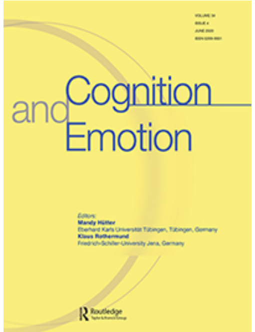

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The combination of multiple affective experiences and their impact on valuation judgments

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ABSTRACT

People's affective experiences can be influenced by multiple informational inputs. It remains unclear however how this occurs? In this paper, we investigate the construction of affective experiences dependent on the varying number of previously presented, affectively-charged, informational inputs. In addition, because affect is often used as a cue in judgment and decision-making, we probe whether the resulting affective experience is mapped onto people's valuation judgments (how much people are willing-to-pay for target rewards and experiences). In three studies, we show that people's overall affective experience is constructed by averaging the affect of the previously presented, affectively-charged inputs. Subsequently, we find that people rely on the resulting affective experience as a cue for their judgments, as willingness-to-pay valuations were predicted by the combined affective experience. We measured integral, expected, as well as momentary affect – using both self-report and physiological measures. We discuss the potential for studying further how multiple inputs change affect as well as the implications for judgment and decision making.

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Affect construction; affect combination; decision-making; willingness-to-pay

People's affective experiences change in response to single, affectively-charged informational inputs (e.g. an image, descriptive vignette, or a movie clip). However, affect can change in response to many informational inputs (Satpute et al., 2015). Sometimes this is one single powerful external event, but typically there are multiple inputs, including some which may be beyond human ability to detect (Russell, 2009). And yet, the question of how multiple informational inputs, which in and of themselves evoke changes in affect, impact the overall affective experience, remains critically underexplored.

Affect is used as a term to describe a neurophysiological state which is accessible to consciousness as a simple non-reflective feeling, e.g. feeling good or bad, feeling lethargic or energised (Barrett, 2006; Russell, 2009). In this paper, we present multiple affectively-charged informational inputs to people, focusing specifically on how the resulting affective experience is constructed and whether it is used as a judgment and valuation cue.

The construction of affective experiences is especially relevant in judgment and decision-making situations. Numerous studies have shown that people rely on affect when making decisions (cf., Cohen, Pham, & Andrade, 2008; Lerner, Li, Valdesolo, & Kassam, 2015 for reviews). This reliance has been described as a heuristic (Finucane, Alhakami, Slovic, & Johnson, 2000) with people often simplifying the process by asking themselves "how do I feel about it", and using affect as a guide for judgments (Wyer, Clore, & Isbell, 1999). Furthermore, judgment situations are rife with various informational inputs. Today's decision makers in particular are inundated with information about their choices (Lurie, 2004) with emotion appeals and affect-laden imagery being a consistent feature of decision-making situations (Brader & Corrigan, 2006). Figuring out how people construct affect can therefore give us a valuable insight into a person's judgments.

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Combination of affect

We propose that people's affective experiences are the result of a combination of previously presented affectively-charged informational inputs. Previous thinking lends credence to this proposition. For instance, Neumann, Seibt, and Strack (2001, p. 727) have suggested that " … whenever a new affective stimulus is encountered, the resulting affective feeling is a function of the valence and intensity of the feelings present at the time of the encounter, and the valence and intensity of the affective feeling elicited by the new stimulus". In similar vein, in the decision-making domain, Slovic, Peters, Finucane, and MacGregor (2005) have proposed an "affect pool", where affective qualities of a stimulus are mapped and integrated (i.e. combined), and which is consulted when making judgments and decisions.

In developing our approach, we draw from findings obtained in impression formation and information integration. This line of research has shown that various stimuli can have an effect on an individual and that the stimuli can be transformed by valuation operations into goal-related values, which are then summed by an integration operation into a unitary response (Anderson, 2013). This research suggests that many processes which include multiple stimuli (informational inputs) are expected to follow simple arithmetic operations (Anderson, 1979). One such operation is *averaging* where attaching moderately desirable to highly desirable features leads to less positive judgments and evaluations (Anderson, 1981). Another identified operation is *summation* (Anderson, 1979), where something with two highly desirable features is valued as less desirable, compared to something with three highly desirable features (Podell & Amster, 1966). Non-integration operations have also been suggested as a response to multiple affectively-charged inputs. For example, when people receive informational inputs in a sequential manner, instances of primacy and recency can take precedence (e.g. González-Vallejo et al., 2014; Olsen & Pracejus, 2004). Thus, unlike Anderson's (2013) suggestion of information integration, seeing a highly desirable feature first (or last), could be valued more in accordance with a primacy (or recency) effect. For affective stimuli, the effect of recency is implied, for instance, by the "peak-end-rule", proposed by Fredrickson and Kahneman (1993), replicated for both aversive stimuli (Ariely & Carmon, 2000) and positively valenced messages (Baumgartner, Sujan, & Padgett, 1997). Primacy has also been found in impression formation (Asch, 1946; Crano, 1977). While there seems to be more evidence for integration in many areas of human psychology (Anderson, 2013), we also pay attention to indications of these sequential effects in our data.

In investigating how affect is constructed, as a function of multiple, affectively-charged inputs, we are also interested in seeing which integration operation (if any) might explain this construction. Although finding a difference between the operations may appear a purely theoretical endeavour, it has important practical implications. To illustrate, imagine that you are looking to book a hotel online. Multiple informational inputs about the hotels are presented, each affectively charged, prompting changes in overall affect (e.g. "hotel is in high demand, you might not make it to booking" – *unpleasant*; "close to the beach" – *pleasant* and so on). Say we have narrowed down your choice to two hotels. Hotel "A" is described with one highly and two moderately pleasant informational inputs while hotel "B" is described with one moderately and one highly pleasant feature. If summation is the governing rule, we should expect hotel A to be more valued since the affect will be added and thus the total sum will be superior for this option. In contrast, if averaging is the rule, hotel B will be more favoured. Therefore, discerning the integration operation would allow us to better understand the affect combination process, but also to predict people's valuation judgments in real life.

Present research[1]

We report three studies that investigate the construction of affective experience as a function of the sequential presentation of multiple, affectively-charged, informational inputs. In all studies, the inputs are related to a single judgment target which was presented in the form of a potential reward to win (Studies 1 and 2) or an experience to participate in (Study 3; e.g. Bateman, Dent, Peters, Slovic, & Starmer, 2007; Rottenstreich & Hsee, 2001). Examples include "concert tickets", "a boat trip" and "restaurant dinner". The rewards and experiences were hypothetical in nature, in all three studies. The inputs were descriptive in Studies 1 and 2 (e.g. "there are more tickets sold than there is space", "the tickets are for your favorite band"), but we used validated images from the OASIS database in Study 3 (Kurdi, Lozano, & Banaji, 2017). After the presentation of the inputs, we measured people's overall affective experience, which we predicted would be emblematic of a combination. We measured several types of affect: *integral* (Studies 1, 2, and 3) – affect arising from the judgment or choice at hand (Loewenstein & Lerner, 2003), *expected* (Studies 1 and 2) – future affect one expects to feel as a result of different courses of action (Loewenstein, Weber, Hsee, & Welch, 2001), and *momentary* affect (Study 3) – overall core affective experience (Lerner et al., 2015; Russell, 2003). Most notably, we tested the operation behind the proposed combination (i.e. whether it is more emblematic of averaging, summation, primacy, or recency). All of the studies followed the same basic trial procedure described in Figure 1.

