30), t (24) = 8.22, $p < .0001$, Cohen's d = 2.299, and more pleasant than neutral pictures ($M = .60$, $SD = .72$), t (24) = 7.76, $p < .0001$, Cohen's d = 1.825. In addition, pictures in the pleasant condition were rated as more pleasant than pictures in the ambivalent condition ($M = 2.42$, $SD = 1.55$), t (24) = 2.47, $p < .05$, Cohen's d = .289. Importantly, pictures in the ambivalent condition were rated as more pleasant than unpleasant pictures and neutral pictures (t (24) = 7.19, $p < .0001$, Cohen's d = 1.999, t (24) = 6.29, $p < .0001$, Cohen's d = 1.519, respectively).

Knowledge-focused negative scale

Comparing the four valence conditions for the knowledge-focused negative scale (i.e. participants reporting about the degree to which the stimulus is negative), the omnibus test was significant, F (3, 72) = 217.69, $p < .0001$, $\eta_p^2 = .901$. Pictures in the unpleasant condition were rated as more negative ($M = 6.68$, $SD = .55$) than pleasant pictures ($M = .78$, $SD = .80$), t (24) = 31.48, $p < .0001$, Cohen's d = 8.753 and neutral pictures ($M = 1.34$, $SD = 1.05$), t (24) = 25.20, $p < .0001$, Cohen's d = 6.527. Pictures in the unpleasant condition were rated as more negative than pictures in the ambivalent condition ($M = 2.95$,

$SD = 1.15$), t (24) = 12.65, $p < .0001$, Cohen's d = 3.283. Importantly, pictures in the ambivalent condition were rated as more negative than pleasant pictures and neutral pictures (t (24) = 7.22, $p < .0001$, Cohen's d = 1.791, $t(24) = 4.82$, $p < .0001$, Cohen's d = 1.239, respectively).

Knowledge-focused positive scale

Comparing the four valence conditions for the knowledge-focused positive scale, the omnibus test was significant, F (3, 72) = 127.30, $p < .0001$, $\eta_p^2 = .841$. Pictures in the pleasant condition were rated as more positive ($M = 6.91$, $SD = 1.05$) than unpleasant pictures ($M = 1.49$, $SD = .65$), t (24) = 22.70, $p < .0001$, Cohen's d = 6.237 and neutral pictures ($M = 4.41$, $SD = 2.10$), t (24) = 7.11, $p < .0001$, Cohen's d = 1.516. Pictures in the pleasant condition were rated as more positive than pictures in the ambivalent condition ($M = 6.34$, $SD = .90$), t (24) = 2.82, $p < .001$, Cohen's d = .571. Finally, pictures in the ambivalent condition were rated as more positive than unpleasant pictures and neutral pictures (t (24) = 24.84, $p < .0001$, Cohen's d = 6.183, t (24) = 4.89, $p < .0001$, Cohen's d = 1.204, respectively).

Mixed index

The proportion of mixed emotions differed between the four valence conditions, F (3, 3414) = 117.74, $p < .0001$. The relative frequency of the mixed emotion index was higher in the ambivalent condition ($M = .53$, $SD = .34$) than in the pleasant ($M = .19$, $SD = .24$), unpleasant ($M = .27$, $SD = .27$), and neutral ($M = .24$, $SD = .30$) conditions (F (1, 1682) = 257.54, $p < .0001$, F (1, 1682) = 159.08, $p < .0001$, F (1, 1682) = 202.39, $p < .0001$).

