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The dynamics of surprise and curiosity

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CHAPTER 2

On the valence of surprise

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On the Valence of Surprise

Common knowledge has it that it is nice to be surprised; many websites are devoted to how to throw the perfect surprise party or find the perfect gift to surprise your loved ones (e.g., www.ehow.com/topic_112_surpriseparty.html, www.surprise.com). However, psychological knowledge has it that people generally don't like surprises; people prefer predictability, consistency, and structure (Abelson et al., 1968; Gawronski & Strack, 2012). So, the question is how people feel when they are surprised. Is surprising a loved one a tragic mistake or is our psychological knowledge of how people react to surprises incomplete?

The relevance of this question clearly goes beyond decisions about whether or not to throw surprise parties. It touches upon a fundamental question in the psychology of emotions, namely to what extent emotions are characterized by a clear-cut valence. Whereas most other emotions have been associated with such a clear-cut valence—they feel either good or bad—for surprise the case is not clear. Large-scale emotion studies have not found a clear positive or negative valence (see Fontaine, Scherer, Roesch, & Ellsworth, 2007; Russell, 1980) and many classical and contemporary ideas of surprise seem to portray it as a kind of emotional chameleon, feeling sometimes good and sometimes bad depending on whether the cause of the surprise was in itself positive (e.g., a gift) or negative (e.g., a tax assessment).

The unclear valence of surprise has sometimes been explained by viewing it not as an emotion, but rather as a pre-emotional cognitive state. For example, Bain (1859/2006) already stated that: "… there are

surprises that delight us, and others that cause suffering; but many surprises do neither" (p. 13). He did not see surprise as a true emotion but rather as a cognitive phenomenon that affects behavior "…by detaining the attention, or by keeping a certain impression in the ascendant" (p. 13). These ideas resonate in some contemporary models of surprise, which position appraisals of unexpectedness and the ensuing interruption of ongoing processes before the analysis of the evaluation of an event (e.g., Meyer, Reisenzein, & Schützwohl, 1997). Thus, Reisenzein and Meyer (2009) concluded that: "in contrast to paradigmatic emotions such as joy or fear, surprise does not presuppose the appraisal of the eliciting event as positive (motive-congruent) or negative (motive-incongruent), and the feeling of surprise is per se hedonically neutral rather than pleasant or unpleasant" (p. 387).

The cognitive view of surprise contrasts with views of surprise as one of the basic emotions (Ekman, 1982). In contrast to Bain, Charles Darwin (1872/1998) saw surprise clearly as an affective state, noting a relationship with fear: "Attention, if sudden and close, graduates into surprise; and this into astonishment; and this into stupefied amazement. The latter frame of mind is closely akin to terror" (p. 278). Darwin observed that many people mentioned seeing terror, horrified, painful, or even disgusted (all distinctly negative emotions) in Duchenne's photographs of a surprised face. These observations were corroborated in later, more systematic studies of facial expressions (e.g., Ekman, 1982). Surprise displays several other characteristics of "regular" emotions such as bodily arousal, a neurophysiological substrate, and an adaptive function (e.g., Breugelmans et al., 2005; Ekman, 1982).

Furthermore, surprise has been fruitfully studied as an emotion in various fields, such as cognitive sciences, economics, marketing, and psychology (e.g., Mellers, Schwartz, Ho, & Ritov, 1997; Schützwohl & Borgstedt, 2005; Valenzuela, Mellers, & Strebel, 2010).

If surprise would indeed be a regular emotion, how should we account for the unclear findings regarding its valence? Many classical models of emotion seem to make the assumption that valence (also labeled evaluation, hedonic tone, or positivity) is a crucial element of what makes an emotion (Barrett, 2012; Barrett, Mesquita, Ochsner, & Gross, 2007; Frijda, 1986; Russell, 2003). Mixed emotions do exist, but these are—as the term implies—co-occurrences of distinct emotions with a singular valence (e.g., Larsen, McGraw, & Cacioppo, 2001). Neutral emotions do not seem to fit these models, but it can of course be questioned whether a neutral valence would theoretically be problematic. If valence is seen as a dimensional property on which emotions take a certain position there is no logical reason why a neutral position would be problematic. The current paper cannot pretend to solve these issues, but rather takes a more pragmatic, explorative position. Given that most emotions that have been described in the literature are experientially characterized by a clear valence, how should we understand the current mixed findings on the valence of experiences of surprise?