Study 1

The first study presented two informational inputs designed to evoke either a pleasant (P) or unpleasant (N) affective experience. It therefore crossed two factors of a 2 (first input: P vs. N) × 2 (second input: P vs. N) within-participant design, resulting in four possible scenarios: PP, PN, NP, and NN – that each participant went through. If people's overall affective experience is a result of combination, as per Anderson (2013), we should observe additive effects in our data. In other words, we should see two main effects. However, if the overall affective experience is a result of primacy or recency, we should only see a main effect of the first or second input, respectively. Because people use affect as a cue (Schwarz & Clore, 2003; Slovic et al., 2005), we also expected that the combined affective experience would map onto the judgment and that we would observe the corresponding effects on the willingness-to-pay measure.

Method

Participants

One hundred and twenty-seven[2] students from the University of Sarajevo participated in exchange for course credit. Three were excluded for failing to follow instructions, leaving us with 124 participants in total (81% female, $M_{Age} = 21.11$, $SD_{Age} = 2.36$). All participants filled out a consent form at the beginning and were debriefed at the end in accordance with ethical standards.

Procedure

Participants completed the study in groups of up to 4. They were separated and could not interact. They

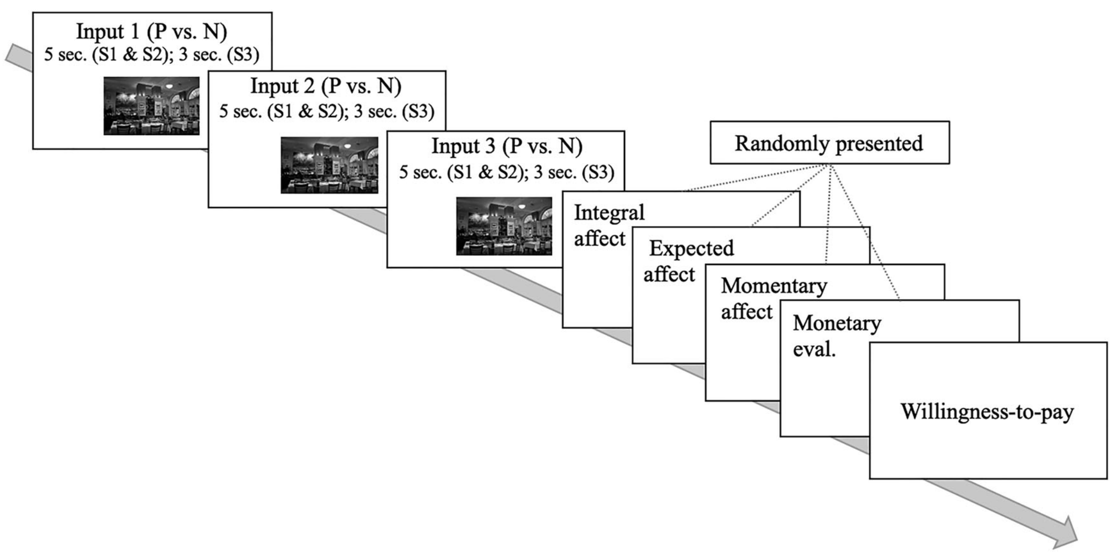

Figure 1. Procedural representation of one trial across all three studies. Each trial consisted of a sequential presentation of a specific affectively charged input (P = pleasant; N = unpleasant). Two inputs were shown in Study 1 (for 5 s), two or three were shown in Study 2 (for 5 s) and Study 3 (for 3 s). The inputs were related to a single judgment target. In studies 1 and 2, the judgment target was illustrated throughout the trial with a corresponding picture (e.g. a picture of a restaurant was presented for the "restaurant dinner" target reward). The association of the inputs and the judgment targets was randomised along with their order. Thus, one participant could see a judgment target (e.g. restaurant dinner) in a PN scenario (meaning that first a P input and then an N input was presented) on the first trial, while a different participant could see the same judgment target in an NN scenario in a different trial. Participants were then asked to provide their estimates of affective experience and monetary evaluation. Finally, the question regarding the hypothetical willingness to pay (i.e. the valuation judgment) was always presented last.

were randomly presented with all four trials corresponding to the crossing of the two factors. Each trial (see also Figure 1) was described as a game, which offered different rewards (judgment targets). The rewards could not actually be won, as they were hypothetical. Participants were then told that for each reward, they would receive several pieces of information, which would be presented for five seconds. These were the affectively charged inputs.[3] The rewards were: concert tickets, restaurant dinner, a set of academic textbooks, and a short trip. During one trial, an image representing the reward was also constantly presented on the screen because we wanted to help our participants visualise the game. Afterwards, in randomised order, participants provided responses to questions on integral affect ("*How does this reward make you feel?*"), expected affect ("*How would you expect to feel if you were to win in the game?*") on a scale from −8 = unpleasant; 8 = pleasant (to facilitate the computation of results, for these two scales, the anchors were re-coded to range from 1 to 17, with higher scores indicating more positive affective reactions), and how much they thought each reward cost in euros (i.e. monetary evaluation). Finally, participants were asked how much money they were willing to pay to play a game where that particular reward could be won. This was measured as the mean number of €0.50 tickets bought, with each ticket ensuring one attempt at the game. The game was fictional and participants were not giving real money, hence providing their hypothetical willingness-to-pay.

Results

Integral affect

In information integration, additive effects can serve as an indication of combination. As expected, a 2 × 2 repeated measures ANOVA showed a main effect of the first, $F(1, 123) = 66.63$, $p < .001$, $dz = .73$ and second input, $F(1, 123) = 63.47$, $p < .001$, $dz = .72$. Adding an N input resulted in less pleasant integral affect. Conversely, adding a P input resulted in more pleasant integral affect. The interaction was not significant, $F(1, 123) = 3.57$, $p = .06$, $dz = .17$ (see Table 1 and Figure 2 for the results on all measures in Study 1).

Expected affect

The same analysis as above again found a main effect of the first, $F(1, 123) = 47.56$, $p < .001$, $dz = .62$ and second input, $F(1, 123) = 44.32$, $p < .001$, $dz = .60$. The interaction however, was significant, $F(1, 123) = 5.22$, $p = .02$, $dz = .21$. The difference between the first P and N input was less strong when the second input was P, $F(1, 123) = 8.52$, $p = .004$, $dz = .26$, than when it was N, $F(1, 123) = 41.33$, $p < .001$, $dz = .58$. Given that the interaction is ordinal, we do not consider it as qualifying the additive effects. Rather, the interaction seems to indicate a negativity effect which we reflect upon in the general discussion.

Monetary evaluation

We again found a main effect of the first, $F(1, 123) = 28.09$, $p < .001$, $dz = .48$ and second input, $F(1, 123) = 7.02$, $p = .01$, $dz = .24$. The interaction was not significant, $F(1, 123) = 1.67$, $p = .20$, $dz = .12$.

Hypothetical willingness-to-pay

Affective experience seemed to have mapped onto the valuation judgment as there was clear indication of additive effects with a main effect of the first, $F(1, 123) = 34.83$, $p < .001$, $dz = .53$ and second input, $F(1, 123) = 28.54$, $p < .001$, $dz = .48$. The interaction was not significant, $F(1, 123) = 1.31$, $p = .25$, $dz = .10$.

Mediation by affect

Next, we aimed to demonstrate that affect mediated the differences between the affective input trials and the valuation judgment. In within-subject designs, multilevel mediation modelling is recommended, but it can

Table 1. Means and SD's for the four affective trials presented in Study 1, for the combined integral and expected affect, monetary evaluation, and hypothetical willingness-to-pay valuation judgment.