Main analysis

Similar to Experiment 1, we computed two measures; a binary mixed emotion and pure emotion index (see Figure 1). Examining whether participants report about mixed emotion feelings (and not just ambivalent semantic evaluations of the stimulus), the proportions of the mixed emotion index for both feelings-focused and knowledge-focused instructions in the ambivalent condition were significantly greater than 0 ((95% CI [.21, .43]), (95% CI [.62, .84]), respectively). Next, we examined if the mixed emotion index changes based on whether participants received feelings-focused or knowledge-focused instructions. The relative frequency of the mixed emotion index in the ambivalent condition was higher under knowledge-focused ($M = .73$, $SD = .27$) than feelings-focused instructions ($M = .32$, $SD = .27$), F (1, 816) = 23.02, $p < .0001$. To verify that the proportion result is unique to self-reports of mixed emotions (and not characteristic of self-reports of pure states), we compared the effect of instructions (affective vs. semantic) between three indexes of valence (mixed index and pure positive/negative indexes). In the positive condition, the proportion of the pure positive emotion index did not show a significant difference between feelings-focused ($M = .70$, $SD = .46$) and knowledge-focused ($M = .65$, $SD = .48$) instructions, F (1, 816) = .64, $p < .43$, and the interaction ([mixed semantic vs. mixed affective] vs. [pure positive semantic vs. pure positive affective]) was significant: the difference between feelings-focused ($M = .32$, $SD = .27$) and knowledge-focused ($M = .73$, $SD = .26$) in the proportions of the mixed emotion index in the ambivalent condition was greater than the difference between feelings-focused ($M = .70$, $SD = .23$) and knowledge-focused ($M = .65$, $SD = .26$) in the pure positive index in the positive category, F (1, 1681) = 98.28, $p < .0001$ (see Figure 3). In the negative picture conditions, the proportion of the pure negative emotion index did show a significant difference between feelings-focused ($M = .79$, $SD = .40$) and knowledge-focused ($M = .52$, $SD = .50$) instructions, F (1, 816) = .18.96, $p < .0001$, however, the pattern was in the opposite direction (see Figure 3). The interaction ([mixed semantic vs. mixed affective] vs. [pure positive semantic vs. pure positive affective]) was significant: the difference between feelings-focused ($M = .32$, $SD = .27$) and knowledge-focused ($M = .73$, $SD = .26$) in the proportions of the mixed emotion index in the ambivalent condition was greater than the difference between feelings-focused ($M = .79$, $SD = .20$) and knowledge-focused ($M = .52$, $SD = .23$) in the pure negative index in the negative condition, F (1, 1681) = 205.66, $p < .0001$ (see Figure 3).

Additional analysis for Experiments 1 and 2: controlling for scale intensity

In Experiments 1 and 2, in previous studies conducted in our lab (Itkes et al., 2017), self-reports based on semantic knowledge tended, on average, to be higher than self-reports based on affective feelings. Consequently, more ratings in the knowledge-

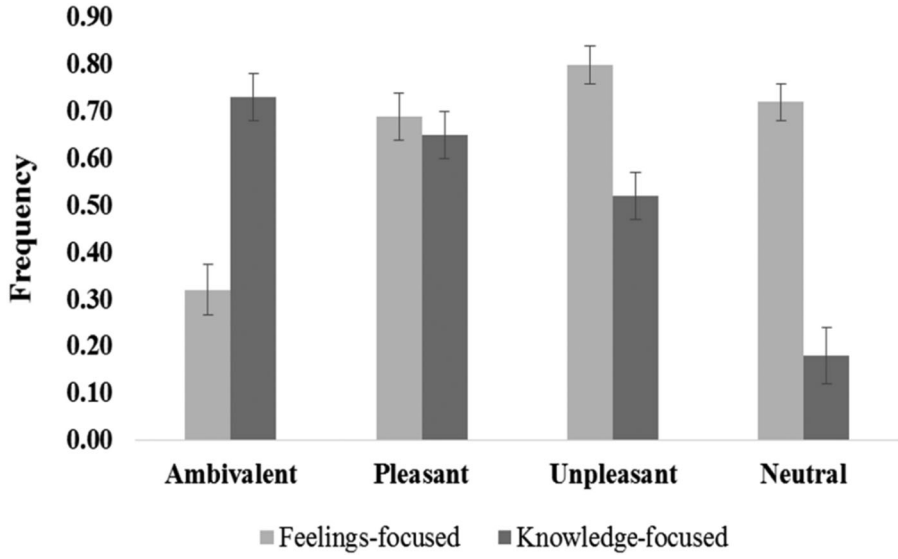

Figure 3. The X axis represents the stimulus category (ambivalent stimuli, pleasant stimuli, negative stimuli, and neutral stimuli). The Y axis represents the response category. Note that the Y axis is different for each stimulus category. For the mixed emotion stimulus category, Y represents the frequency of mixed emotions. For the "Pleasant" stimulus category, Y represents the frequency of pure pleasant reports, for the "Unpleasant" stimulus category, Y represents the frequency of pure unpleasant reports, and for the "Neutral" stimulus category, Y represents the neutral reports (both zero).

focused condition might exceed the threshold for mixed emotion, not because there are more mixed emotions but due to a random error.