This paper explores the idea that experiences of surprise may actually have a negative valence. This idea is based on an integration of models of surprise as an interruption mechanism with a broad literature

on how people deal with unexpectedness and violations of predictability.

Surprise can be seen as an interruption mechanism (Meyer et al., 1997); it is elicited by unexpected events, interrupting ongoing thoughts and activities, and motivating people to pay attention to the unexpected stimulus. Such interruptions tend to be not merely cognitive events, but are rather unpleasant. Unexpectedness frustrates people's need for predictability and structure (Abelson et al., 1968; Gawronski & Strack, 2012), which is experienced as threatening and uncomfortable (Elliot & Devine, 1994; Mendes, Blascovich, Hunter, Lickel, & Jost, 2007). For example, a classical study by Aronson and Carlsmith (1962) showed that people experience an uncomfortable dissonance when they are confronted with unexpected good performance. People even tend to prefer self-consistent over self-enhancing feedback in order to bolster their perceptions that reality is predictable and controllable (Swann, 1990). Comparable findings have been found in studies of meaning violating experiences (see Proulx, Inzlicht, & Harmon-Jones, 2012, for an overview) and compensatory control processes that people employ to protect the belief that reality is orderly and nonrandom (see Kay, Whitson, Gaucher, & Galinsky, 2009, for an overview).

The idea that surprise represents a negative interruption is congruent with findings from neuroscientific and psychophysiological studies. Recent models of the medial prefrontal cortex and especially the anterior cingulate cortex in learning and predicting outcomes of actions suggest that negative *as well as positive* surprises result in a prediction error signal (Alexander & Brown, 2011; Egner, 2011). For

instance, Error Related Negativity (ERN) has been observed in response to surprising outcomes (see Alexander & Brown, 2011). According to Hajcak and Foti (2008), the ERN can be related to emotional or motivational aspects of error detection and reflects an aversive defensive response. Furthermore, when interacting with an expectancy-violating partner people display physiological threat responses, even when this partner is *positively* surprising (Mendes et al., 2007). Taken together, these findings suggest that at a neural and psychophysiological level, responses to surprise are similar for positive and negative events. In other words, responses to surprise seem to be independent of the valence of the stimulus. Moreover, these findings point to the possibility that surprise has a negative valence.

In view of the long history on studies of surprise and unexpectedness/ inconsistency, it could be asked why a negative valence for surprise has not been suggested before. Part of the answer may be that the emotion literature and the literature on inconsistencies have remained largely separate until now. Another part of the answer may be that the most elaborate and sophisticated research programs on surprise have primarily focused on cognitive processes and consequences and less so on affective consequences (see Reisenzein & Meyer, 2009). However, we think there is a third answer that is of a methodological nature and that is particular to the way surprise has been studied in research that did include measures of emotional valence. Such studies typically employed retrospective and linguistic methods, meaning that participants rated how intensely or frequently they felt surprise (Russell, 1980) or what affective states could be

delineated from someone saying that he/she is surprised (Fontaine et al., 2007). Because surprise is a short-lived emotion (Ekman, 1982) it is plausible that episodic memories of surprising events involve a blend of the experience of surprise with that of the emotion that followed after sense-making, being either positive or negative depending on whether the event was goal-conducive or not. Thus, unexpected events initially result in surprise but once the event is understood other affective states follow depending on the nature of the event. The reliance on retrospective and linguistic methods probably resulted in a measure of both responses, producing mixed results. As Tomkins (1984) already noted about surprise: "Whatever its quality (…) it is frequently confused with the affect that immediately follows it" (p. 171). Similarly, the use of emotion words may have led to a particular blurring of the memories of surprise because everyday uses of surprise in phrases such as "throwing a surprise party" and "buying someone a surprise" may have caused the connotation of the word surprise to be biased towards a positive valence.

So, in addition to exploring the idea that surprise may have a negative valence, we will also study a) linguistic biases and b) the temporal dynamics of surprise as possible explanations for why such a negative valence has not been found before. We present three experiments that use a diverse set of methods to explore the valence of surprise. Specifically, we studied autobiographical recall of experiences of unexpected and surprising events in Experiment 2.1, ratings of words and facial expressions in Experiment 2.2, and judgments of

naturalistic facial expressions unfolding after surprising events in Experiments 2.3a/2.3b.