Affective trials	Integral M (SD)	Expected M (SD)	Mon value M (SD)	Will-to-pay M (SD)
PP	14.19 (2.84)	14.40 (3.24)	226.98 (200.00)	25.72 (26.29)
PN	12.37 (3.64)	13.08 (3.26)	189.77 (213.44)	18.65 (23.89)
NP	12.70 (3.41)	13.19 (3.29)	174.07 (175.13)	19.88 (22.45)
NN	9.61 (3.77)	10.51 (3.67)	102.08 (123.14)	8.40 (13.40)

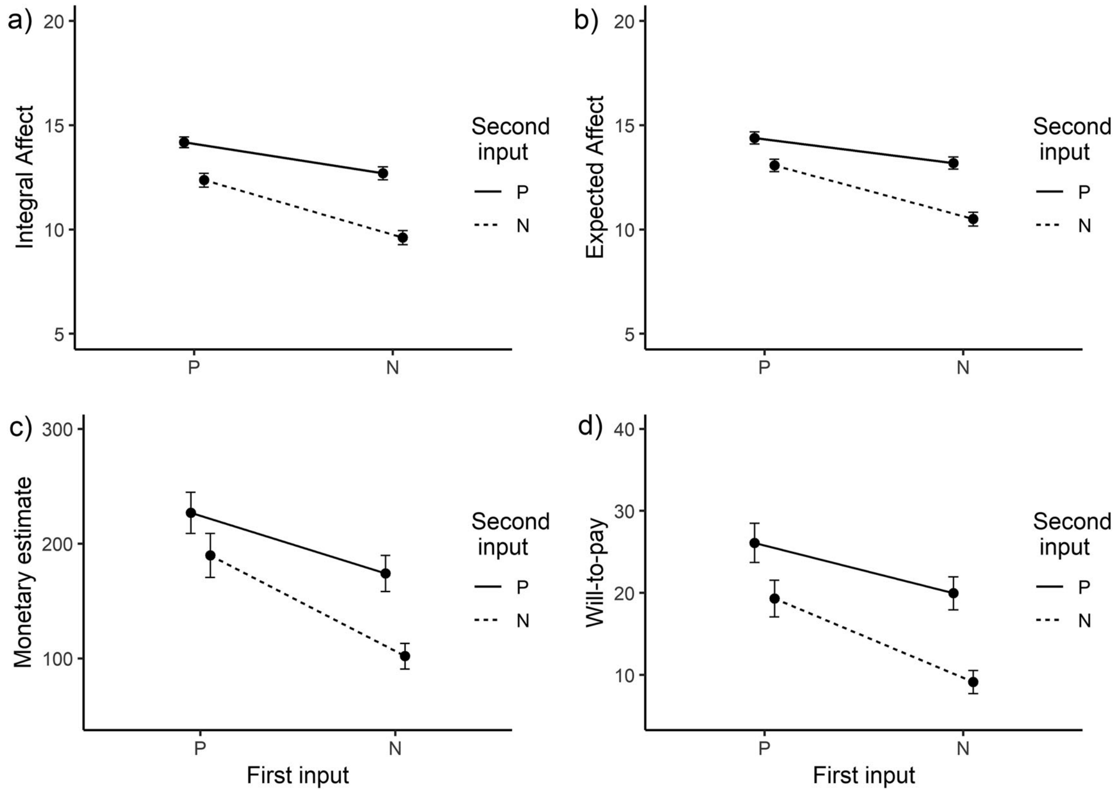

Figure 2. Demonstration of affective combination with two affectively-charged inputs. Means and SE's of the mean for: (a) integral affect, (b) expected affect, (c) monetary estimation, and (d) hypothetical willingness to pay, as a function of the pleasantness (P = pleasantly charged input and N = unpleasantly charged input) of the first and second input for Study 1. Note the additive effects which indicate combination for the affective measures and the mapping of said combination onto the hypothetical willingness-to-pay.

be difficult to do with more than two (MacKinnon, Fairchild, & Fritz, 2007) experimental groups as here. Therefore, we decided to focus on two trials i.e. PP and NN. This contrast has the greatest difference in input affectivity as well as the greatest difference in overall affective experience, allowing us to more directly demonstrate that the change in the judgment valuation is transmitted through affect. We used the "*blml*" package in R for multilevel mediation (Vuorre & Bolger, 2017) and conducted two mediation analyses with the X variable having two levels: PP and NN. The first analysis had integral, while the second had expected affect as the mediating variable. The Y variable, in both analyses, was hypothetical willingness-to-pay. The mediation model was estimated using Stan's Markov Chain Monte Carlo algorithms with 10.000 MCMC's.

Mediation by integral affect

The magnitude of the mediation effect, me = −5.03, 95% CI [−12.04, 1.95] did not find support for mediation. The total effect however, of c = −17.11, 95% CI [−22.15, −12.08] did decrease after adding integral affect, c′ = −12.08, 95% CI [−20.07, −4.48].

Mediation by expected affect

In contrast to integral affect, expected affect did mediate between the two affective trials and hypothetical willingness-to-pay, me = −3.11, 95% CI [−7.04, −0.10]. Total effect of c = −17.07, 95% CI [−21.69, −12.60] decreased to c′ = −13.96, 95% CI [−18.73, −8.88], after adding expected affect.

Discussion

The results of Study 1 indicate that the overall affective experience, as measured by integral and expected affect, was a product of a combination of the previously presented, affectively-charged, informational inputs. Relying on previous research in information integration (Anderson, 2013), we found the predicted additive effects in our data. In practice, this meant that people's affective experiences were most pleasant when the preceded inputs were both pleasant (PP), lower when one was pleasant and the other unpleasant (PN and NP), and lowest when both were unpleasant (NN). Crucially, none of the findings favoured a primacy or recency operation. If they had, we would have observed either only a main effect of the first, or second input. Furthermore, the same result distributions were observed for people's hypothetical willingness-to-pay judgments, indicating that (the combined) affect was mapped onto the valuation judgment. This was also partially corroborated with a mediation analysis which found that expected affect was a significant mediator between the two trials with the highest affective contrast (i.e. PP and NN) and hypothetical willingness-to-pay. However, the design we employed did not allow us to discern whether the affective combination is more emblematic of an averaging or summation operation. We address this in the following study.

Study 2

To illustrate the issue more clearly, one can think of the averaging and summation operations in their mathematical sense. Say $P = 1$, while $N = -1$. As Table 2 shows, the distribution of the results would be the same in both operations. That is, we would see the overall affective experience diminish with the addition of an unpleasant input. Thus, in Study 1 we were not able to discern which of the two operations was favoured. However, if we contrast cases with varying number of inputs, but of the same valence, we could see a difference in operations. For example, between PP and PPP, with averaging, there would be no difference as: $(1 + 1)/2 = 1$ and $(1 + 1+1)/3 = 1$. However, for summation, we would see a difference as: $1 + 1 = 2$ while $1 + 1+1 = 3$. The same would be expected when comparing two or three unpleasant inputs.