To examine and exclude this alternative explanation, we performed an additional analysis on the results of Experiments 1 and 2 that controls for the maximum score (MAX (PL, UN)) of mixed emotion ratings. To control for the maximum score, we repeated the same analyses as reported in the main text (i.e. GLMM with instruction type as a between-participants variable, mixed index as a dependent variable, and participant as random variable) but we added the maximum score as an additional predictor. We first repeated the analysis of Experiment 1, controlling for the maximum score. The effect of the maximum score was significant F (1, 2910) = 98.23, $p < .0001$, suggesting that knowledge-focused instructions are indeed higher than feelings-focused. Critically, even when controlling for the maximum score, the frequency of mixed emotions in knowledge-focused instructions was higher than in the feelings-focused instructions, F (1, 2910) = 18.10, $p < .0001$. Next, we repeated the analysis of Experiment 2, controlling for the maximum score. Here we found no significant effect for maximum score, thus suggesting no difference between knowledge-focused and feelings-focused instructions. Critically, even when controlling for the maximum score, the frequency of mixed emotions in the knowledge-focused instructions was higher than in the feelings-focused instructions.

Discussion

In Experiment 2, pictures that were *a priori* selected to elicit mixed emotions were used. Similar to Experiment 1, participants reported a greater proportion of "mixed emotions" when they were asked to report about the valence of the stimulus (knowledge-focused), compared to when they were asked to report about their feelings. This pattern suggests that while stimuli can often be perceived as both positive and negative (e.g. when people rely on their conceptual knowledge), the affective mixed emotion response is scarce. The low frequency of such reports that were observed in both Experiments 1 and 2 could potentially stem from using stimuli that were simply not strong enough in terms of valence magnitude (Karmon-Presser, Sheppes, & Meiran, 2018). Experiment 3 is designed to address this issue by using ambivalent scenes from a movie that have previously been demonstrated to elicit strong mixed emotions (Larsen & McGraw, 2011).

Experiment 3

In Experiments 1 and 2, participants rated either their feelings (feelings-focused condition) or their knowledge (knowledge-focused condition) in response to pictorial stimuli. In Experiment 3, instead of pictures we used clips from the movie "Life Is Beautiful" that was used previously to show strong mixed emotion reports (Larsen & McGraw, 2011).

Participants

40 undergraduate students (24 women) from the University of Haifa participated in this study. The participants received either course credit or monetary compensation for their participation. All participants had normal or corrected-to-normal vision. The participants were randomly assigned to one of the two instruction groups: (a) feelings-focused, instructions that tap affective feelings, and (b) knowledge-focused, instructions that tap semantic knowledge.

Self-report scales

We used feelings-focused and knowledge-focused self-report scales identical to those in Experiments 1 and 2.

Stimuli

Two clips from the movie "Life Is Beautiful" (Benigni, 1997) were used in this experiment. The movie was dubbed in English and had Hebrew subtitles. Based on the study of Larsen and McGraw (2011), we chose two clips, ambivalent and negative, to serve as controls. The ambivalent clip was 19 min and 43 s long, and the control clip was 19 min and 40 s long. In Larsen and McGraw (2011), participants provided online ratings of their feelings while watching these clips. To ensure we selected those moments in the clip that have the highest probability of eliciting mixed and unpleasant emotions, self-report ratings in our study were presented at three different time points during each clip, based on the reported feelings of Larsen and McGraw (2011). For the ambivalent clip, self-report scales were presented after 6 min and 53 s, after 12 min and 10 s, and at the end of the clip (19:43). For the control clip, we sampled only those time points at which participants reported having negative emotions, so that self-report scales were presented after 13 min and 13 s, after 18 min and 54 s, and at the end of the clip (19:40).

Design and procedure

Participants were tested individually in a quiet room. Upon arrival, they were allocated to either the feelings-focused or knowledge-focused instructions group and asked to sign a consent form. During each trial, the ambivalent and negative clips were randomly presented (a within-participants condition). After each segment (3 segments during the ambivalent and 3 segments during the control clip), the rating scales appeared in counterbalanced order (in the feelings-focused group, the general feelings scale always appeared first). The participants were instructed to rate either their feelings or their semantic knowledge at the same exact moment the movie stopped.

