Affective Responses to Coherence in High and Low Risk Scenarios

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Abstract

Presenting information in a coherent fashion has been shown to increase processing fluency, which in turn influences affective responses. The pattern of responses have been explained by two apparently competing accounts: hedonic marking (response to fluency is positive) and fluency amplification (response to fluency can be positive or negative, depending on stimuli valence). This paper proposes that these accounts are not competing explanations, but separate mechanisms, serving different purposes. Therefore, their individual contributions to overall affective responses should be observable. In three experiments, participants were presented with businesses scenarios, with riskiness (valence) and coherence (fluency) manipulated, and affective responses recorded. Results suggested that increasing the fluency of stimuli increases positive affect. If the stimulus is negative, then increasing fluency simultaneously increases negative affect. These affective responses appeared to cancel each other out (Experiment 1) when measured using self-report bipolar scales. However, separate measurement of positive and negative affect, either using unipolar scales (Experiment 2) or using facial electromyography (Experiment 3), provided evidence for co-occurring positive and negative affective responses, and therefore the co-existence of hedonic marking and fluency amplification mechanisms.

Keywords: Processing fluency; Coherence; Affect; fEMG

The experience of encountering coherent information will be common to most people: a researcher receiving new data for their existing dataset, a doctor discovering a new symptom in a patient that they are treating, a detective uncovering a new clue to collate with their current evidence. Even without analysis of the new information, the above subjects experience a feeling of whether it fits coherently with the existing pattern, if it is inconsistent (Sweklej, Balas, Pochwatko, & Godlewska, 2014), or if a discrepancy has occurred (Whittlesea & Williams, 2000). Such feelings, vibes (Epstein, 1994), or hunches (Topolinski & Strack, 2009c) can be accurate, with evidence showing that participants can distinguish coherent word triads, those that share a common semantic associate, from incoherent triads (Bauman & Kuhl, 2002; Bolte, Goschke & Kuhl, 2003; Topolinski & Strack, 2008), even when under time pressure (Bolte & Goschke, 2005), and without requiring actual common associate retrieval. These responses to coherent information have also been recorded in the form of affective responses, whereby coherent word triads are liked more than incoherent triads (Topolinski, Likowski, Weyers, & Strack, 2009; Topolinski & Strack, 2009a).

The accuracy of intuitive coherence detection is thought to arise from the increased processing fluency of coherent information compared to incoherent information. In remote associate tests (RAT; Mednick, 1962) and similar word triad designs (e.g. Bolte & Goschke, 2005; Bowers, Regeher, Balthazard, & Parker, 1990), coherent word triads (e.g. SALT DEEP FOAM) are those that share a common semantic associate (e.g. SEA). It is thought that when an individual reads the final word in a coherent triad, it is already partially activated by the common associate, and therefore its processing is facilitated. This results in coherent word triads being processed faster than incoherent triads (Topolinski & Strack, 2009b).

Increased processing fluency has been shown to influence a wide range of judgements, such as truth (Reber & Schwarz, 1999), familiarity (Whittlesea, Jacoby, & Girard, 1990), confidence

(Kelley & Lindsay, 1993), and many others (see Alter & Oppenheimer, 2009 for a review). However, affective responses are potentially the most important. This is because evidence has suggested that affect can act as a cue for other judgements (Topolinski, 2011). Yet there is some debate over the patterns of affective responses to increased processing fluency. It has been argued that an increase in processing fluency is always met with a positive response (hedonic marking; Winkielman, Schwarz, Fazendeiro, & Reber, 2003). On the other hand, affective responses to increasing processing fluency could be dependent on the valence of stimuli used (fluency amplification; Albrecht & Carbon, 2014). Whilst these accounts have been presented as competing or alternative explanations, this paper proposes that hedonic marking and fluency amplification are different mechanisms, and serve different purposes. Furthermore, affective responses to increased fluency may be best explained by the co-existence and combined contribution of these two mechanisms.

Hedonic marking of processing fluency

Hedonic marking has perhaps been the dominant explanation of the direct effects of fluency (Claypool, Mackie, & Garcia-Marques, 2015), suggesting that fluent processing of information is fundamentally positive (Winkielman et al., 2003). As such, increasing fluency enhances positive affective responses (Topolinski et al., 2009; Reber, Winkielman, & Schwarz, 1998). Support for this prediction has been gathered from a diverse range of fluency manipulations, including perceptual, conceptual, linguistic, and embodied cognition (Alter & Oppenheimer, 2009). Compelling evidence has also been gained using facial electromyography (fEMG). This method has demonstrated higher levels of activity in the zygomaticus major muscle – indicating positive affect (Cacioppo, Petty, Losch, & Kim, 1986) – for fluent stimuli compared to non-fluent stimuli. Such increased activity has been found reliably, using perceptual manipulations such as contour priming and stimuli duration (Winkielman & Cacioppo, 2001), and familiarisation (Harmon-Jones & Allen, 2001), as well as using conceptual manipulations such as semantic coherence (Topolinski et al., 2009). The use of fEMG as method of measure affect reduces unintentional cueing that may arise from self-report scales, and therefore further supports a direct link between fluency and positive affect.

Fluency Amplification

Despite extensive support for the hedonic marking of processing fluency, it has been observed that these experiments tend to use stimuli of a neutral valence. In response, Albrecht and Carbon (2014) varied the valence of their stimuli in addition to manipulating fluency (using contour priming). Results indicated that, consistent with hedonic marking, positive stimuli were liked more in the high processing fluency condition. However, for “very negative” stimuli, stimuli were disliked more in the high processing fluency condition. This evidence suggests that processing fluency emphasises affective responses, leading to “more intense” evaluations rather than strictly positive evaluations. Whilst there is less research into this relationship compared to using neutral or positive stimuli, support can be found from a retrospective survey of the literature. For example, from mere exposure (Zajonc, 1968) studies, negatively valenced words were judged to be significantly more negative on repeated exposure (Grush, 1976), and increasing the number of exposures of initially disliked paintings resulted in a decrease in affective rating (Brickman, Redfield, Harrison, & Crandall, 1972). Although not classified as such at the time, these findings support fluency amplification. The same pattern has also been found in marketing research, where increasing the retrieval ease of a target product can lead to increased negative evaluations when primed by a conceptually related, but negative product (Lee & Labroo, 2004).

Multi-source account

Hedonic marking and fluency amplification make different predictions for the affective response to increasing the processing fluency of negatively valenced stimuli. Hedonic marking predicts that such an increase in fluency would be met with a positive affective response, regardless of the stimuli's valence. In contrast, fluency amplification predicts a negative affective response due to the amplification of the stimuli's negative valence. These two accounts have therefore been offered as competing or alternative explanations for affective responses to fluency (Cheetham, Suter, & Jancke, 2014; Chetverikov & Kristjánsson, 2016; Gerger, Forster, & Leder, 2016; Muth, Hesslinger, & Carbon, 2015).

However, we propose that hedonic marking and fluency amplification are separable mechanisms that serve different functions. The hedonic marking mechanism indicates that information has been processed fluently, with the reaction being positive for a number of possible reasons: a signal for progress "toward cognitive goals" (Claypool et al., 2015), for familiarity and safety (Winkielman et al., 2003), or for the use of non-analytic thinking (Alter, Oppenheimer, Epley, & Eyre, 2007). The purpose of a fluency amplification response has not been investigated as comprehensively. However, a mechanism of emphasising a stimulus' valence appears useful for indicating unambiguity (Albrecht, Raab, & Carbon, 2014), for making choices without deliberation (Novemsky, Dhar, Schwarz, & Simonson, 2007), or forming more definitive opinions, particularly in a social context (Haddock, 2002; Tormala, Falces, Briñol, & Petty, 2007). A similar pattern occurs in affective forecasting due to impact bias (e.g. Wilson & Gilbert, 2005), where similar polarisation may help motivate us to seek out good scenarios, whilst motivating us to avoid bad ones. Given their separate utility, co-existence is appropriate, in a similar vein as to having a number of heuristics in our adaptive toolboxes (Gigerenzer, Todd, & The ABC Research Group, 1999). Therefore, rather than competing explanations for affective responses to fluency, we suggest that hedonic marking and fluency amplification co-exist, with both mechanisms contributing to the overall response.

This multi-source account for affective responses to fluency makes an interesting prediction for circumstances where fluency is increased for negative stimuli. In such cases, increased processing fluency would result in an increase in positive affect (via hedonic marking) and an increase in negative affect (via fluency amplification). The presence of both positive and negative affect is consistent with the conceptualisation that positive and negative affective responses are separable (Winkielman & Cacioppo, 2001; Cacioppo & Berntson, 1994), and can operate independently (Bettman, Luce, & Payne, 2008); as well as the notion that fluency can produce "competing forces" (Oppenheimer, 2008) which may interact or cancel each other out. However, co-existence has not been detected in previous studies. This would require the manipulation of stimulus valence, as well as separate measurement of positive and negative affect. To the authors' knowledge, such a design has yet to be implemented.