In Study 2, we attempted to do just that and we employed a 2 (first input: P vs. N) × 2 (second input: P vs. N) × 3 (third input: None vs. P vs. N) within participant design, resulting in 12 different affective trials. The same four as in Study 1, PP, PN, NP, NN, and an additional eight where either a third P or N input was added. This allowed us to present scenarios with a different number of inputs, but of the same valence. Therefore, in this study, we had 12 different rewards and we added new descriptions for the affectively-charged inputs.[4] Most findings in impression formation favour the averaging operation in combination (Anderson, 2013). In the affective domain, there has been similar hints as overall judgments regarding a person's previous day were predicted well by averaging emotion ratings made during that day (Miron-Shatz, 2009). If, however, the combination is more emblematic of summation, we would expect to find a difference between the PP and PPP as well as the NN and NNN scenarios. In addition, despite our pre-test, which might have artificially inflated the difference between P and N by presenting multiple inputs in a within-subject procedure, one could argue that we still do not know whether each input actually led to an expected change in affective experience. To remedy this, affective reactions to each input were unobtrusively assessed using facial electromyography (EMG).

Table 2. Hypothetical expected results in overall affective experience (i.e. valence) dependent on the combination operation (averaging vs. summation) where the pleasantness of the affective experience evoked by an informational input is represented as: $P = 1$ and $N = -1$.

Affective trial	Averaging	Summation
PP	1	2
PN	0	0
NP	0	0
NN	−1	−2

Method

Participants

Results of Study 1 indicated that the effect sizes were largely underestimated, since the vast majority of the effect sizes were much larger (most $dz > .50$). In this study, we therefore ran a total of 37 psychology students from the University of Bordeaux who participated voluntarily. The EMG signal could not be used for three individuals so we excluded them from the analyses, leaving us with 34 participants in total (88% female, $M_{Age} = 19.65$, $SD_{Age} = 2.40$). This amounted to having 92% power to detect an effect size of $dz = .60$, 80% power to detect an effect size of $dz = .50$, as well as, 61% power to detect an effect size of $dz = .40$ (as calculated by G*Power). All participants filled out a consent form at the beginning and were debriefed at the end in accordance with ethical standards.

Procedure and materials

Participants followed a similar procedure as in Study 1, with two changes. First, before the presentation of each input, there was a blank screen (duration 2 sec), which served as a baseline measure for the EMG. Second, for the self-report measures of affect, participants provided their answer on a 0 (unpleasant) to 10 (pleasant) instead of the "−8 to 8" scale as in Study 1. We changed the anchors because some participants in Study 1 reported that the "−8 to 8" format was confusing. In addition to the 4 rewards used in Study 1, we added another 8: bicycle, coupon for supermarket, a foreign language course, movie tickets, boat trip, laptop, smartphone, and a movie set visit. The rewards could not actually be won as they were hypothetical.

EMG

Two muscles were of interest: the *corrugator supercilii* – more active for unpleasant, and the *zygomaticus major* – more active for pleasant affect (Larsen, Norris, & Cacioppo, 2003). EMG activity was measured during the presentation of the inputs and was collected using BIOPAC's MP150 hardware with the Bionomadix wireless EMG module (Biopac, Goleta, CA). Instructions by Fridlund and Cacioppo (1986) were followed for the positioning of electrodes. Re-usable Ag/AgCl electrodes were used. No mention of affect or emotion was made. The signal was online filtered with a high pass of 20 Hz and a low pass at 500 Hz at a sampling frequency of 2000 Hz. Offline, the data were rectified and smoothed with a root mean square analysis (Principe & Langlois, 2011). A 50 Hz notch filter was also applied in order to eliminate any noise that could have emanated from other electrical sources. Facial muscle activity was averaged across the measurement periods. To assess affective reactions, the baseline EMG values were subtracted from the corresponding EMG activity values obtained during the presentation of the informational inputs.

Results

Manipulation check – EMG

We first verified whether each of the P and N inputs really did evoke corresponding changes in affective experience, independent of whether they were being shown first, second, or third. Therefore, the data were analysed in a 2 (Muscle: Zygomaticus vs. Corrugator) × 2 (Valence: P vs. N) × 3 (Input rank: First vs. Second vs. Third) manner. We converted the activation data to z-scores for easier comparisons between muscles. The results show a significant interaction between muscle and valence, $F(1, 33) = 16.33$, $p < .001$, $dz = .70$ and a three way interaction, $F(2, 66) = 4.00$, $p = .023$, $dz = .34$ (all other Fs < 1.35, $ps > .27$). We decomposed the three-way interaction by muscle. Looking at the corrugator, as expected, there was a difference between P and N in the first, $F(1, 33) = 5.18$, $p = .03$, $dz = .40$ and third, $F(1, 33) = 9.83$, $p = .004$, $dz = .54$ ranking, while the difference in the second ranking was not significant, but in the right direction, $F(1, 33) = 3.92$, $p = .06$, $dz = .34$. When looking at the zygomaticus, there was similarly a difference between P and N in the first, $F(1, 33) = 8.11$, $p = .008$, $dz = .49$ and third ranking, $F(1, 33) = 7.07$, $p = .01$, $dz = .46$, while the difference in the second ranking was not significant, but in the right direction, $F(1, 33) = 3.14$, $p = .09$, $dz = .30$. The results indicate that the informational inputs used were indeed producing discernable affective changes, albeit slightly weaker ones in the second ranking (see Figure 3).

Integral affect

A 2 (first input: P vs. N) × 2 (second input: P vs. N) × 3 (third input: None vs. P vs. N) repeated measures ANOVA replicated the findings from Study 1 by again obtaining additive effects with a main effect of the first, $F(1, 33) = 12.55$, $p = .001$, $dz = .61$, second, $F(1, 33) = 36.91$, $p < .001$, $dz = 1.04$, and third input, $F(1, 33) = 8.31$, $p = .01$, $dz = .50$ (all other Fs < 1.88, $ps > .18$). Furthermore, we found no difference in integral affect comparing the PP with the PPP ($p = .57$) and comparing the NN with the NNN trials ($p = .11$). The results on the comparisons indicate that averaging was favoured. A Bayesian paired samples *t*-test also indicated more support for the null, rather than the alternative hypothesis with $BF_{01} = 4.67$ and $BF_{01} = 1.62$ for PP vs. PPP and NN vs. NNN, respectively (although slightly inconclusive for the NN vs. NNN comparison). (see Table 3 and Figure 4 for the results on all measures in Study 2).

Expected affect

Using the same analysis as above, we again obtained additive effects with main effects of the first, $F(1, 33) = 16.74$, $p < .001$, $dz = .70$, second, $F(1, 33) = 52.80$, $p < .001$, $dz = 1.20$, and third input, $F(1, 33) = 10.90$, $p = .002$, $dz = .60$ (all other F's < 3.35, $ps > .08$). There was no difference in expected affect comparing the PP with the PPP ($p = .75$) nor comparing the NN with the NNN ($p = .14$), similarly indicating averaging. A Bayesian analysis indicated more support for the null