Experiment 2.1

Experiment 2.1 studied temporal dynamics in people's autobiographical recalls of surprise. In addition, we explored semantic biases in the emotion word surprise by asking some participants to report an unexpected event and others to report a surprising event. We expected participants to rate their initial experiences as more negative and more surprising than their subsequent experiences.

Method

Participants. A total of 446 people (278 females, 166 males, 2 not reported; M_{age} = 27.78 years, SD_{age} = 14.59) were recruited through snowball sampling by assistants and completed a questionnaire about an *unexpected* event (n = 326) or a *surprising* event (n = 120).

Procedure. Participants described a personal experience of an unexpected or a surprising event. They rated this experience for two separate moments: "Right at the moment that something unexpected/surprising happened" (t1); and "After a short while, when you understood what had happened" (t2). Experiences at both moments were rated on three items that loaded high on Fontaine et al.'s (2007) *unexpectedness* dimension (unpredictable, happened suddenly, was unexpected), three items that loaded high on the *evaluation* dimension (dangerous, pleasant, lost), eight items measuring general *affect* adapted from Elliot and Devine (1994: happy, energetic, uncomfortable, uneasy, calm, optimistic, annoyed, and dejected), and two items measuring

surprise (surprised and amazed; all ratings on 5-point scales, 1 = *not at all* to 5 = *very strongly*).

Results

Principal Component Analysis (PCA) on the appraisals showed a two-dimensional structure within both conditions (i.e., unexpected and surprising). This was true for measures at t1 (Eigenvalues of the two components: 2.21 and 1.33; 59% variance explained for the unexpected condition and Eigenvalues 2.32 and 1.42; R^2 = 62% for surprising) and at t2 (unexpected Eigenvalues 2.43 and 1.43, R^2 = 64%; surprising Eigenvalues 2.18 and 1.65, R^2 = 64%). On the first component loaded appraisals of suddenness, unpredictability, and unexpectedness. Items were averaged to form the *unexpectedness* index (Cronbach's α at t1 = .67 and at t2 α = .79 in the unexpected condition; t1 α = .78 and t2 α = .74 in the surprising condition), with higher scores signifying more unexpectedness. On the second component loaded appraisals of pleasantness, danger, and loss of control. Items were recoded and averaged to form the *evaluation* index (unexpected t1 α = .59 and t2 α = .60; surprising t1 α = .68 and t2 α = .58), with higher scores indicating a more positive evaluation.

PCA on the affect scale showed a unidimensional structure in both conditions at t1 (unexpected Eigenvalue 3.36 and R^2 = 42%; surprising Eigenvalue 4.22 and R^2 = 53%) and at t2 (unexpected Eigenvalue 3.56 and R^2 = 43%; surprising Eigenvalue 4.33 and R^2 = 54%). Items were recoded and averaged to form the *affect* index (unexpected t1 α = .79 and t2 α = .81; surprising t1 α = .85 and t2 α = .86), with higher scores indicating more positive affect. The emotion items surprised and

amazed were significantly correlated both at t1, unexpected r(326) = .49, $p < .01$, surprised, $r(120) = .30$, $p < .01$, and at t2, unexpected $r(326) = .67$, $p < .01$, surprised $r(120) = .62$, $p < .01$. Items were averaged to form the *surprise* index, with higher scores indicating more surprise.

We performed repeated measures ANOVAs on each of the four dependent measures, with Condition as between-participants factor and Time as within- participants factor. *Evaluation* revealed significant effects of Condition, $F(1, 444) = 141.84$, $p < .001$, $\eta^2 = .24$, and Time, $F(1, 444) = 40.20$, $p < .001$, $\eta^2 = .08$. *Affect* revealed a significant effect of Condition, $F(1, 444) = 162.49$, $p < .001$, $\eta^2 = .27$, of Time, $F(1, 444) = 72.47$, $p < .001$, $\eta^2 = .14$, and a significant interaction, $F(1, 444) = 13.58$, $p < .001$, $\eta^2 = .03$. *Unexpectedness* revealed a significant effect of Time, $F(1,444) = 87.77$, $p < .001$, $\eta^2 = .17$, and *Surprise* revealed significant effects of Condition $F(1, 444) = 12.46$, $p < .001$, $\eta^2 = .03$, and of Time, $F(1, 444) = 251.09$, $p < .001$, $\eta^2 = .36$.