Analytical strategy

The manipulation check was set to examine the difference between ambivalent stimuli and negative (control) stimuli. We used a within-participant ANOVA with valence condition (ambivalent, negative) as within-participant variable and positive/negative ratings as a dependent variable. Similar to Experiments 1 and 2, the main analysis was set to examine two hypotheses. Firstly, whether there is a difference in the proportion of mixed emotions between feelings-focused and knowledge-focused self-reports and, secondly, whether this difference was greater than the difference between feelings-focused and knowledge-focused self-reports in the negative indexes. To test the main hypothesis, we used a GLMM, to analyze the ambivalent condition only, with instruction condition as a between-participants variable, mixed index as a dependent variable, and participants as a random variable.

Results and discussion

Manipulation check

Table 1 summarises the descriptive statistics of self-report ratings for the ambivalent and control video clips (collapsed across the three movie segments). In order to demonstrate mixed emotion manipulation, we compared the ambivalent video clip to the negative clip. We expected the ambivalent clip to be rated as more positive than the negative clip, but show no less negativity than the negative clip. Ambivalent clips were rated as more positive than the negative control clips, $F\ (1,\ 38) = 4$, $p < .05$, $\eta_p^2 = .106$ and were not different in negativity from

Table 1. Average self-report ratings for ambivalent and control video clips.

	Ambivalent				Control (negative)			
	Pleasant		Unpleasant		Pleasant		Unpleasant	
Group	M	SD	M	SD	M	SD	M	SD
Feelings–focused	3.25	1.69	8.00	5.58	2.48	1.62	5.02	1.45
Knowledge–focused	4.03	1.13	4.83	1.42	3.35	1.64	5.28	2.30

Note: Average ratings of pleasure and displeasure for ambivalent and control (negative) movie clips for feelings-focused and knowledge-focused instructions.

the negative control clips, $F < 1$, suggesting that ambivalent clips were associated with both positive and negative ratings.

Main analysis

Similar to Experiments 1 and 2, we computed two measures: a binary mixed emotion and a pure emotion index (see Figure 1). Examining whether participants report about mixed emotion feelings (and not just ambivalent semantic evaluations of the stimulus), the proportions of the mixed emotion index for both feelings-focused and knowledge-focused instructions were significantly greater than 0 (95% CI [.71, .95]), (95% CI [.70, .93], respectively).

Next, we examined whether the mixed emotion index changes based on whether participants received feelings-focused or knowledge-focused instructions. We compared the effect of instructions (feelings-focused vs. knowledge-focused) between two valence conditions (negative vs. ambivalent). Similar to Experiments 1 and 2, the dependent variable was relative frequency of the mixed emotion index (see Figure 1). The relative frequency of the mixed emotion index was higher in the ambivalent ($M = .83$, $SD = .25$) relative to the negative control ($M = .71$, $SD = .33$) condition, $F\ (1,\ 199) = 4.96$, $p < .05$. However, contrary to Experiment 1, the difference between ambivalent and control clips was similar for the feelings-focused and knowledge-focused groups, $F(1, 80) = .21$, $p < .65$. In the negative control condition, the proportion of self-reported pure negative emotions did not differ between feelings-focused ($M = .83$, $SD = .38$) and knowledge-focused ($M = .82$, $SD = .39$) conditions, $F\ (1,\ 80) = .05$, $p < .83$. Given that no difference was found between feelings-focused and knowledge-focused conditions, the analysis for the second hypothesis was not performed.

The findings in Experiment 3 suggest that, contrary to the pictorial stimuli of Experiments 1 and 2, self-reports about ambivalent movie clips result in a similar frequency of mixed emotion feelings and semantic knowledge. The difference in the pattern of results between Experiments 1 and 2 and Experiment 3 might result from the type or intensity of stimuli we used. In particular, it is possible that the movie clips manipulated ambivalence more strongly. A direct comparison between self-reports in Experiments 2 and 3 supports this theory (see SOM 1): the movie clips we used elicited stronger feelings than the pictures used in Experiments 1 and 2.