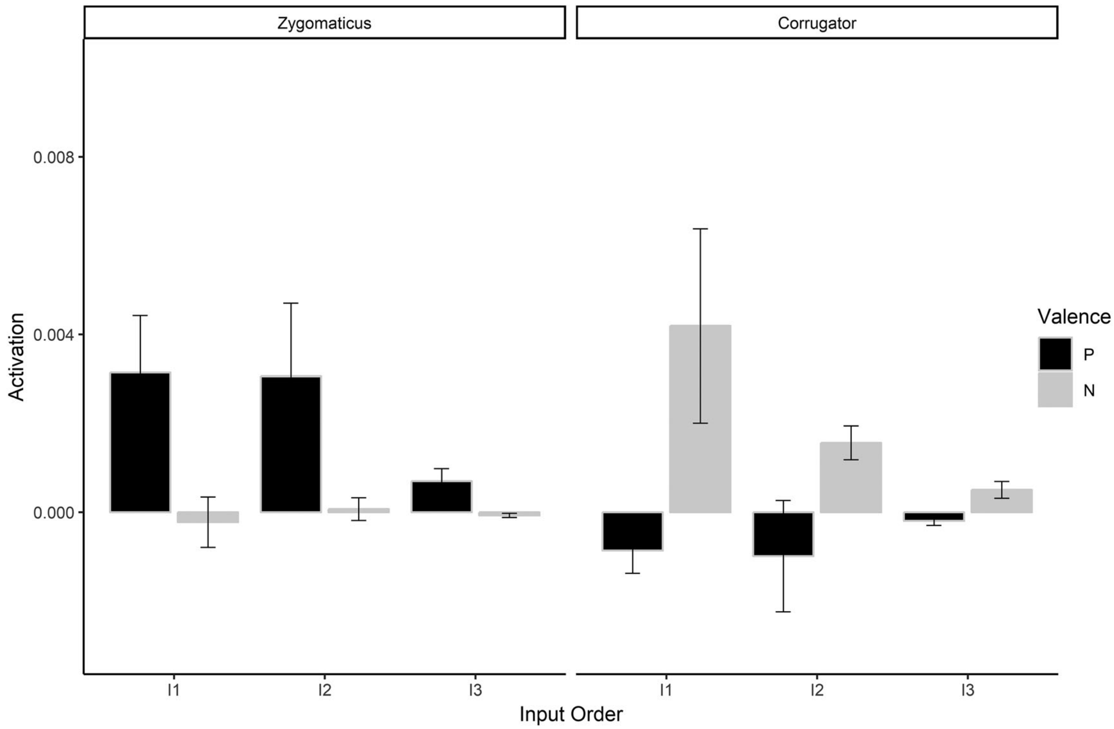

Figure 3. EMG activation in response to affectively-charged inputs. Means and SE's of the mean for the EMG activation on the Zygomaticus muscle (left side) and the Corrugator muscle (right side) as a function of the input order (shown first = I1, second = I2, third = I3) and valence (P = pleasantly charged input and N = unpleasantly charged input) for Study 2.

hypothesis with $BF_{01} = 5.19$ and $BF_{01} = 1.97$ for PP vs. PPP and NN vs. NNN, respectively (although slightly inconclusive for the NN vs. NNN comparison).

Monetary evaluation

Using the same analysis, unlike in Study 1, there was no effect of any of the inputs on the measure of monetary evaluation. (all F's < 2.70, $ps > .11$).

Hypothetical willingness-to-pay

Using the same analysis, we only obtained a main effect of the first input, $F(1, 33) = 6.02$, $p = .02$, $dz = .42$ and a three-way interaction, $F(2, 66) = 4.17$, $p = .02$, $dz = .35$ (all other $Fs < 2.90$, $ps > .06$). We decomposed the three-way interaction by the third input. We first verified hypothetical willingness-to-pay when no additional inputs were presented (i.e. the same trials as in Study 1). Replicating results from Study 1, there

Table 3. Means and SD's for the twelve affective trials presented in Study 2, for combined integral and expected affect, monetary evaluation, and hypothetical willingness to pay valuation judgment.

Affective trial	Integral M (SD)	Expected M (SD)	Mon value M (SD)	Will-to-pay M (SD)
PP	7.38 (2.15)	8.00 (2.15)	186.44 (227.15)	18.88 (27.10)
PN	6.26 (2.34)	6.62 (2.30)	130.44 (158.58)	7.84 (14.67)
NP	6.91 (1.96)	7.15 (1.78)	93.00 (91.83)	8.00 (9.78)
NN	5.65 (1.92)	5.74 (1.94)	64.97 (57.06)	5.09 (7.40)
PPP	7.68 (2.11)	8.15 (1.44)	172.50 (219.00)	12.09 (13.76)
PNP	7.26 (1.62)	7.59 (1.46)	687.21 (258.93)	8.88 (9.14)
NPP	7.26 (1.52)	7.76 (1.94)	293.41 (250.33)	11.56 (17.84)
NNP	6.09 (1.50)	6.50 (1.31)	100.76 (146.85)	6.94 (10.50)
PPN	6.76 (2.03)	6.91 (2.12)	176.47 (211.86)	8.97 (12.61)
PNN	6.26 (2.08)	6.29 (2.38)	101.91 (102.77)	8.66 (15.53)
NPN	6.35 (1.89)	6.88 (1.74)	121.06 (187.51)	6.81 (14.36)
NNN	5.06 (2.39)	5.18 (2.42)	103.56 (200.80)	3.44 (4.77)

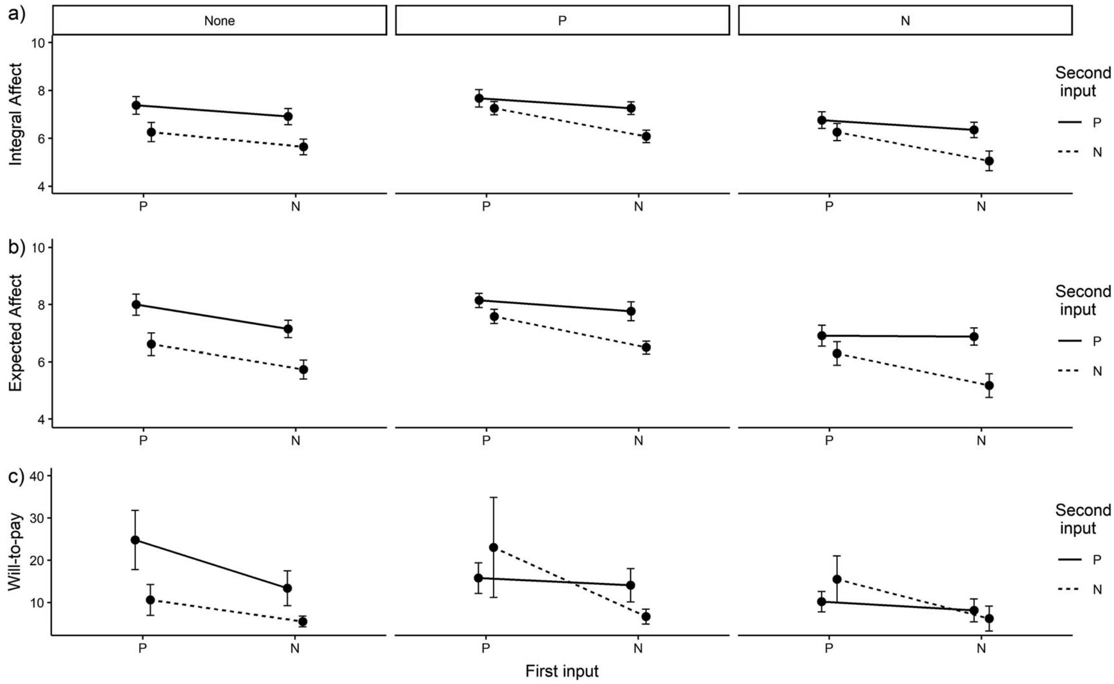

Figure 4. Demonstration of affective combination with three affectively-charged inputs. Means and SE's of the mean for: (a) integral affect, (b) expected affect, and (c) hypothetical willingness-to-pay, as a function of the pleasantness (P = pleasantly charged input and N = unpleasantly charged input) of the first, second, and third input for Study 2. The left side graphs show trials where no third input was added. The middle graphs show the results when a third P input was added, while the graphs on the right shows the results when a third N input was added. Note the additive effects which indicate combination for the affective measures and the mapping of said combination onto the hypothetical willingness to pay.

was a main effect of the first, $F(1, 33) = 4.45$, $p = .04$, $dz = .36$ and second input, $F(1, 33) = 10.18$, $p = .003$, $dz = .55$. The interaction was not significant, $F(1, 33) = 2.40$, $p = .13$, $dz = .27$. When adding a third P input however, none of the effects were significant (all *F*s < 2.06, *p*s > .16) nor was there any significant effects when adding a third N input (all *F*s < 3.33, *p*s > .08).