Table 2.1: Mean (and SD) evaluation, affect, unexpectedness, and surprise as a function of Time and Condition (Experiment 2.1).

	unexpected event		surprising event	
	time 1	time 2	time 1	time 2
evaluation	2.80 (1.11)	2.96 (1.07)	4.00 (0.89)	4.25 (0.74)
affect	2.75 (0.89)	3.11 (0.90)	3.96 (0.75)	4.10 (0.69)
unexpectedness	4.04 (0.86)	3.71 (1.04)	4.00 (0.66)	3.57 (0.86)
surprise	4.03 (0.93)	3.36 (1.12)	4.45 (0.58)	3.59 (0.98)

Note: Ratings on a 5-point scale (1= *not at all* to 5 = *very strongly*). Higher ratings indicate more positive evaluation and affect.

As can be seen in Table 2.1, participants in both conditions evaluated their experiences as more negative and also as more

unexpected/surprising at *t1* than at *t2*. In addition, participants evaluated their experience as more positive in the Surprise condition than in the Unexpected condition, suggesting a possible semantic bias in the emotion word. This idea was further tested in Experiment 2.2.

Experiment 2.2

Experiment 2.2 studied whether ratings of a surprised face are influenced by the word surprise (cf. Barrett, 2012). If the word surprise has a positive connotation, then adding this emotion word below a surprised face should make evaluation of the surprised face more positive as compared to not adding a word.

Method

Participants. A total of 81 students (42 females, 39 males; M_{age} = 20.36 years, SD_{age} = 2.39) were randomly assigned to one of two conditions: face-without-a-word or face-with-a-word.

Procedure. Participants rated 24 faces taken from Ekman and Friesen (2003; six faces for surprise, fear, sadness, and happiness). Pictures of male and female faces were shown in random order on a computer screen. The face-without-a-word condition showed only the pictures; the face-with-a-word condition also showed the emotion word below the picture. Participants rated for each picture "How does this person feel?" on a 7-point scale from *very negative* (1) to *very positive* (7).

Results

Ratings of faces were collapsed across emotions. Independent samples *t*-tests on the ratings of each emotion revealed a significant difference for surprise. Participants rated the surprise face as

significantly more positive in the face-with-a-word-condition (M = 4.25, SD = 0.56) than in the face-without-a-word-condition (M = 3.72, SD = 0.58), $t(79) = -4.21$, $p < .001$. No such differences were found for any other emotions: fear ($M_{without\text{-}word}$ = 2.65, SD = 0.65 versus $M_{with\text{-}word}$ = 2.45, SD = 0.46), $t(79) = 1.56$, $p = .12$; sadness ($M_{without\text{-}word}$ = 2.36, SD = 0.52 versus $M_{with\text{-}word}$ = 2.52, SD = 0.51), $t(79) = -1.37$, $p = .18$; and happiness ($M_{without\text{-}word}$ = 5.94, SD = 0.55 versus $M_{with\text{-}word}$ = 5.91, SD = 0.50), $t(79) = 0.27$, $p = .79$. These results suggest that the emotion word surprise conveys a positive bias to the perception of facial expressions of surprise, which was not found for fear, sadness, and happiness. These findings suggest this specific bias may be unique to or at least more pronounced for surprise (however, see Barrett, 2012).

Experiment 2.3a

Experiment 2.3 studied the unfolding of expressions to unexpected events in TV-shows where people were positively surprised. Following the idea that surprise has a negative valence that—in positive cases—is followed by a positive state, we expected spontaneous expressions to be rated more negatively in the first seconds after a surprise than those in later seconds.

Method

Participants. A total of 119 people (66 females, 53 males; M_{age} = 30.50 years, SD_{age} = 2.50) were recruited to participate in an online study through snowballing on a social network site (*Hyves*).