General discussion

As Russell (2017) stated recently: "Feeling bad is one thing, judging something to be bad is another." This statement is supported by studies that suggest a distinction between affective and semantic representations of affect (Itkes et al., 2017). In accordance with this line of thought, it was suggested that what is reported as feelings of mixed emotions might not only reflect the affective state of the participant, but also semantic judgments of stimuli. In the current study, participants were asked to rate either their feelings (affective valence) or the valence of the stimuli (semantic valence) in response to pictures (Experiments 1 and 2) or movie clips (Experiment 3). The results showed that responses to pictorial stimuli were characterised by a higher frequency of semantic than affective mixed reports. However, responses to video clips showed a similar frequency of semantic and affective mixed reports.

The existence of mixed responses is traditionally taken as evidence for a dual unipolar structure of a valence system in which pleasure and displeasure are independent and can be activated simultaneously. Russell (2017) suggested that mixed emotion reports could potentially reflect semantic judgment. Specifically, measures that are typically used to probe mixed emotions might actually reflect semantic judgments or could be interpreted by the participants as such. The current empirical investigation shows that participants report about having mixed feelings even when the distinction between reporting about

feelings and reporting semantic knowledge is made explicitly. However, in two experiments, when pictorial stimuli were used, the proportion of semantic judgments of mixed emotions was much higher than affective judgments. These results are in accord with the findings of Hunter et al. (2008), that showed a greater proportion of mixed emotions when participants rated the valence of music compared to when they rated their own feelings in response to the same music.

Why was the proportion of self-reported mixed emotions higher when participants watched the ambivalent scenes from the movie "Life is Beautiful" than when they had seen ambivalent pictures? One possible explanation is that the movie clips elicit more intense emotions than the pictures (see also the analysis in SOM 1). If stimuli elicit a weak affective response, the probability that both pleasure and displeasure meet the criterion to be reported is lower (Karmon-Presser, Sheppes, & Meiran, 2018). Consequently, more cases of either pleasure or displeasure are expected with low intensity stimuli compared to stimuli that elicit a stronger affective response. Contrary to affective reports, semantic reports are not expected to be influenced by the intensity of the affective response. For example, Itkes et al. (2017) showed that repeated exposure to affective stimuli reduces the magnitude of the affective response but does not affect semantic knowledge. One way to explain why semantic mixed reports are less affected by stimulus intensity, is that semantic knowledge is *category* specific (Farah & McClelland, 1991; Farah, Hammond, Mehta, & Ratcliff, 1989; Thompson-Schill, Aguirre, Desposito, & Farah, 1999) and not affected by the properties of a particular stimulus. For example, semantic judgment of valence in response to a picture of a snake reflects the valance of the entire category (snakes in general). That is, to what degree *snakes* are positive or negative. The category of *snakes* encompasses different potential instances and, consequently, the probability of a snake having both positive and negative features increases. However, unlike semantic judgments, judgment about feelings are object related (see Beedie et al., 2005, for a review) and are a reaction to a *specific* object or event (e.g. Damasio, 1999; Lazarus, 1994; Levenson, 1994). As such, reports about feelings depend on the specific features of the stimuli, i.e. the specific snake in the picture. The probability that one specific instance will elicit both highly pleasant and unpleasant feelings at the same time is lower.

The different patterns of semantic versus affective mixed reports for pictures and movies suggest that when examining mixed emotions, stimuli selection is crucial. In emotion experimental research, stimuli usually vary between words (e.g. Bradley & Lang 1999), pictures (e.g. Lang, 1995), movies (e.g. Carvalho, Leite, Galdo-Álvarez, & Gonçalves, 2012), and sounds (e.g. Bradley & Lang, 2007). Our results suggest that certain types of stimuli might have a greater degree of success in eliciting actual affective mixed responses in experimental settings. This question is especially important in studies that aim to select stimuli that have a high probability of eliciting affective responses in the participants; and not just semantic evaluations. For example, in a study by Larsen and colleagues (Larsen, Norris, & Cacioppo, 2003; see also Kron et al., 2013), self-reported mixed emotions were obtained for pictures (27%)[4], words (29%), and video clips (36%). Given the current results, it is quite possible that these results are inflated, as the reports are most likely, at least partially, influenced by the participants' semantic evaluations.