Mediation by affect

Mediation by integral affect

We used the same procedure as in Study 1. Because there was no effect of the third input on hypothetical willingness-to-pay, we again focused on the PP and NN trials. The magnitude of the mediation effect found support for mediation, me = −6.55, 95% CI [−13.59, −1.68]. The total effect c = −17.25, 95% CI [−28.33, −7.49] decreased after adding integral affect, c′ = −10.70, 95% CI [−18.03, −3.80].

Mediation by expected affect

There was again a significant mediation, me = −11.45, 95% CI [−22.63, −3.04]. The total effect c = −18.80, 95% CI [−29.01, −8.26] decreased to c′ = −7.35, 95% CI [−16.38, −0.33] after adding expected affect.

Discussion

The results of Study 2 replicated our findings pertaining to the construction of affective experience observed in Study 1. Adding an additional affectively-charged informational input led to an affective experience that was a result of a combination of the previously presented inputs, as measured by integral and expected affect. Furthermore, our results comparing two affective scenarios which have a different number of informational inputs, but the same valence (i.e. PP vs. PPP and NN vs. NNN) indicated no difference between these conditions. This result is more in line with averaging rather than summation as the combining operation. In addition, the implications of affective involvement are much stronger since we also unobtrusively measured people's affective experience using EMG, which corroborated that the inputs we presented actually evoked affective reactions. It is worth pointing out though that we considered each piece of affective information as carrying similar, if not the same, weight for the receiver. It is possible however, that the different pieces of information had different weights as a function of the order change – something future research should pay attention to. Results for the mapping of the affective experience on the monetary evaluation, where no effects were observed, and the hypothetical willingness-to-pay valuation judgment were mixed. Specifically, for hypothetical willingness-to-pay, when looking at the condition where no third input was added, the additive effects emerged in the same distribution, replicating findings from Study 1. However, looking at the conditions where either a P or N third input was added, there seems to have been no discernible impact of this input on people's judgments. We present possible reasons for the lack of a mapping in the general discussion. Focusing only on the first and second input, the mediation analysis between the PP and NN scenarios, found that both integral and expected affect significantly mediated the difference between these two trials and hypothetical willingness-to-pay valuation judgments.

Although the lack of a difference between the PP and PPP (as well as NN and NNN) scenarios hints that the combination operation is averaging, this assumption is based on a finding of no difference. The third study tries to address this issue. Furthermore, both integral and expected affect are related to a specific judgment target, meaning that our studies lacked a more detached, pre-conceptual measure of affect, not related to a target. In Study 3, we therefore also measure momentary affect by asking participants how they feel at the moment.

Study 3

Besides relying on trials with a different number of inputs, but the same valence (e.g. PP vs. PPP), a differential prediction between an averaging and summation operation can be made when inputs in a given set vary in their desirability (Anderson, 1965). Hendrick (1968) has, for instance, suggested that when inputs in a set vary from moderately to highly desirable, the averaging model would predict that the response would be some value in between. However, the summation model would predict that the response would be higher than the value of the highly desirable input in the set. Using a mathematical example, with a moderately or lower pleasant input L = 1, and a higher pleasant input H = 2, the distribution of the results on the overall affective experience would be different (see Table 4). In averaging, the LLH combination would have a lower affective value than LH, while it would be the opposite in summation. We now employ this approach and test these two conditions. Alongside, we also decided to include a third (LHH) condition as an additional test of combination. The inclusion of this condition gives extra weight to our claim of combination since we expect the affective experience to be highest in this condition (independent of whether the combination rule is averaging or summation).

Table 4. Hypothetical expected results in overall affective experience (i.e. valence) dependent on the combination operation (averaging vs. summation) where the pleasantness of the affective experience evoked by an informational input is represented by: L = 1 and H = 2.

Affective trial	Averaging	Summation
LLH	1.33	4
LH	1.5	3
LHH	1.66	5

Thus, in Study 3, we present participants with three affective scenarios LLH, LH, and LHH. Instead of using descriptive inputs as in the previous studies, we use images. Using descriptive text in the previous studies could have induced unnecessary variability. By using images, we attempted to reduce this as images are a validated method of inducing changes in affect (Siedlecka & Denson, 2018). We selected already rated images from the OASIS system (Kurdi et al., 2017). For the lower pleasant images,[5] we chose those that received a rating from 3.5 up to 4.99 while for the higher in pleasantness images we chose those that received a rating from 5 up to 7 (on a scale from 1 = very negative to 7 = very positive). We expect to see that the overall affective experience will be the result of averaging.

Method

Participants

Participants were recruited on MTurk and paid $0.40 for participation. After completing the consent form, a total of 167[6] participants took part in the study. We excluded those that did not pass an initial attention check and did not complete the full study. Because the study was conducted online, there was another attention check at the end asking individuals to correctly identify which of the two images they had seen previously (one of the images was not shown).

Two individuals did not answer correctly so we excluded them from the analyses, meaning that we were left with 156 participants in total (48% female, $M_{Age} = 35.66$, $SD_{Age} = 10.55$).

Procedure and materials

The procedure was similar as in previous studies. Participants went through 2 repetitions of the main 3 scenarios resulting in 6 trials in total, with 6 different experiences as judgment targets. They were: a beach holiday, a camping trip, a mountain trek, a night out at the bar, a visit to the lake, a visit to the zoo. The experiences could not actually be won as they were hypothetical. Unlike in the previous study, after the presentation of the inputs, participants were asked to report their momentary (*"How do you feel right now?"*) and integral affect using a slider scale centred in the middle with *unpleasant* and *pleasant* at the ends. The scale ranged from 0 to a 100 (numbers were not shown to the participants). Sliders were used to obtain more fine-grained (high-resolution) measures of affective experiences (Betella & Verschure, 2016). We did not include expected affect for two reasons: (a) given the addition of momentary affect, we felt that three measures of affect would lead to spillover in the way participants responded, thus minimising our chances of capturing separate affective constructs, and (b) the measure of integral affect already captures the affective relationship connected with a judgment target. Similarly, a slightly different question was used to measure hypothetical willingness-to-pay valuation, namely: "How much money would you be willing to pay to play a game where this experience is the prize?" We changed the wording to be more in line with previous measures of willingness-to-pay (e.g. Kahneman, Knetsch, & Thaler, 1991).