For example, in Winkielman & Cacioppo's (2001) paper supporting hedonic marking, positive and negative affect were measured separately, with fEMG used to record zygomaticus major and corrugator supercilii (associated with negative affect) muscle activity. However, the stimuli used in the study were drawings of neutral objects, meaning the affective response to negative stimuli would not have been examined. Additionally, a fluency amplification mechanism would not contribute any affective response when the stimuli are neutral. As neutral valence cannot be amplified in a positive or negative direction, only the contributions from hedonic marking would be measurable.

On the other hand, Albrecht and Carbon's (2014) study supporting fluency amplification measured affective responses over a range of stimuli valence, from very negative to very positive.

However, as responses were recorded using a bipolar self-report scale, it meant that positive and negative affect were not measured separately. Furthermore, as the affective response from hedonic marking is only brief, subtle (Topolinski & Strack, 2009c), and mild (Winkielman & Cacioppo, 2001), any contribution from this mechanism may have been eclipsed in the more intensely positive and negative conditions, to the point of being separately undetectable.

The present research

The current research tested for the co-existence of hedonic marking and fluency amplification, and their respective contributions to affective responses to fluency. Affective responses were measured using self-report (Experiments 1 & 2) and fEMG (Experiment 3), and fluency was manipulated for stimuli of positive and negative valence. However, rather than using overtly positive or negative stimuli, participants were presented with business scenarios. The valence of the scenario was determined by their riskiness, with risks being associated with negative affect, and benefits being associated with positive affect (Finucane, Alhakami, Slovic, & Johnson, 2000; Slovic, Finucane, Peters, & MacGregor, 2004). The link between risk and valence was tested for and confirmed in the pre-study detailed in this paper. Meanwhile, processing fluency was manipulated conceptually: fluent scenarios were those that were consistent with a typical schema for the given business, whilst non-fluent scenarios contained an item of information that, whilst relevant to the business, would not be considered as typical.

The decision to use business scenarios was made, firstly to increase ecological validity, as business scenarios have greater similarity to the tasks people may come across in day to day life. Ecological stimuli, and conceptual fluency manipulations in general, are under-represented in the literature despite their utility, and this study addresses the gap. Secondly, the use of a more covert manipulation for valence was important considering fluency effects have been shown to be most notable when the source is unknown (e.g. Bornstein, 1989; Bornstein & D'Agostino, 1992, 1994; Whittlesea & Williams, 1998).

Regardless of whether the business scenarios are high risk (negative) or low risk (positive), the hedonic marking hypothesis predicts that business scenarios that are easier to process (those that are made up of typical items) would receive increased positive affective responses. In contrast, fluency amplification would predict that the affective response is dependent on the condition's valence. Therefore, easier to process scenarios in the high risk condition would lead to an increase in negative affect. However, under the multi-source account, we expect hedonic marking and fluency amplification to be separate mechanisms which will make individual contributions to affective responses. Therefore, it is expected that easier to process scenarios in the high risk condition will result in an increase in both positive and negative affect. The positive affect is evoked due to the positive marking of processing fluency, whereas the negative affect is generated as an amplification of the stimuli valence. See Table 1 for a summary of the predictions of these accounts.

Evidence for this dual affective response will first be sought from self-report ratings (bipolar in Experiment 1; unipolar in Experiment 2). This will then be examined using fEMG (Experiment 3), whereby separate measurement of zygomaticus major and corrugator supercilii muscles will allow for the separate detection of increases in positive and negative affect.

Pre-study

Research has shown that there is an association between risk and valence (Finucane, Alhakami, Slovic, & Johnson, 2000; Slovic, Finucane, Peters, & MacGregor, 2004). For example, presenting participants with benefits about a technology (such as nuclear power, water fluoridation, chemical plants; Finucane et al., 2000) may lead to a positive affective response, whereas presenting participants with risks may lead to a negative affective response.

Therefore, in the current study, we constructed positive and negative conditions by manipulating riskiness. In positive conditions, participants were presented with business scenarios made up of benefits, whereas in negative conditions, the scenarios were made up of risks. However, it is possible that people would not have strong emotional opinions about business scenarios (such as clothing retail, coffee shops, and leisure centres) compared to the stimuli used by Finucane et al. (2000), which included items such as cigarettes, pesticides, and alcoholic beverages. Furthermore, a straightforward association between risk and affect cannot be taken for granted, as the type of risk being assessed (Song & Schwarz, 2009) as well as the type of stimuli (Bahník, & Vranka, 2017) may have an influence. Therefore, the pre-study aimed to validate the use of our business scenarios. If the association between risk and valence generalises to this domain, we expect that business scenarios constructed of benefits would be liked significantly more than business scenarios constructed of risks.

Method

Participants. Thirty (fourteen female) students were recruited, the majority of whom were postgraduates (27 postgraduate students). The results from one participant were discarded due to the length of time they spent completing the task (z-score > 3.29), resulting in a final sample of twenty-nine (thirteen female) students (26 postgraduates) with a mean age of 26.30 years old (SE ± 1.10 years). Compensation was provided in the form of a cash prize draw.

Materials. The stimuli used in the study were business scenarios. Each scenario consisted of a short description of the business for background information, followed by three items of information relevant to the business. The items of information were obtained from Datamonitor and Mintel industry reports. There were nine business types, and for each type, two scenarios were created. The first was a high risk scenario, whereby all of the items of information were risks that the business faces. The second was a low risk scenario, whereby all of the items were strengths of the business. There were therefore 18 scenarios (nine High risk and nine Low risk), which were each presented only once. The scenarios, including the items of information, remained unchanged for each participant. The only difference was the randomisation of the order in which the scenarios were seen. An example of the business scenarios used can be seen in Table 2.

Two rating scales were used in the experiment: one for measuring liking and one for measuring risk. The liking scale was a five-point Self-Assessment Mannequin (SAM) scale for affective valence (Bradley & Lang, 1994). The risk rating scale was a 1-7 self-report Likert scale, ranging from “extremely low risk” to “extremely high risk”.

Design. The pre-study followed a repeated measures design, with riskiness of the scenario as the independent variable, and self-reported affect as the dependent variable. Self-reported risk ratings were also obtained as way of a manipulation check.

Procedure. Before the task, participants provided informed consent and read a briefing document, which informed them that they were to read and rate a series of business scenarios. Participants were instructed to work quickly but carefully through the trials, and that we were interested in first impressions – participants were not to think too critically or analytically. Participants were also told that there were no right or wrong answers to the rating scales. The experimental task was run on E-Prime, displayed on a PC monitor. Participants input their responses on the computer keyboard. Each trial consisted of the following: participants were first shown a sentence explaining what the business is. Having read this, participants proceeded by pressing the Space bar. Participants were then shown three additional items of information relating to the business, presented sequentially in the centre of the screen. Participants pressed the Space bar once they had read each item of information to proceed. In between each item of information, a fixation cross appeared in the centre of the screen for 500ms. Once all three items had been presented, participants were shown the SAM scale and asked to rate how much the liked the scenario by pressing the corresponding keyboard key to proceed (ranging from 1 to 5). Following this, participants were asked to provide a rating for how risky they thought the scenario was using the keyboard to enter the appropriate score. See Figure 1 for a timeline presentation of the procedure. Participants completed four practice trials, followed by 18 experimental trials. The order of the experimental trials was randomised for each participant.

Results

Firstly, the participants' self-report ratings of risk were examined. The High risk scenarios were rated as more risky (M = 6.36 out of 7.00) than the Low risk scenarios (M = 3.51, $t_{(28)} = 10.751$, $p < .001$, $d_z = 1.996$). In addition, the participants gave higher liking ratings to the Low risk scenarios (M = 4.01 out of 5.00) compared to the High risk scenarios (M = 2.82, $t_{(28)} = 5.765$, $p < .001$, $d_z =$ 1.071). See Figure 2 for self-report judgements of risk and affect.

Discussion

The results of the pilot experiment demonstrated firstly that the High risk scenarios were indeed felt to be risky by the participants in comparison to the Low risk scenarios. As predicted, participants also liked the Low risk scenarios more than the High risk scenarios. This therefore supports the theory that there is a link between valence and risk. It also provides assurance that a risk manipulation can be used in the forthcoming experiments in place of more explicit valence manipulations.

Experiment 1

The pre-study used a simple one-way design, establishing that High risk and Low risk business scenarios could be used to manipulate valence. With confidence gained over the use of these scenarios, Experiment 1 added a fluency manipulation as a second level (an example of the items used can be seen in Table 3), allowing for the observation of affective responses to increased processing fluency, in both positive (Low risk) and negative (High risk) conditions.

Fluency was manipulated using coherence. For Coherent business scenarios, participants were shown three items of information that were all relevant and stereotypical to the business. In contrast, Incoherent scenarios featured an item that was relevant to the business being discussed, but stereotypical to a different type of business. Therefore, Coherent scenarios feature items that all converge on a common associate (the business in question), whereas Incoherent scenarios do not. In RAT designs, the common associate in coherent conditions facilitates processing by partially activating related concepts. This results in improved response times compared to incoherent conditions (Topolinski & Strack, 2009b). Similarly, it is expected that Coherent scenarios in Experiment 1 will be processed more fluently than Incoherent scenarios.