In most experiments, the reports do not focus explicitly on affective or semantic judgment (for an exception, see Hunter et al., 2008). In such cases, it is unclear whether and to what degree they reflect affective or/and semantic judgments. Here, the intensity of stimulus might also play a critical role. For example, Robinson and Clore's accessibility model (2002a) suggests that if information about the actual feelings is absent or vague (such as in cases where a great deal of time has passed since the emotional event), the report will reflect more episodic or semantic information. While Robinson and Clore emphasised the amount of time passed since the emotional event occurred, the magnitude of the emotional response might influence its accessibility as well. When stimuli elicit a low affective response, experience is less accessible and, consequently, reports might rely more on semantic information.

Another explanation for the divergent pattern of semantic vs. affective mixed reports in pictures and movies has been suggested by an anonymous reviewer. It is possible that affective and semantic representation of valence interact. It might be so that when stimuli have weak to moderate intensity, participants are able to differentiate between their affective and semantic representations. However, when both affective and semantic intensity are high, it might not be possible to reflect only on the affective component of the response. Given that the movie "Life is

Beautiful" has a strong semantic and affective meaning to the participants of this study (the story in the movie takes place during the holocaust and participants are Israeli Jews), it is possible that a strong semantic component interacted with the affective response, which resulted in a mixed emotion self-reported response.

An important research question that is implied by the above discussion is the difference in intensity of feelings in response to pictures and movie clips. We found that movie clips elicited stronger affective responses than pictures. These results are in accord with previous research that shows a similar pattern of results (e.g. Heiman, 1980; Julien & Over, 1988; see also Uhrig et al., 2016). It has been suggested that the representation created by movies is more concrete (contains more details) than the representation created by pictures (Posner, 1970; Trope & Liberman, 2010). The more concrete the media, the larger the amount of details it provides. The more abstract the media is, the less it reflects a single, specific event and, therefore, the level of emotional impact is lower (Carnevale, Fujita, Han, & Amit, 2015). There were also other possible differences between picture stimuli and movie clips in the current study, such as the topic represented by the stimuli, the discrete emotions they might elicit, etc. As a first step, the current research suggests that movie clips might elicit a higher proportion of mixed feelings. Further investigation is needed to determine the relevant stimulus properties that affect the degree to which participants experience mixed emotions.

Notes

1. Picture number in the IAPS:

8475	8475	4668	4668	4668	6200	6200	6200	4664.1	4664.1	4664.1	1710
1710	1710	1750	1750	1750	5500	5500	5500	5764	5764	5764	2688
2688	2688	7092	7092	7092	1070	1070	1070	2491	2491	2491	8080
8080	8080	3185	3185	3185	1670	1670	1670	3000	3000	3000	4142
4142	4142	7640	7640	7640	8170	8170	8170	1450	1450	1450	5130
5130	5130	2530	2530	2530	2040	2040	2040	2456	2456	2456	9008
9008	9008	5910	5910	5910	3213	3213	3213	2445	2445	2445	3061
3061	3061	6570	6570	6570	9045	9045	9045	1350	1350	1350	1304
1304	1304	7185	7185	7185	7490	7490	7490	2205	2205	2205	1112
1112	1112	8190	8190	8190	7004	7004	7004	4490	4490	4490	2095
2095	2095	1610	1610	1610	1720	1720	1720	4693	4693	4693	1050
1050	1050	2384	2384	2384	5270	5270	5270	9331	9331	9331	4240
4240	4240	5661	5661	5661	3500	3500	3500	8116	8116	8116	8030
8030	8030	9220	9220	9220	3110	3110	3110	4225	4225	4225	7920
7920	7920	7200	7200	7200	4603	4603	4603	3005.2	3005.2	3005.2	1321
1321	1321	6832	6832	6832	5629	5629	5629	8160	8160	8160	4220
4220	4220	3053	3053	3053	5970	5970	5970	8497	8497	8497	4210
4210	4210	7286	7286	7286	2396	2396	2396	5779	5779	5779	8475

2. In Experiments 1, 2 and 3 facial electromyography signal was collected and will not be reported here.
3. Only pure positive reports obtained in the positive condition were included in the pure positive index (pure positive reports to pictures from the negative or ambivalent conditions were not included in the pure positive index). Similar logic was applied to the pure negative index (only pure negative reports to pictures from the negative condition were included) and to the mixed emotion index (only mixed emotion reports to pictures from the ambivalent condition were included).
4. The pictures used in Larsen et al., (2003) were sampled from the same pool as those selected for Experiment 1 in the current work.

Disclosure statement

No potential conflict of interest was reported by the authors.

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