Results

Given that we had clear directional hypotheses, the presence of an averaging strategy was tested with two orthogonal contrasts (Brauer & McClelland, 2005; Judd, McClelland, & Ryan, 2017). The first contrast tests our model (LLH = −1, LH = 0, LHH = 1) while the second contrast (LLH = 1, LH = −2, LHH = 1) tests the residual variance (i.e. this contrast should not be significant if the averaging model fits the data). If the first contrast is significant while the second is not, this would indicate that LLH, LH, and LHH conditions are on a line as predicted by an averaging combination rule (see Table 4). For integral affect, the first contrast was significant, $F(1, 155) = 30.53$, $p < .001$, $dz = .44$ and, more importantly, the second was not ($F < 1$, $p = .81$). Similar findings were obtained for momentary affect, where the first contrast was also significant, $F(1,155) = 19.01$, $p < .001$, $dz = .35$, while the second was not ($F < 1$, $p = .59$). Thus, consistent with an averaging combination rule, the LLH condition produced less positive affective reactions than the LHH condition, with the LH condition staying in between (see Table 5 for means and SD's). Neither of the contrasts were significant for monetary evaluation (both $F < 1$, $ps > .46$). Finally, for hypothetical willingness-to-pay, following similar results on the affective measures, the first contrast was significant, $F(1, 155) = 19.53$, $p < .001$, $dz = .35$, while the second was not ($F < 1$, $p = .56$). Thus, in line with the averaging combination rule, the WTP was lowest in the LLH condition and highest in LHH conditions with the LH condition staying in between (see Figure 5c). Based on the results of our contrast analysis and considering the overall mean pattern (see Table 5 and Figure 5) averaging appears to be the affective combination rule.

Mediation by affect

Mediation by momentary affect

We again focused on the two trials with the greatest contrast, i.e. the LLH and LHH. The magnitude of the mediation effect found support for mediation, me = 8.22, 95% CI [1.06, 16.54]. The total effect of c = 43.85, 95% CI [25.61, 62.13] decreased to c′ = 35.63, 95% CI [18.98, 52.57] after adding momentary affect.

Table 5. Means and SD's for the three affective trials presented in Study 3, for combined integral and momentary affect, monetary evaluation, and hypothetical willingness-to-pay valuation judgment.

Scenario	Integral M (SD)	Momentary M (SD)	Mon value M (SD)	Will-to-pay M (SD)
LLH	62.73 (22.01)	66.10 (19.93)	204.09 (371.67)	25.00 (32.03)
LH	67.75 (24.63)	68.50 (22.60)	187.23 (312.73)	43.56 (75.10)
LHH	72.00 (23.31)	72.37 (21.88)	207.69 (430.77)	69.67 (161.60)

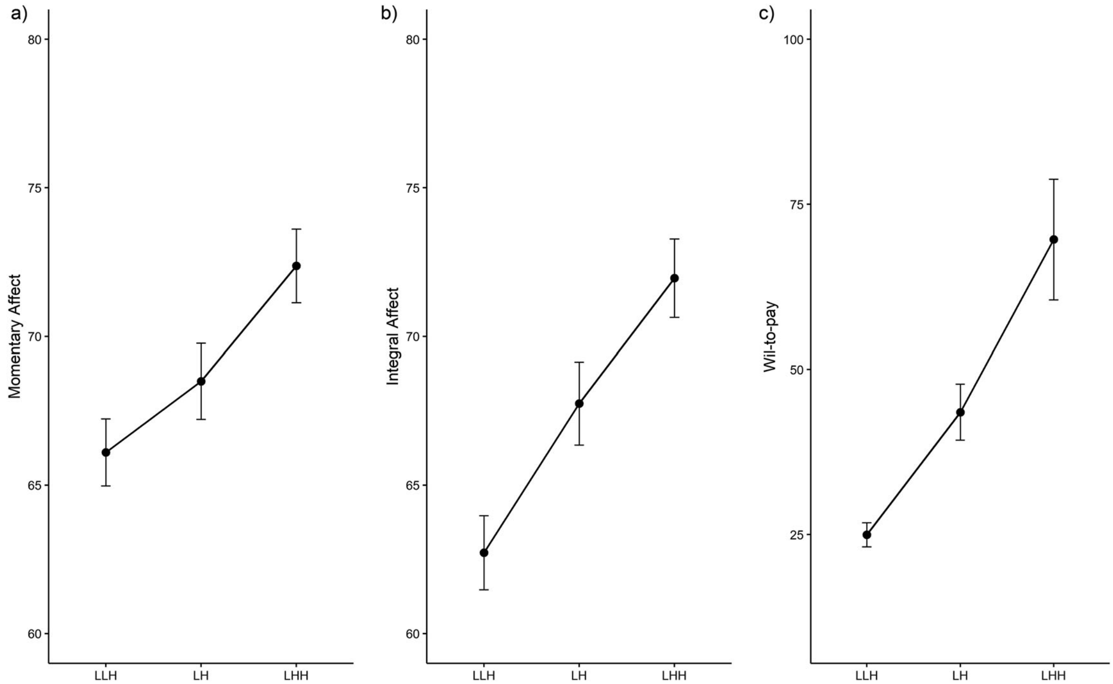

Figure 5. Demonstration of averaging as an affective combination rule. Means and SE's of the mean for the: (a) combined momentary affect, (b) combined integral affect, and (c) hypothetical willingness-to-pay, as a function of conditions containing a lower pleasant input = L, and a higher pleasant input = H for Study 3. Had summation been the combination rule, we would have observed a different pattern of results, namely LH, then LLH, then LHH.

Mediation by integral affect

The magnitude of the mediation effect again found support for mediation, me = 6.78, 95% CI [2.51, 11.95]. The total effect of c = 44.64, 95% CI [24.46, 64.75] decreased to c′ = 37.86, 95% CI [17.99, 58.07] after adding integral affect.

Discussion

Study 3 introduced several methodological modifications that served to strengthen our claim of demonstrating affective combination. Firstly, we did not use both unpleasantly and pleasantly charged inputs, but rather uniquely less and highly pleasant inputs. This allowed us to make clear predictions of what the results would look like had we observed combination in the form of averaging and summation. In accordance with averaging, our results showed that a combination of two less and one highly pleasant affective input (LLH) resulted in combined affect that was much lower, than a combination of one less and one highly pleasant input (LH), which in turn was lower than a combination of one less and two highly pleasant inputs (LHH). Had summation been the combination rule, our results would look like this: LH < LLH < LHH. Furthermore, using previously validated images from the OASIS database as inputs instead of descriptive text and measuring momentary affect, we again demonstrated that in response to sequentially presented affectively-charged inputs, people's affect is a result of combination in the form of averaging.

General discussion

People's affective experiences are often continuously constructed and can vary substantially as a function of previous inputs or events. For instance, when a person confronts an event, core affect begins to change immediately, sometimes even before the event is registered (Öhman, 1999). Similarly, affect has been shown to change due to a number of visual or auditory inputs (e.g. Satpute et al., 2015). In practice people are usually not exposed to one single event or input, but multiple ones, meaning that affective experiences should reflect the presentation and exposure to these inputs. However, not a lot of research has been done on how affect is constructed dependent on multiple affectively-charged inputs. Relying on impression formation research (Anderson, 2013; Hendrick, 1968) as well as previous suggestions from the affective literature (e.g. Neumann et al., 2001), we proposed that people's affective experiences are constructed as the result of a combination of previously presented affectively-charged inputs. In addition, we also verified whether the resulting affective experiences had an impact on people's valuation judgments. We considered the inclusion of this measure as a natural extension since people rely on affect as a cue when making judgments and decisions (Finucane et al., 2000) and since these situations often entail the presentation of multiple informational inputs, usually pertaining to the judgment target.