As shown in Table 1, the hedonic marking hypothesis states that fluency is positively marked, and therefore predicts that increasing processing fluency results in a positive affective response, regardless of whether the stimulus is positive or negative. In contrast, fluency amplification suggests that affective responses arise from the amplification of the stimulus' valence. Unlike hedonic marking, fluency amplification therefore predicts that when processing fluency is increased for negative stimuli, the affective response is negative. However, the multi-source account proposed by this paper proposes that these two accounts should not be treated as competing or alternative explanations, as they may be separate, co-existing mechanisms. If this is the case, then neither hedonic marking nor fluency amplification in isolation should be able to explain the pattern of affective responses to fluency.

Affective responses will be better understood by considering the combined contribution of both processes. In the context of the current experiment, it therefore means that increasing the coherence of Low risk (positive valence) business scenarios should be met with a positive affective response, as measured using self-report. This pattern is consistent with both hedonic marking and fluency amplification (see Table 1). However, when coherence is increased for High risk (negative) scenarios, it is expected that positive affect will be evoked due to hedonic marking, alongside an increase in negative affect due to the amplification of the valence of the scenario. As affect is measured using self-report, it is expected that liking ratings will be made from an interaction of the positive and negative affect.

Method

Participants. Thirty two (27 female) students were recruited, mostly from the psychology undergraduate course (28 psychology students), in return for credits towards the University's lab token scheme. The mean age was 20.19 years old (*SE* ± 0.35 years).

Materials. The Coherent conditions in this experiment were identical to the pre-study, using the same nine high risk and nine low scenarios. To construct the Incoherent conditions, the final item in a Coherent scenario (e.g. Travel) was replaced with the final item from another Coherent scenario (e.g. Leisure). The resulting Incoherent scenarios were created to present three items of information that were relevant to the business, however the final item would be less typically associated with that business (see Table 3 for an example). Therefore, four scenarios were created for each of the nine business types (Coherent-High risk, Coherent-Low risk, Incoherent-High risk, Incoherent-Low risk, see Table 3), totalling 36 business scenarios in this experiment. Participants were shown each scenario once, and in a random order. To control for factors such as sentence length and difficulty, we made sure that the stimuli were balanced; each triad item appeared once in a coherent scenario, and once in an incoherent scenario. The two rating scales, for liking and for risk, were the same as used in the pre-study.

Design. The experiment used a two (Coherent vs Incoherent) by two (High risk vs Low risk) repeated measures design, with self-reported affect as the dependent variable. Coherence related to whether the scenario fit a typical schema, whilst risk related to whether the scenario was made up of risks or strengths. Self-reported risk and the reading time of the final item of the triad were recorded as manipulation checks.

Procedure. The procedure followed that of the pre-study, except for the addition of the Incoherent scenarios (detailed above), meaning the participants now viewed 36 scenarios. The time it took the participants to read the final item in each triad was also recorded in E-Prime as a measure of fluency. Reading time was also used as an indicator for outliers – unexpectedly long reading times would indicate more analytic processing, and unexpectedly short reading times would indicate guessing, skipping, or mistakes.

Results

Response times. A 2 (Coherence: Coherent vs Incoherent) x 2 (Risk: High vs Low) ANOVA was run on the reading times for the third items in the risk item triads, revealing a main effect of

Coherence ($F_{(1,31)} = 18.591$, $p < .001$, $\eta_p^2 = .38$), but no main effect of Risk ($F_{(1,31)} = .080$, $p = .779$, $\eta_p^2 < .01$), and no interaction effect ($F_{(1,31)} = .763$, $p = .389$, $\eta_p^2 = .02$). For the main effect of Coherence, paired samples *t*-tests revealed that the effect resulted from the reading time for the final item in the triad being shorter for Coherent triads than Incoherent triads in both the Low risk (Coherent M = 2,752ms; Incoherent M = 3,190ms; $t_{(1,31)} = 3.568$, $p = .001$, $d_z = .631$) and High risk conditions (Coherent M = 2,848ms; Incoherent M = 3,141ms; $t_{(1,31)} = 2.558$, $p = .016$, $d_z = .452$). This pattern can be seen in Figure 3.

Liking ratings. A 2 (Coherence: Coherent vs Incoherent) x 2 (Risk: High vs Low) ANOVA was run on participants' liking ratings, revealing a main effect of Risk ($F_{(1,31)} = 21.443$, $p < .001$, $\eta_p^2 = .41$), as well as a significant interaction between Risk and Coherence ($F_{(1,31)} = 6.568$, $p = .015$, $\eta_p^2 = .18$), but no main effect of Coherence ($F_{(1,31)} = 2.786$, $p = .105$, $\eta_p^2 = .08$). This interaction occurred due to participants liking Coherent triads ($M = 3.83$) more than Incoherent triads ($M = 3.65$, $t_{(1,31)} = 2.784$, $p = .009$, $d_z = .492$) in the Low risk conditions. However, in the High risk conditions there was no significant difference between the liking of Coherent ($M = 2.99$) and Incoherent ($M = 2.99$, $t_{(1,31)} = .003$, $p = .998$, $d_z < .001$) triads, as shown in Figure 4. Both the significant main effect of Risk and the significant *t*-test on Coherence had observed Power > .80.

Risk ratings. A 2 (Coherence: Coherent vs Incoherent) x 2 (Risk: High vs Low) ANOVA was also run on participants' risk ratings, revealing only a main effect of Risk ($F_{(1,31)} = 292.883$, $p < .001$, $\eta_p^2 = .90$), with the high risk conditions ($M = 6.36$) being judged as riskier overall than the low risk conditions ($M = 3.34$). There was no main effect of Coherence ($F_{(1,31)} = .001$, $p = .981$, $\eta_p^2 < .01$) or interaction effect ($F_{(1,31)} = 2.966$, $p = .095$, $\eta_p^2 = .09$).

Discussion

Experiment 1 successfully manipulated processing fluency by varying the coherence of business scenarios, as seen in the manipulation check and Figure 2. Results indicated that the final item in a triad was read faster when preceded by other items typically associated with the same type of business, compared to when the preceding items were more typically associated with a different type of business.

As predicted by both hedonic marking and fluency amplification, liking ratings in the Low risk (positive valence) conditions were higher for Coherent triads of information than for Incoherent triads of information. However, the liking results from the High risk (negative valence) condition cannot be explained by either the hedonic marking hypothesis or the fluency amplification account in isolation. Hedonic marking would predict an increase in liking ratings for Coherent triads due to the increased processing fluency; fluency amplification would predict a decrease in liking ratings for Coherent triads due to the amplification of the negative valence of this condition. Instead, no significant difference was found, and it may therefore be that both processes occurred, as predicted by a multi-source account (Table 1). This account would therefore predict opposing directions of affective response, which negate each other in order to decide upon a single self-report rating.

Despite reaching a different conclusion, these results are consistent with Albrecht and Carbon (2014). Although their “very negative” condition found that fluent stimuli were liked less than non-fluent stimuli, indicating the amplification mechanism, their “mildly negative” condition showed no significant difference between fluent and non-fluent stimuli. This could be explained by a multi-source account. As positive affect evoked via hedonic marking has been shown to be brief, subtle (Topolinski & Strack, 2009c), and mild (Winkielman & Cacioppo, 2001), in “very negative” scenarios, this positive affect may have been outweighed by such an extent that it had an inconsequential, undetectable effect on the overall liking rating. In contrast, in the “mildly negative” condition, the affective responses from the separate hedonic marking and fluency amplification mechanisms would have been of a more similar intensity, and therefore cancelled each other out as in the current Experiment 1.

If it is the case that both positive and negative affect were being generated in the Coherent-High risk condition, it should be possible to record them separately. After all, models suggest that positive and negative affect do not exist on a simple continuum, but are separate processes (Winkielman & Cacioppo, 2001; Cacioppo & Berntson, 1994). The next experiment addressed this by using unipolar scales to separately measure positive and negative affect.

Experiment 2

An alternative explanation for Experiment 1’s High risk condition, where we did not find a significant difference in liking between Coherent and Incoherent triads, would be that fluency did not evoke an affective response at all. In Experiment 2, we challenged this alternative explanation by measuring positive and negative affect separately with unipolar scales: one for liking, and one for disliking. This addresses the aforementioned shortfall in the literature, whilst also gathering more evidence using our business scenario paradigm.