Procedure. Participants rated stills of eleven faces (randomized order) on 7-point valence scales from *very negative* to *very positive*. Stills

were taken from a public website (uitzendinggemist.nl) from two Dutch TV-shows in which people were positively surprised: a garden program (*Tuinruimers*; Festen, 2009, 2010) where gardens are renovated as a surprise and Antiques Roadshow (*Tussen Kunst en Kitsch*; Drion, 2009) where people received high assessments of their antiques. Selection was based on the following criteria: (1) the situation is clearly a positive surprise; (2) people's facial expression is clearly visible for at least four seconds; and (3) the expression is seen from the front. From each episode we took five stills; t0 was the moment at which the person was first confronted with the surprising event; t1-t4 were taken consecutively every second after t0. The resulting 55 stills were distributed over five groups (with t0-t4 randomly distributed) with the constraint that one participant never saw the same face more than once.

Results

Ratings were averaged across participants and episodes in a Still (11) x Time (5) matrix. A repeated measures ANOVA with Time as within-participants factor revealed a significant effect, Wilks' Lambda = .15, $F(4, 7) = 9.76$, $p < .01$, $\eta_p^2 = .85$ (see Table 2.2). Simple contrast analysis showed that faces at t0 and t2 were rated as significantly more negative compared to those at t4 (ps < .05).

Experiment 2.3b

These findings were replicated in a second experiment where an independent sample ($N = 48$; 35 females, $M_{age} = 21.37$ years, $SD_{age} = 2.63$) viewed the same faces to assess the situation that this person was

in. They rated the faces on the *evaluation, affect, unexpectedness,* and *surprise* scales from Experiment 2.1 (see Table 2.2).

Table 2.2: Mean (and SD) valence, evaluation, affect, unexpectedness, and surprise of facial expressions as a function of Time (Experiments 2.3a/2.3b).

	Time				
	0	1	2	3	4
Experiment 3a					
valence[1]	3.39[a]	4.00[abc]	3.61[ab]	4.31[bc]	4.37[c]
	(0.89)	(1.15)	(1.35)	(1.41)	(1.35)
Experiment 3b					
evaluation[2]	2.01[a]	2.63[bc]	2.36[ab]	3.00[c]	3.50[d]
	(0.47)	(0.91)	(1.00)	(1.00)	(0.88)
affect[2]	1.92[a]	2.37[ab]	2.24[a]	2.95[bc]	3.42[c]
	(0.50)	(0.87)	(1.05)	(0.97)	(0.88)
unexpected[2]	3.82[a]	3.26[ab]	3.44[a]	2.88[bc]	2.81[c]
	(0.52)	(1.02)	(1.07)	(0.86)	(0.92)
surprise[2]	3.85[a]	3.34[ab]	3.35[abc]	2.97[bc]	2.87[c]
	(0.52)	(0.99)	(1.13)	(0.74)	(0.94)

Note: Means with different superscripts in rows differ significantly at $p < .05$.
[1] Ratings on a 7-point scale (1 = *very negative* to 7 = *very positive*).
[2] Ratings on a 5-point scale (1= *not at all* to 5 = *very strongly*). Higher ratings indicate more positive evaluation and affect.

Ratings were averaged across participants and episodes in a Still (11) x Time (5) matrix. A repeated measures ANOVA with Time as within-participant factor (see Table 2.2) revealed a significant effect of Time on unexpectedness, Wilks' Lambda = .20, $F(4, 7) = 6.98$, $p = .014$, $\eta_p^2 = .80$. Simple contrast analyses showed that participants rated the faces on t0-2 as more unexpected than on t4 (ps < .05). On evaluation, we also found a significant effect of Time, Wilks' Lambda = .13, $F(4,7) = 11.62$, $p = .003$, $\eta_p^2 = .87$. Simple contrast analyses

showed that the participants rated the faces on t0-3 as more unpleasant than on t4 (ps < .05). Next, on affect, we also found a significant effect of Time, Wilks' Lambda = .15, $F(4, 7) = 10.17$, $p = .005$, $\eta_p^2 = .85$. Simple contrast analyses showed that the participants rated the faces on t0-2 as showing more negative affect than on t4 (ps < .05) and t3 marginally more negative than t4 ($p < .08$). Finally, on surprise, we found a significant effect of time, Wilks' Lambda = .29, $F(4, 7) = 4.21$, $p = .048$, $\eta_p^2 = .71$. Simple contrast analyses showed that the participants rated the faces on t0-1 as more surprised than on t4 ($p <$ .05).