In three studies, we demonstrated that people's overall affective experiences are the result of a combination which occurs by averaging the affect evoked by previously presented affectively-charged inputs (Anderson, 1965). The overall findings are strengthened by the fact that we varied the input stimuli, using both text descriptions and normatively rated images (Kurdi et al., 2017) and that we measured various types of affect (Lerner et al., 2015) including integral, expected, and momentary. In addition, in Study 2, we also implemented an unobtrusive measure of affect (i.e. beyond self-report) by using facial electromyography, which confirmed that the informational inputs we used really did evoke discernible changes in affective experience. On our measure of monetary evaluation (i.e. how much people thought the judgment targets were worth), the impact of the inputs did not, baring our findings in Study 1, follow the same pattern as for the affective measures. This might be due to larger variability in people's opinions about how much various products and experiences are worth (McGraw, Shafir, & Todorov, 2010).

Looking at whether the resulting affective experience was mapped onto the valuation judgment, we found encouraging results. Specifically, in Study 1 and 3, people's hypothetical willingness-to-pay judgments mirrored the resulting affective experience. In other words, the distribution of results found on the measure(s) of affect was the same as for hypothetical willingness-to-pay. This was further strengthened by significant mediations through integral (in studies 2 and 3), expected (in studies 1 and 2) and momentary (study 3) affect (Charpentier, De Neve, Li, Roiser, & Sharot, 2016; Schlösser Dunning, & Fetchenhauer, 2013). The results of the mediation analyses indicate that people, at least in part, used the constructed affective experience as a cue for their valuation judgments. This goes in line with several theoretical propositions like the affect heuristic (Slovic et al., 2005), the "how do I feel about it" heuristic (Schwarz & Clore, 2003), and the risk-as-feelings hypothesis (Loewenstein et al., 2001) in that people use an affective impression as an efficient way of making judgments. However, the usage of the overall affective experience as a cue differed slightly in Study 2. Adding a third affectively-charged input, did not have an effect on people's hypothetical willingness-to-pay. While the results echoed those obtained in Study 2 when no additional input was added, adding an additional P or N input, produced no significant differences. This could be due to a number of reasons. With a higher number of inputs, it could be that people's reliance on the overall affective experience diminishes and people are more selective which inputs they want to use as a cue. Another reason could be that with an increase in inputs people might not consider all of them as relevant or representative of the target – a phenomenon which has been shown to decrease reliance on affect (Greifeneder, Bless, & Pham, 2011). The increased number of inputs and judgments in Study 2 could also have simply overwhelmed our participants leading to diffusion or blunting. For instance, Branscombe (1985) as well as Neumann et al. (2001) have demonstrated that an existing affective state can blunt a subsequent emotional experience when the valences of the two states are opposite to one another.

The results of our studies pertaining to the averaging strategy fall in line with a large literature on stimulus integration and impression formation. Recent work (e.g. Ullrich, Krueger, Brod, & Groschupf, 2013) as well as some older findings (Anderson, 1967, 1981) seem to overwhelmingly favour averaging as an integration strategy. Indeed, findings seem to converge on the fact that the averaging law is by far the most frequent when it comes to integration (Anderson, 2013). The idea that various judgments, attitudes, and perhaps affect as well, follow simple laws of information integration like averaging, lends further credence to Anderson's (2013) claim that the unification, or combination, of multiple variables into a unitary response follows simple arithmetic rules. Although, it is worth pointing out that while we did not observe effects of primacy or recency, we did focus exclusively on valence. For example, previous work on the peak-end rule has always held valence constant while varying intensity (Fredrickson & Kahneman, 1993). Different combination rules could thus be observed if other affective qualities like arousal are manipulated.

The presented results also hold practical value and they can be construed as a move towards studying more representative judgment and decision-making situations. Previous work on affect and decision making has been applying a very straight-forward methodological strategy – invoking a single input or event which changes the affective experience and subsequently observing the impact on decisions (e.g. Lerner, Li, & Weber, 2013; Rottenstreich & Hsee, 2001). However, this is not emblematic of the environment in which people usually make judgments and decisions. Most likely, people will be exposed to a number of inputs or pieces of information, most of which can cause discernible changes in affective experience.

The presented studies were however limited in the number of inputs that were presented, varying between two or three. Future studies should include more variety in the number of inputs and thereby also verify if the averaging operation remains the best description of how an overall affective experience is constructed. Follow-up studies should nevertheless be careful of possible ceiling or ordering effects in that additional affective changes (in particular, subtle ones) may not be registered at all. This also means that, with an increase in inputs, an averaging, compared to a summation combination, rule will be favoured. This is worth considering as a general limitation of such arithmetic propositions. As was observed by the lack of an effect on the EMG activation measure for the second input in Study 2, there might be indications of different weighting (i.e. that not all inputs were given equal weight in the combination). More precise stimuli, with data on weighting for the task at hand, would help ease some of these suspicions. Different weighting is also somewhat concurrent with a result obtained in Study 1, where there was an indication of a negativity effect on the measure of expected affect, in that negatively valenced inputs had a much stronger impact. Indeed, Anderson (2013) has suggested that a negativity effect might arise in unequal weighting conditions (i.e. when every instance of a given variable does not have equal weight importance). Future work should therefore perhaps pay more attention to weighting of inputs and verify whether weight differences might reflect on the integration mechanism. Similarly, the studies presented here did not have objective measures of affect after the presentation of the inputs, i.e. the measures of overall affective experience were purely self-report. This means that we do not know whether the actual physiological feeling would reflect the combination as well. Further, the effect of combined affect on actual choice decisions (e.g. choosing between two vacations instead of valuing them with willingness-to-pay) should be looked at more closely. People's choice strategies might be highly impacted by the resulting combined affect, allowing decision-making researchers to more reliably predict people's preferences. Finally, exploring the construction of affective experience as a function of multiple inputs should be extended to other types of affect, e.g. moods and specific emotions. Affect can also be incidental to the decision at hand and future studies should focus on the possible interactions of incidental moods or emotions with integral affective reactions (Västfjäll et al., 2016). Agrawal and Duhachek (2010) for example, showed that anti-drinking appeals that exacerbate guilt or shame were less effective among participants who were already feeling guilt or shame. These results suggest that the role of affect in judgment and decision-making is probably more complex than presumed and that we need to further explore this fascinating domain.

Notes

1. The data, analysis code, and materials (including all inputs, rewards, and experiences) for this paper are available here: https://osf.io/m98ay/.
2. We decided beforehand to collect at least 100 participants. This ensured 80% power to detect a medium to small-sized main effect ($d = .30$) as calculated by the PANGEA app. Because of group assignments, we ended up with more participants.
3. In a pre-test, 59 individuals reported that P inputs (see list here) did evoke more pleasant affective experience ($M = 14.90$, $SD = 3.00$), than N inputs ($M = 7.30$, $SD = 4.87$), $F(1, 58) = 390.05$, $p < .001$, $dz = 2.57$.
4. In a new pre-test, 31 individuals indicated that P inputs evoked more pleasant affective experience ($M = 15.00$, $SD = 2.76$), than N inputs ($M = 6.44$, $SD = 4.49$), $F(1, 30) = 298.70$, $p < .001$, $\eta_p^2 = .91$, $dz = 3.1$.
5. The OASIS codes for the images used are: I59, I60, I160, I238, I807, I104, I107, I108, I111, I172, I173, I175, I660, I6, I11, I190, I198, I456, I460, I463, I673, I398, I482, I616. Lower pleasant images, $M = 4.19$; $SD = 0.35$. Higher in pleasantness images $M = 6.00$, $SD = 0.40$.
6. A pre-data collection power analysis using the PANGEA app, indicated that we need around 150 participants to have 90% power to detect a small to medium effect (*dz*

= .30). As we were using an online sample, we were unsure of the effect size, opting rather to highly power our study to detect a conventionally small to medium effect.

Disclosure statement

No potential conflict of interest was reported by the authors.

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