We also wanted to address a second alternative explanation: that the changes in affective response were caused by differences in meaning between the Coherent and Incoherent scenarios, rather than processing fluency. To do this, a new scenario type was introduced: Early Incoherent. The Early Incoherent scenarios contained exactly the same items and information as the Incoherent scenarios, but the item order was altered. Whilst Incoherent scenarios ended with the incoherent item, the Early Incoherent scenarios presented the incoherent item first. Early Incoherent items therefore finish with stereotypical items, and should feel more fluent as a result. If meaning caused the difference in affective responses, then we would expect the Incoherent and Early Incoherent scenarios to be judged the same in terms of positive and negative affect. However, as we predict that fluency causes changes in affective response, we expect the Incoherent and Early Incoherent to differ in terms of positive and negative affect, with the Early Incoherent scenarios behaving in the same way as the Coherent scenarios instead. Specifically, the Early Incoherent condition is expected to be liked more than the Incoherent condition, and when the items are high risk (negative valence), we would also expect the Early Incoherent condition to be disliked more than the Incoherent condition, a pattern which is consistent with a multi-source account.

Method

Participants. Forty one (35 female) students were recruited, mostly from the psychology undergraduate course (39 psychology students), in return for credits towards the University's lab token scheme. The mean age was 20.00 years (*SE* ± 0.43 years). In a between subjects design, twenty participants (16 female, mean age = 20.13 years, *SE* ± 0.88 years) completed the experiment using a liking scale, and twenty one participants (19 female, mean age = 19.90 years, *SE* ± 0.40 years) completed the experiment using a disliking scale.

Materials. The Coherent and Incoherent conditions remained the same as Experiment 1. For Experiment 2, we added a third scenario type: Early Incoherent. These scenarios were constructed by reorganising the items from the Incoherent scenarios, but keeping the overall content exactly the same. As in Experiment 1, Incoherent scenarios ended on the incoherent item; for Early Incoherent scenarios, the incoherent item was presented first, followed by the two coherent items. For each of the nine business types, participants were presented with six conditions (four were the same as Experiment 1: Coherent-High risk, Coherent-Low risk, Incoherent-High risk, Incoherent-

Low risk; two were new to Experiment 2: Early Incoherent-High risk, Early Incoherent-Low risk), totalling 54 business scenarios in this experiment. Participants were shown each scenario once, and in a random order.

Instead of using a bipolar rating scale, Experiment 2 used two separate unipolar scales. Both scales were nine point SAM scales, with the liking version ranging from a neutral expression to a happy expression, and the disliking version ranging from a neutral expression to an unhappy expression.

Design. The experiment used a three (Coherent vs Incoherent vs Early Incoherent) by two (High risk vs Low risk) by two (Liking scale vs Disliking scale) mixed design, with the type of scale manipulated as the between groups variable. Self-reported affect was recorded as the dependent variable, whilst response time to complete the affect rating was recorded as a check for fluency.

Procedure. The procedure followed that of Experiment 1, save for the following adjustments. We added a third scenario type (Early Incoherent – detailed above), added a break in the middle of the experiment to allow the participants to relax their eyes, and we removed the risk rating scale.

Results

Response times. We ran a 3 (Coherence: Coherent, Incoherent, Early Incoherent) x 2 (Risk: High vs Low) x 2 (Scale: Liking vs Disliking) mixed ANOVA, with Scale as the between groups variable on the time to respond to the rating (liking or disliking) SAM scales. Results showed a main effect of Coherence ($F_{(2, 78)} = 26.877$, $p < .001$, $\eta_p^2 = .408$) and a main effect of Risk ($F_{(1, 39)} = 15.171$, $p < .001$, $\eta_p^2 = .280$). There was no significant main effect regarding Scale ($F_{(1, 39)} = 0.674$, $p = .417$, $\eta_p^2 = .017$), nor significant interaction effects. For further information, simple effects revealed that the response time to rate Incoherent scenarios (1,733ms) was longer than Coherent scenarios (1,415ms, $p < .001$) and Early Incoherent scenarios (1,263ms, $p < .001$).

Liking ratings. A 3 (Coherence: Coherent, Incoherent, Early Incoherent) x 2 (Risk: High vs Low) repeated measures ANOVA was run on the liking ratings. Results (Figure 5) revealed main effects of Coherence ($F_{(2, 38)} = 21.128$, $p < .001$, $\eta_p^2 = .527$) and Risk ($F_{(1, 19)} = 16.438$, $p = .001$, $\eta_p^2 = .464$), but no significant interaction effect ($F_{(2, 38)} = 0.187$, $p = .830$, $\eta_p^2 = .010$).

For further information, Coherent scenarios ($M = 6.22$) and Early Incoherent scenarios ($M = 6.00$) were liked more than Incoherent scenarios ($M = 4.72$; vs Coherent: $t_{(19)} = 4.804$, $p < .001$, $d_z = 1.074$; vs Early Incoherent: $t_{(19)} = 4.024$, $p = .001$, $d_z = .900$) in the High risk condition. There was no significant difference in liking ratings between the Coherent and Early Incoherent scenarios ($p = .085$, $d_z = .406$). Similarly, Coherent scenarios ($M = 7.49$) and Early Incoherent scenarios ($M = 7.31$) were liked more than Incoherent scenarios ($M = 6.08$; vs Coherent: $t_{(19)} = 4.882$, $p < .001$, $d_z = 1.092$; vs Early Incoherent: $t_{(19)} = 4.263$, $p < .001$, $d_z = .953$) in the Low risk condition. There was no significant difference in liking ratings between the Coherent and Early Incoherent scenarios ($p = .105$, $d_z = .381$).

Disliking ratings. A 3 (Coherence: Coherent, Incoherent, Early Incoherent) x 2 (Risk: High vs Low) repeated measures ANOVA was run on the disliking ratings. Results (Figure 5) revealed a main effect of Risk ($F_{(1, 20)} = 73.741$, $p < .001$, $\eta_p^2 = .787$), which was qualified by a significant Coherence x Risk interaction effect ($F_{(2, 40)} = 5.847$, $p = .006$, $\eta_p^2 = .226$). The main effect of Coherence was not significant ($F_{(2, 40)} = 2.702$, $p = .079$, $\eta_p^2 = .119$).

Unpacking the significant interaction effect, paired samples *t*-tests revealed that, in the High risk condition, Coherent scenarios ($M = 6.45$) were disliked more than Incoherent scenarios ($M =$

5.86, $t_{(20)} = 2.527$, $p = .020$, $d_z = .551$). Early Incoherent scenarios ($M = 6.51$) were also disliked more than the Incoherent scenarios ($t_{(20)} = 2.631$, $p = .016$, $d_z = .574$). There was no significant difference in disliking ratings between the Coherent and Early Incoherent scenarios ($t_{(20)} = .498$, $p = .624$, $d_z = .109$).

In comparison, the Low risk condition showed no significant difference in rating between Coherent ($M = 2.57$) and Incoherent scenarios ($M = 2.69$, $t_{(19)} = .890$, $p = .384$, $d_z = .194$), between Early Incoherent ($M = 2.76$) and Incoherent scenarios ($t_{(19)} = .298$, $p = .769$, $d_z = .065$), or between Coherent and Early Incoherent scenarios ($t_{(19)} = 1.228$, $p = .234$, $d_z = .268$).

Discussion

The results from Experiment 2 expanded on those from the first experiment. As before, processing fluency was successfully manipulated by coherence of scenario; with Coherent scenarios being responded to faster than Incoherent scenarios. The increased processing fluency appeared to influence both liking and disliking ratings, measured separately with unipolar scales.

The results from the liking ratings showed that Coherent scenarios were liked more than Incoherent, regardless of whether the scenarios were high or low risk. In contrast, the disliking ratings demonstrated that valence has an effect: when the scenarios were high risk, participants disliked the Coherent scenarios more, but when the scenarios were low risk, there was no significant difference in disliking ratings.

Although the findings have consistencies with hedonic marking (including rare evidence of hedonic marking using negative stimuli) and fluency amplification (see Table 1 for predictions), neither models can account for the full pattern of results individually. For example, hedonic marking would not account for an increase in disliking for Coherent scenarios in the high risk condition. Similarly, fluency amplification would not account for an increase in liking for Coherent scenarios in the high risk condition. Instead, the results are consistent with the proposed multi-source model; where in these special circumstances – fluent and negative – we see increased liking and increased disliking. These results also shed light on the Coherent-High risk condition of Experiment 1, where we found no significant difference in liking ratings between Coherent and Incoherent scenarios. Extrapolating the results from Experiment 2, it is suggested that positive and negative affect had been evoked, before cancelling each other out when completing the bipolar rating scale.

Experiment 2 also addressed an alternative explanation from Experiment 1: that differences in affective response could be due to changing meaning, rather than fluency. We created a new scenario type – Early Incoherent – by reordering the information from the Incoherent scenarios. With these new scenarios, we were able to alter the processing fluency, without changing the content. Tests of response time indicated that the manipulation was successful in altering processing fluency, with Early Incoherent scenarios being responded to faster than the Incoherent scenarios. Despite containing the same information, results showed that participants liked Early Incoherent scenarios more than the Incoherent scenarios. In the High risk condition, participants also disliked the Early Incoherent scenarios more than the Incoherent scenarios. The pattern of results mirrors that of the Coherent vs Incoherent comparison; providing evidence that fluency effects affective responses, even when the meaning is tightly controlled.