Thus, in Experiments 2.3a/2.3b, faces were judged as more surprised *and* more negative in the first few seconds and as less surprised and more positively the more time elapsed.

General Discussion

This research explored the valence of surprise. More specifically, we explored the idea that surprise is experienced and perceived in others as a negative emotion, based on reasoning that surprise represents the interruption of ongoing thoughts and activities, which is unpleasant and in conflict with the desire for predictability and structure (Abelson et al., 1968; Gawronski & Strack, 2012). A series of three experiments, using different research methods, provided some initial evidence that surprise may indeed be a (mildly) negative emotion.

Our experiments also suggest why a negative valence for surprise has not been found before. Experiments 2.1 and 2.3a/2.3b suggest that surprise is a short-lived emotion (see also Ekman, 1982), which could

lead to experiences of surprise to be confused with emotions that follow it (see also Tomkins, 1984). Experiments 2.1 and 2.2 in addition suggest a positivity bias in the emotion word surprise, further adding to the confusion when using retrospective, linguistic methods. In order to identify the valence of surprise, it seems important to distinguish it from subsequent emotions that emerge when the situation is understood and appraised in terms of goal-conduciveness (i.e., after surprise has dissipated).

While our data are suggestive of a negative valence, surprise was clearly not as strongly negative as for instance sadness or fear (see Experiment 2.2). Though this might have to do with the strength of the experimental manipulation, with more extreme surprises resulting in more negative responses, it seems also plausible that the negativity associated with uncertainty is less intense than that associated with clearly aversive situations (e.g., Proulx et al., 2012). An alternative possibility is that because of the short duration of surprise people are used to interpreting expressions of this emotion more in context than those of happiness, sadness, or fear (see Barrett, 2012).

In addition, the negative valence of surprise does not imply that the experience of a surprising event can never be positive. Once the surprising event is understood people can feel good about it. Interestingly, this also opens the possibility that surprise may contribute to more intense positive experiences through what has been called an emotion-amplification effect. Given that surprise induces arousal (e.g., Fontaine et al., 2007; Russell, 1980), residual arousal may still be present when the surprising event is understood and the emotion surprise has

dissipated. Any subsequent emotion, such as joy, may thus arise in a situation where people already are in a state of heightened arousal, which may lead to more intense experiences of this emotion (see Schachter & Singer, 1962; see also Valenzuela et al., 2010). In other words, the residual arousal can become "attached" to the subsequent emotional state, which intensifies it. As such, a surprise visit of a friend may, for instance, result in increased joy as compared to a planned get together. This possibility would be an interesting avenue for further research on surprise.

A final interesting question is how the desire for predictability and structure relates to the fact that people are also curious creatures that actively explore novel, unknown, and unfamiliar things. How do the apparently opposite desires for predictability on the one hand and for interest in discovering new things on the other relate, and what are the consequences for the experience of surprise? The answer may lie in the sequential nature of emotion processes. According to sequential appraisal perspectives (Scherer, 1999) people first respond to the novelty of a situation (i.e., novelty check) after which other appraisals follow. Silvia (2005) argues that because of this sequential nature, surprise comes first but can shift to interest as the situation unfolds: "... it seems likely that the novelty check precedes the coping potential check, because people must identify a disruption in processing before assessing their ability to comprehend the source of the disruption (p. 99)." In other words, experiences of surprise, driven by the first appraisal of novelty, could shift following a subsequent appraisal of coping potential (see also Gendolla & Koller, 2001). Similarly, when

people actively search for novelty (rather than being confronted with it) they probably do this when they think they are able to cope with is. Interestingly, this probably involves an element of anticipating the unexpected and the unknown; the "expected unexpected" can be exciting and interesting but this is probably less surprising than events that were not anticipated at all.

In conclusion, the finding that surprise has a negative valence may further our understanding of how people experience consistencies and inconsistencies in the world around them. With this, we can give a tentative answer to our opening question on whether surprising a loved one is a tragic mistake: it is probably not, but don't expect a happy face or outright gratitude before the person had some time to make sense of the situation.