Where the results indicated that the Early Incoherent scenarios were liked more than the Incoherent scenarios, one may question whether this is due to expectation generation and disconfirmation: in Incoherent scenarios, were participants being led to expect a coherent third item based on the previous two items, only to be surprised and frustrated when they encounter an incoherent item? However, examination of the disliking ratings demonstrates that this explanation is not appropriate. In the Low risk (positive valence) condition, there was no significant difference in disliking between the Incoherent, Early Incoherent, and Coherent scenarios. Furthermore, for the High risk (negative valence) condition, the Incoherent scenarios were disliked less than the other conditions. These findings demonstrate the importance of measuring positive and negative affect separately, alongside the manipulation of stimuli valence. Similarly, if the presence of an incoherent item within a scenario was causing participants to become frustrated, to find the scenario difficult to comprehend, or to feel annoyed at a breach of experimenter discourse rules, then one would expect the Early Incoherent trials – which contained an incoherent item – to also be liked less (and disliked more) than the Coherent trials.

Experiment 3

Experiment 2 showed that under certain conditions – fluent and negative – it was possible for positive and negative affect to be evoked by processing fluency. However, a limitation was the use of self-report scales. As shown by Bornstein and D’Agostino (1994), participants may attribute fluency onto the most appropriate source available, such as if they are presented with a liking scale. In our final experiment, we wanted to ensure that we were recording genuine affect, and not merely the attribution of processing fluency. Considering this, we removed the liking self-report scales, and instead measured affect using fEMG.

Following electrode placement recommended by Fridlund and Cacioppo (1986), it is possible to measure positive affect by recording the muscle activity of zygomaticus major. Similarly, recording the activity of corrugator supercilii reveals the level of negative affect (Cacioppo et al., 1986). Applying this to the predictions in Table 1, hedonic marking would therefore predict that increasing fluency would result in an increase in zygomaticus activity, regardless of stimuli valence. Fluency amplification would make the same prediction for positive scenarios, however in negative scenarios, an increase in fluency should result in an increase in corrugator supercilii activity. However, if the two processes are indeed separate and make individual contributions to affect, it is expected that the separate measurement of positive and negative affect will show evidence of both hedonic marking and fluency amplification.

If this is the case, in low risk conditions we would expect fluent scenarios to be met with increased zygomaticus activity, which is consistent with both accounts. However, in the high risk conditions, we would expect an increase in zygomaticus activity – due to the positive marking of processing fluency – as well as an increase in corrugator activity – due to the amplification of the condition's valence.

Method

Participants. Forty-one (35 female) students were recruited, mostly from the psychology undergraduate course (34 psychology students), in return for credits towards the University's lab token scheme. The mean age was 19.39 years old (*SE* ± 0.23 years). Power analysis recommended a sample size of 37, considering a medium-large effect size and Power > .80. We recruited past this to take into account four participants whose corrugator supercilii data were discarded due to artefacts.

Materials. Once again, business scenarios were used as the stimuli, in the same design as Experiment 1, but with the following changes:

Firstly, we effectively doubled the number of scenarios from 36 to 72 in anticipation for discarded trials as a result of artefacts, such as eye blinks. We did this by swapping the positions of the first and second item in each scenario. Secondly, following feedback from participants, the business scenarios were potentially too complicated for the targeted participant pool. Therefore, the wording was simplified, and more straightforward businesses used (e.g. replacing manufacturing and pharmaceutical trials with a zoo and a cinema). An example of the new items used in Experiment 3 can be seen in Table 4.

Lastly, Experiment 3 used fEMG recording to measure the affective responses, instead of the self-report SAM scales used in the previous experiments. The same risk rating scale was used as in the Experiment 1. fEMG was recorded for the duration of the experiment from bipolar electrodes. The two sites recorded were the zygomaticus major muscle (cheek) and the corrugator supercilii muscle (brow). Electrode placement followed the guidelines of Fridlund and Cacioppo (1986). The experimental procedure was started once the impedance was reduced to less than 10kΩ.

Design. The experiment used a two (Coherent vs Incoherent) by two (High risk vs Low risk) repeated measures design, with fEMG amplitude as the dependent variable. Self-reported risk was recorded, but reading time of the final item was not, as we needed a constant window in which to record fEMG.

Procedure. Once the participant had given consent, their face was prepared for electrode placement. The left cheek, left eyebrow, centre of forehead, and right jaw were wiped with alcohol. At these sites, the skin was also gently abraded using conductive gel. Bilateral electrodes were prepared with conductive gel and then attached at the left cheek and let eyebrow using surgical tape – with the electrode placement following Fridlund and Cacioppo (1986). A ground electrode was attached in the same way at the centre forehead, as well as a reference electrode at the right jaw.

The remainder of the experimental procedure followed that of Experiment 1, except for the following alteration to accommodate fEMG. The final item of information in the triad was no longer self-paced. Instead, the final item remained on the screen for 3,000ms, whilst facial muscle activity was recorded, before automatically progressing to the next screen. This next screen was now the risk rating screen, as per Experiment 1, with the SAM scale for liking ratings no longer being used.

fEMG analysis. For each trial, fEMG activity was captured from the zygomaticus major and corrugator supercilii at two key segments. The first was a pre-stimulus baseline, which was a period of 0-500ms prior to the onset of the final item of information. At this point, the participant was viewing a fixation cross in the centre of the screen. The second segment was the test period, 1,501-3,000ms post onset of the final item of information. During this period, the final item of information was still visible on the screen (see Figure 1 for a timeline displaying fEMG segmentation). The test period was selected based on previous findings, with no significant differences in zygomaticus or corrugator activity being found between Coherent and Incoherent trials in the period 0-1,500ms post stimulus onset (Topolinski et al., 2009). Similarly, fluency effects on zygomaticus activity have not been found in later periods (Winkielman & Cacioppo, 2001). It was also based on the reading times from Experiment 1, showing that participants took roughly 3 seconds to read the final item. A window of 1,501-3,000ms from stimulus onset was therefore deemed appropriate, as this would capture the immediate affective response to reading the scenario, and reduce the risk of the participant undergoing more effortful reasoning.

These segments were screened for outliers, in particular for artefacts from movement such as blinking. Any trials containing such artefacts were manually rejected following visual inspection. For the remaining trials, the average, absolute activity was exported. This activity was standardised and any trials with a *z*-score of ±3.29 were discarded. We also compared the number of rejected trials across conditions to ensure that no condition was over or under represented.

For the remaining trials, the rectified, average absolute activity from the test segment was compared to the pre-stimulus baseline from the same trial. This gave a percentage change from baseline for each trial, for both the zygomaticus major and corrugator supercilii muscles.

Results

The overall 2 (Muscle: Zygomaticus vs Corrugator) x 2 (Coherence: Coherent vs Incoherent) x 2 (Risk: High vs Low) returned a significant Muscle x Coherence x Risk interaction ($F_{(1, 36)}$ = 5.288, p = .027, η_p^2 = .13), which allowed for the separate analysis of each muscle.

Zygomaticus. A 2 (Coherence: Coherent vs Incoherent) x 2 (Risk: High vs Low) repeated measures ANOVA was run on the Zygomaticus data for the test interval (1501-3000ms post stimulus onset) against the pre-stimulus baseline. Results revealed a main effect of Coherence ($F_{(1,40)}$ = 6.927, p = .012, η_p^2 = .15), with Coherent triads (M = .050) showing a greater increase in activity from baseline than Incoherent triads (M = .022). Neither the main effect of Risk ($F_{(1,40)}$ = 0.269, p = .607, η_p^2 < .01), nor the interaction effect ($F_{(1,40)}$ = 0.015, p = .905, η_p^2 < .01) were significant. Percentage changes from baseline for all four conditions are shown in Figure 6.

Corrugator. A 2 (Coherence: Coherent vs Incoherent) x 2 (Risk: High vs Low) repeated measures ANOVA was run on the Corrugator data for the test interval (1501-3000ms post stimulus onset) against the pre-stimulus baseline, revealing a significant interaction effect between Coherence and Risk ($F_{(1,36)}$ = 5.590, p = .024, η_p^2 = .13). Neither of the main effects were significant (Coherence: $F_{(1,36)}$ = 1.761, p = .193, η_p^2 = .05; Risk: $F_{(1,37)}$ = 1.583, p = .216, η_p^2 = .04). Percentage changes from baseline for all four conditions are shown in Figure 7.

Unpacking the interaction effect, paired samples *t*-tests revealed that for the High risk condition, Corrugator activity rose from baseline significantly more for Coherent scenarios (M = .065) compared to Incoherent scenarios (M = .019, $t_{(36)}$ = 2.403, p = .022, d_z = .395). For the Low risk condition, there was no significant difference between Coherent (M = .045) and Incoherent scenarios (M = .061, $t_{(36)}$ = 1.095, p = .281, d_z = .180).

Risk ratings. A 2 (Coherence: Schema Coherent vs Schema Incoherent) x 2 (Risk: High vs Low) ANOVA was run on the participants' risk ratings, revealing a main effect of Risk ($F_{(1,40)}$ = 343.304, p < .001, η_p^2 = .90), with the high risk conditions (M = 6.53) receiving higher risk ratings than the low risk conditions (M = 3.12), and a significant interaction effect between Coherence and Risk ($F_{(1,40)}$ = 6.517, p = .015, η_p^2 = .14). The main effect of Coherence approached significance ($F_{(1,40)}$ = 3.983, p = .053, η_p^2 = .09).

Paired samples *t*-tests were used to investigate the interaction effect. Results revealed that for the Low risk condition, Coherent scenarios (M = 3.06) were judged to be significantly less risky than Incoherent scenarios (M = 3.19, $t_{(40)}$ = 3.428, p = .001, d_z = .535). For the High risk condition, no significant differences were found between Coherent (M = 6.53) and Incoherent scenarios (M = 6.53, $t_{(40)}$ = .179, p = .859, d_z = .028).

Rejected trials. The number of rejected trials due to artefacts, such as eye blinks, were compared across condition. A 2 (Muscle: Zygomaticus vs Corrugator) x 2 (Coherence: Coherent vs Incoherent) x 2 (Risk: High vs Low) returned only a significant effect of Muscle ($F_{(1, 36)}$ = 104.079, p < .001, η_p^2 = .743), indicating that artefacts were more likely to occur from corrugator measurement than zygomaticus.

Discussion

The use of fEMG in this experiment allowed for the separate measurement of positive and negative affective responses by separately measuring the zygomaticus major and corrugator supercilii muscles. The results from the zygomaticus major muscle (indicating positive affect) demonstrated a greater increase in activity from baseline for Coherent scenarios, compared to Incoherent scenarios. This main effect occurred across high and low risk scenarios, supporting the hedonic marking of fluency.

In contrast, the results from the corrugator supercilii muscle (indicating negative affect) showed an interaction effect. As illustrated in Figure 7, the affective response to coherence was dependent on the valence of the scenario. In High risk (negative valence) scenarios, muscle activity increased more for Coherent scenarios than Incoherent scenarios. In Low risk (positive valence) scenarios, muscle activity increased more for Incoherent scenarios than Coherent scenarios. This pattern is consistent with a fluency amplification account.

These findings therefore suggest that increasing the processing fluency in negative conditions results in both a positive affective response (indicated by increase zygomaticus activity from baseline), and a negative affective response (indicated by increase corrugator activity from baseline). Neither the hedonic marking, nor the fluency amplification hypotheses account for this pattern individually. Instead, the pattern supports a mutli-source account, whereby the separate mechanisms contribute to the affective response.

It could be questioned whether the corrugator activity was reflecting an increase in effort, the emotion of surprise, or (as addressed in the discussion for Experiment 2) frustration in comprehension, rather than negative affect. However, if this was the case, we would expect greater activity for Incoherent conditions compared to Coherent conditions, regardless of valence, such as demonstrated by Topolinski & Strack (2015). Instead, results showed an interaction effect and no main effect of coherence. Confidence can therefore be gained that corrugator activity was indeed representing negative affect.

General Discussion

This paper tested the contribution of two key processes – hedonic marking and fluency amplification – to overall affective responses to fluency. A novel multi-source perspective was taken, treating hedonic marking and fluency amplification as two separate, co-existing mechanisms, rather than as competing explanations (e.g. Cheetham et al., 2014; Chetverikov & Kristjánsson, 2016; Gerger et al., 2016, Muth et al., 2015). As such, it was predicted that affective responses to fluency would be best described using a multi-source account.

Over three experiments, we found that Coherent (fluent) scenarios were liked more than Incoherent scenarios, as consistent with both the hedonic marking hypothesis and the fluency amplification model. However, the critical condition was for negative scenarios, as the two accounts make incompatible predictions (see Table 1). For these negative scenarios, we found patterns of affective responses to increased processing fluency that could not be explained by hedonic marking or fluency amplification in isolation. When liking was measured using bipolar self-report scales (Experiment 1), there was no difference in liking between the Coherent and Incoherent negative scenarios. This could be explained by the multi-source account, as the co-occurring positive and negative affect would have negated each other. This was investigated further in Experiment 2 by separate unipolar scales to look at positive and negative affect separately. In the critical negative condition, we found evidence for both increased liking and increased disliking when the scenarios were fluent. This was supported by fEMG evidence (Experiment 3), whereby increasing the coherence of negative scenarios resulted in an increase in both zygomaticus major activity (indicating positive affect) and corrugator supercilli activity (indicating negative affect).

The manipulation of stimulus valence, alongside separate measurement of positive and negative affect in the current study allowed for two other unique findings. Firstly, by providing support for a hedonic marking process, even in more negative conditions. Previously evidence for hedonic marking was limited to more positive or neutral stimuli (e.g. Winkielman & Cacioppo, 2001). Secondly, the current study has found evidence for fluency amplification processes using fEMG, whereas previous evidence has been based on bipolar self-report (e.g. Albrecht & Carbon, 2014).

The current study also adapted the traditional word triad task procedure (e.g. Topolinski et al., 2009; Topolinski & Strack, 2009b), incorporating business scenarios as task items. Using these scenarios, we were able to successfully manipulate the processing fluency by varying the consistency to typical schemas. A secondary benefit of this study is therefore the demonstration that testing fluency effects is achievable using more ecologically valid designs.

A competing explanation for the results gathered in this paper could be proposed regarding expectation generation and disconfirmation (e.g. Oliver, 1980; Oliver & Swan, 1989). This would suggest that participants were being led to expect a coherent third item, based on the first two items in a scenario. Therefore, in Incoherent scenarios, the participants may feel frustrated when encountering the incoherent item. We argue against this explanation, firstly as expectation disconfirmation would typically relate to valanced incongruence. This would be appropriate if, for example, participants were presented with Low risk (positive) items, followed by a High risk (negative) item. This would cause negative disconfirmation, where participants have expectations built up, only to be let down by the final item. This has been shown to cause negative evaluations for household products (Darke, Ashworth, & Main, 2010), automobiles (Oliver & Swan, 1989), and holidays (Zehrer, Crotts, & Magnini, 2011). In contrast, the current set of experiments keep the valence of the item consistent within each scenario. In other words, if the first item is Low risk (positive), then so will the second and third items. Therefore, the incoherent items do not cause either positive or negative disconfirmation, as their valence never differs from those items preceding it in any given scenario.

Secondly, if frustration, annoyance, or difficulty in comprehension were responsible for the lower liking ratings for Incoherent scenarios, then one would also expect the Incoherent scenarios to result in higher disliking ratings. In contrast, examination of the High risk scenarios demonstrates higher disliking ratings for Coherent scenarios compared to Incoherent scenarios in Experiment 2. Furthermore, Experiment 3 found a greater increase in corrugator activity (indicating negative affect) for Coherent-High risk scenarios than for Incoherent-High risk scenarios.

That is not to say that expectation does not play some part in our findings. The current experiments used business scenarios that were either Coherent or Incoherent with typical schemas that participants hold; and those scenarios that are Coherent with these schemas are by nature more in line with expectations. So, whilst expectation disconfirmation does not explain the results, it is clear that there are commonalities. It is therefore suggested that expectation disconfirmation studies could be revisited through a multi-source lens, with conceptual fluency examined as the link between expectation and evaluation.

A limitation of the current research could be that the use of business scenarios and risk manipulations would not have been particularly affective. This is apparent in comparison to Albrecht and Carbon (2014), where the “very negative” and “very positive” images would have evoked a stronger emotional response. However, making the business scenarios more extreme in terms of valence may have reduced the realism. Therefore the loss of affective range is considered acceptable in the light of aiming for greater ecological validity. We were also limited to the complexity of scenarios used, due to the student sample. It is suggested that future studies expand on the business scenario task by adding an increased number of scenarios, with increasing levels of complexity, to test participants with higher levels of expertise.

A second limitation is that the current research, in line with the vast majority of research on affective responses to fluency, used valence as the affect measure. Whilst the scope of this research was to investigate patterns of affective response to fluency, we note that there is more to affect than valence. Moving forward, the components of this affective response should be investigated, as has been done by a small minority of studies using PANAS (Pronin, Jacobs, & Wegner, 2008) or arousal (Forster, Leder, & Ansorge, 2016), another dimension to affect.

Having provided preliminary evidence for hedonic marking and fluency amplification co-existing, it would beneficial to further understand their relationship, and why fluency potentially evokes both positive and negative affect. A possibility is that hedonic marking detects fluency, identifying situations where it is deemed safe to use non-analytic processing mechanisms such as fluency amplification. This would represent a system for jumping to conclusions, quickly emphasising positives and negatives, provided it is safe to do so. This would fit conceptually with the idea that fluency does not just influence judgement, but also our cognitive operations (Oppenheimer, 2008); especially if affect was found to be the link in this process. For example, Graf and Landwehr’s (2015) Pleasure-Interest Model of Aesthetic Liking suggests that fluency-based positive affective responses (such as from hedonic marking) act as a cue deterring controlled processing, in favour of automatic processing. If automatic processing is encouraged, perhaps fluency amplification acts as the mechanism to quickly decide whether the aesthetic stimulus is liked or disliked. Along this line of enquiry, it would be therefore of interest in further studies to determine if there is a timing element to these processes, for example does hedonic marking trigger fluency amplification?

A further explanation would be that fluency amplification can act as a defence mechanism for hedonic marking. For example, a negative scenario may evoke positive affect due to hedonic marking, thus acting as a cue for safety. Fluency amplification would work in the opposite direction in this case, potentially cancelling out positive affect, and motivating the individual to avoid the situation. Further studies exploring this avenue could therefore incorporate approach/avoidance paradigm (e.g. Carr, Rotteveel, & Winkielman, 2016) alongside negative stimuli to test the hypothesis.

As well as understanding more about the affective responses, this research has implications for other judgements arising from fluency manipulations. As has been shown, affective responses to fluency can used as a cue for other judgements (Topolinski, 2011), rather than fluency itself. Topolinski and Strack (2009b) demonstrated this with a misattribution paradigm, whereby participants were able to intuitively discriminate coherent from incoherent word triads, provided they did not misattribute the source of affect to a different source. This assumes the cue is the positive affective response resulting from hedonic marking. However, it could be investigated as to whether the affective response arising from fluency amplification holds any information as a cue for judgement. For example, does misattribution work if the stimuli are negative, and therefore also generating negative affect? Is it possible to reattribute negative affect as well as positive affect?

Conclusion

The experiments in this paper present a unique pattern of results, not entirely explained by either the hedonic marking hypothesis or by fluency amplification, in isolation. Instead, the pattern of affective responses to increased processing fluency may be best explained by a multi-source account, which predicts the co-existence of these two processes as discrete mechanisms. Firstly, increasing the coherence of stimuli results in a positive affective response, regardless of the stimuli's valence, due to the positive marking of processing fluency. Secondly, increasing coherence results in an affective response that is congruent with the condition's valence. Therefore, preliminary evidence has been gathered suggesting that hedonic marking and fluency amplification are not alternative accounts for the direct response to fluency, but are separate mechanisms, and both make a contribution to overall affective responses.

Disclosure Statement

No potential conflict of interest was reported by the authors

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Table 1: Table of predictions for the 3 accounts – hedonic marking, fluency amplification, and the multi-source account – for positive and negative stimuli.

Hypothesis	Increased processing fluency (coherent vs incoherent) for…	
	Positively Valenced Stimuli (Low Risk)	Negatively Valenced Stimuli (High Risk)
Hedonic Marking	Increases *positive affect*	Increases *positive affect*
Fluency Amplification	Increases *positive affect*	Increases **negative affect**
Multi-source account	Increases *positive affect*	Increases *positive affect* & Increases **negative affect**

Table 2: Example items of information used in the pilot study, for the Travel business scenarios. The participants were given the following background information:

> "A well known 'bricks-and-mortar' travel agent situated in town offering holiday bookings to a wide range of destinations, in the UK and overseas. The company has expanded its online offering, and has expertise in adventure, action, and sports holidays."

Followed by one of the triads of information as per the grids below:

	High Risk	Low Risk
Item 1	An area which consumers look to cut back on during difficult economic times	Recovery of global tourism industry
Item 2	Big competitor companies hold a large market share	The number of domestic holidays has steadily increased over the last few years
Item 3	Instability overseas can threaten consumer confidence	The company is selling a desirable product

Risks

Strengths

Table 3: Example items of information used in Experiment 1, for the Travel business scenarios. The participants were given the following background information:

> "A well known 'bricks-and-mortar' travel agent situated in town offering holiday bookings to a wide range of destinations, in the UK and overseas. The company has expanded its online offering, and has expertise in adventure, action, and sports holidays."

Followed by one of the triads of information as per the grids below.

	High risk Coherent	Low risk Coherent	High risk Incoherent	Low risk Incoherent
Item 1	An area which consumers look to cut back on during difficult economic times	Recovery of global tourism industry	An area which consumers look to cut back on during difficult economic times	Recovery of global tourism industry
Item 2	Big competitor companies hold a large market share	The number of domestic holidays has steadily increased over the last few years	Big competitor companies hold a large market share	The number of domestic holidays has steadily increased over the last few years
Item 3	Instability overseas can threaten consumer confidence	The company is selling a desirable product	Increase in popularity of free sports such as running and cycling increases competition	Government increasingly promoting activities that lead to a healthy, active lifestyle

Schema incoherent

Schema coherent

Table 4: Example items of information used in Experiment 3 for the Leisure Centre business. The design was structurally the same as in Experiment 1, but the items themselves were re-written to be more salient to the participants. Participants were given the following background information:

> "A premium independent leisure centre in town offering state of the art facilities, including 25m swimming pool, fitness centre, squash courts, and individual suites for classes and courses."

Followed by one of the triads of information as per the grid below.

	High risk Coherent	Low risk Coherent	High risk Incoherent	Low risk Incoherent
Item 1	Risk of injury to customers	Offers a good variety of services	Risk of injury to customers	Offers a good variety of services
Item 2	Staff must be well trained	Appeals to up-market customers	Staff must be well trained	Appeals to up-market customers
Item 3	Maintaining equipment is expensive	Promotes a healthy, positive image	Can be weather dependent	Popular day out for families

Schema incoherent
Schema coherent

Figure 1: Timeline detailing the timings for stimuli presentation in Experiments 1-3, alongside recording periods for fEMG.

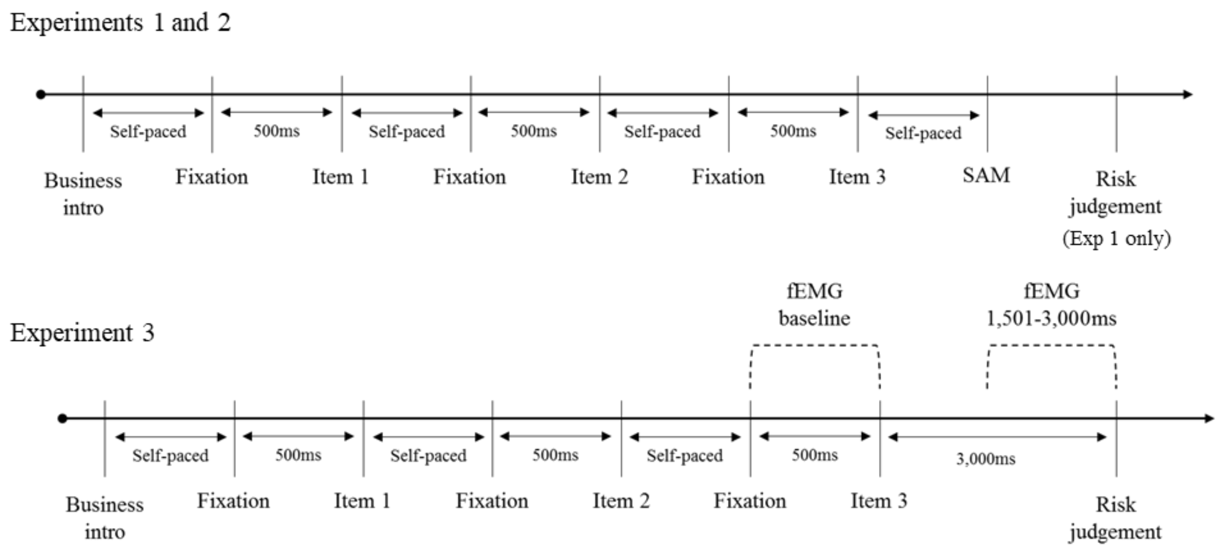

Figure 2: Pre-study - Graph showing liking ratings from the five-point SAM scale, and self-reported risk, for high risk and low risk business scenarios.

* p < .001

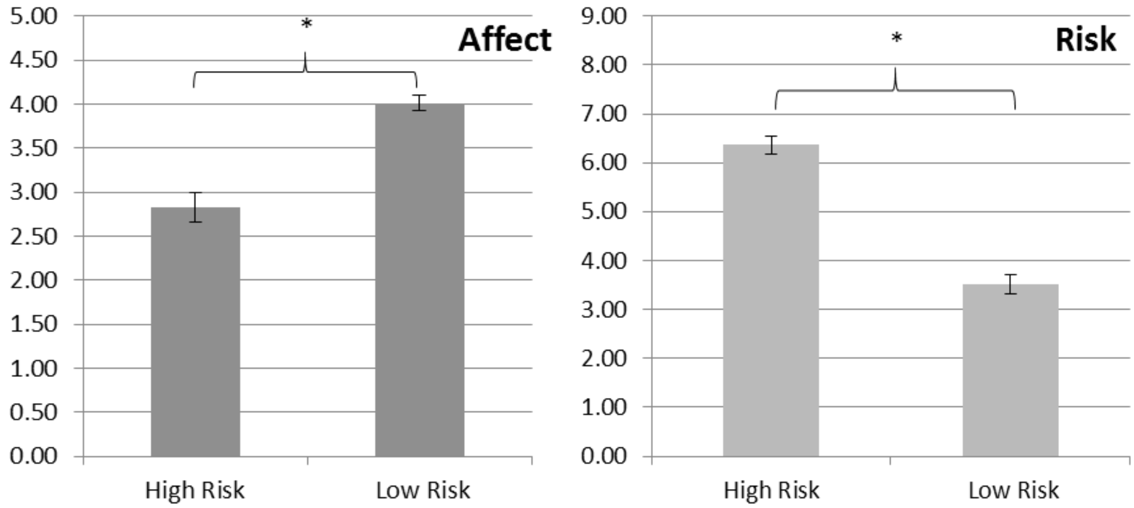

Figure 3: Experiment 1 – Mean reading times (ms) for the final item in the triad. Comparing items that are presented as part of a schema coherent triad of information, to items presented incoherent to the schema, and for both high risk and low risk conditions.

* p = .016, ** p = .001.

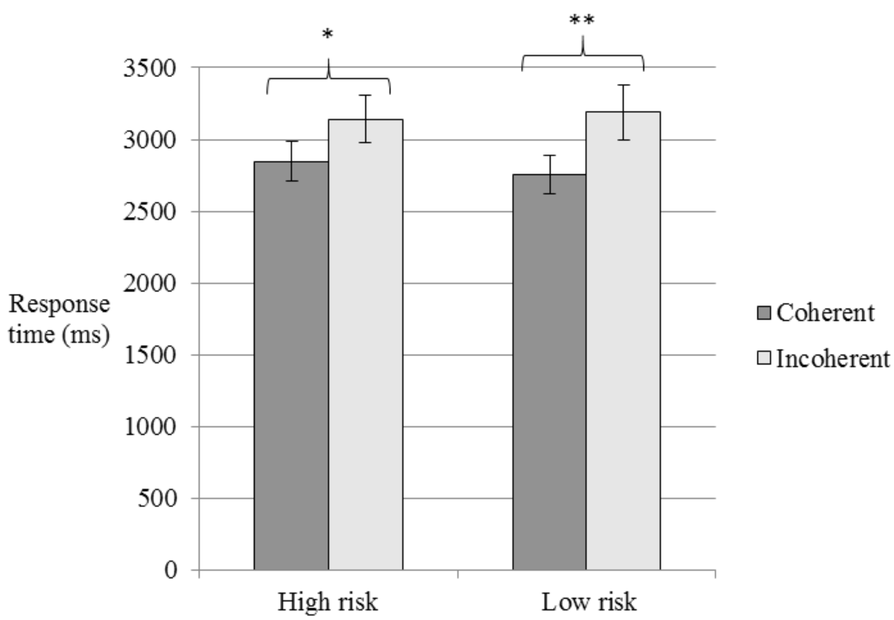

Figure 4: Experiment 1 – Mean liking ratings for the business scenarios. Comparing coherent and incoherent triads, for both high risk and low risk conditions.

* p = .009.

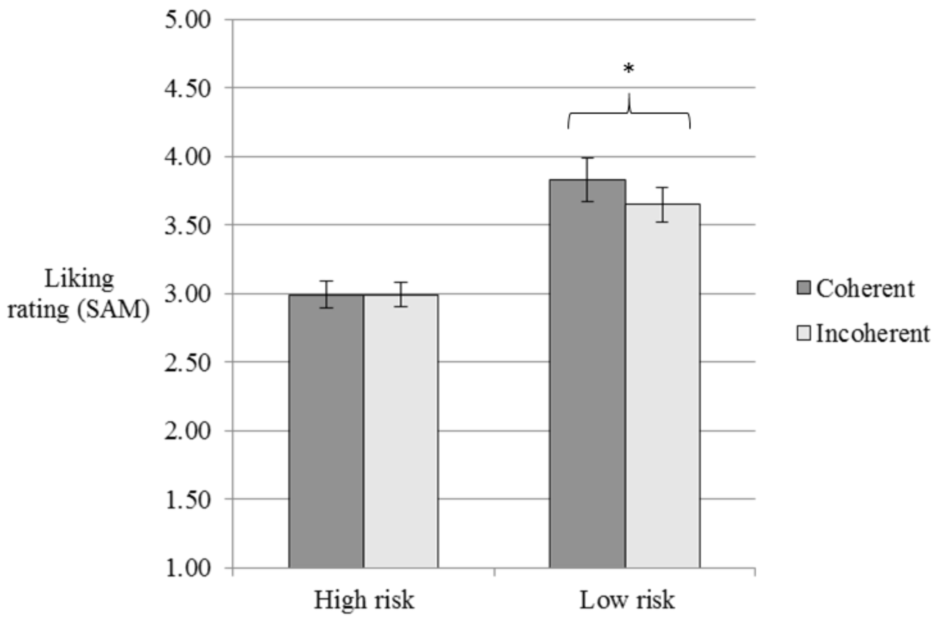

Figure 5: Experiment 2 – Mean liking and disliking ratings for the business scenarios.

Comparing Coherent, Early Incoherent, and Incoherent triads.

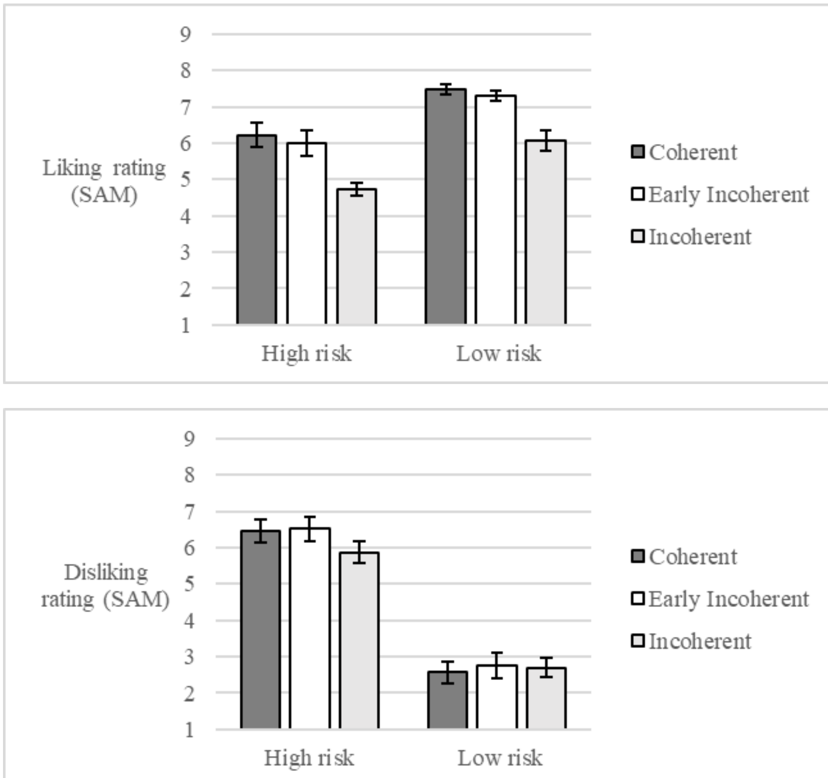

Figure 6: Experiment 3 – Zygomaticus activity in the test phase (1,501-3,000ms post stimulus onset) shown as a percentage change from pre stimulus baseline. Comparing coherent and incoherent triads, for both high risk and low risk conditions.

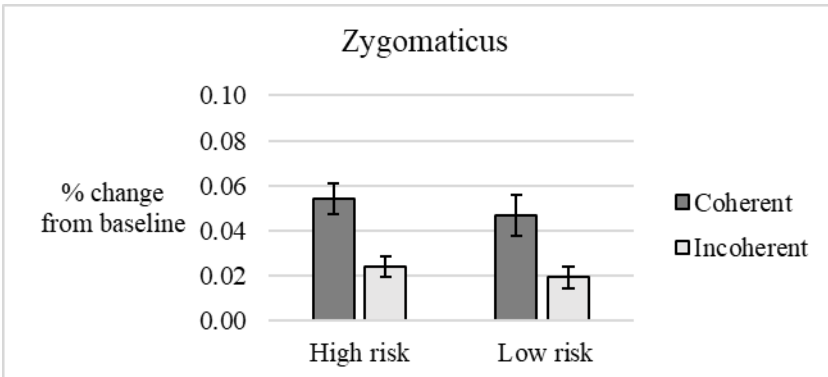

Figure 7: Experiment 3 – Corrugator activity in the test phase (1,501-3,000ms post stimulus onset) shown as a percentage change from pre stimulus baseline. Comparing coherent and incoherent triads, for both high risk and low risk conditions.