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The Effect of Mental Imagery on Emotion Assessed Using Picture-Word Cues

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### Abstract

The hypothesis that mental imagery is more likely to elicit emotion than verbal processing of the same material was investigated in two studies. Participants saw a series of pictures, each accompanied by a word, designed to yield a negative or benign meaning when combined. Participants were either free to combine the picture and word as they wished (Experiment 1) or instructed to integrate them using either a descriptive sentence or a mental image (Experiment 2). Emotional response was consistently greater following imagery than after producing a sentence. Experiment 2 also demonstrated the causal effect of imagery on emotion and evaluative learning. Additional participants in Experiment 2 described aloud their images / sentences. Independent ratings of descriptions indicated that, as well as being more emotional, images differed from sentences elicited by identical cues by greater similarity to memories, and greater involvement of sensations and specific events. Results support the hypothesis that imagery evokes stronger affective responses than does verbal processing, perhaps due to sensitivity of emotional brain regions to imagery, the similarity of imagery to perception, and to autobiographical episodes.

**KEYWORDS:** Mental imagery, emotion, imagination, verbal thought, anxiety, depression, autobiographical memory, evaluative learning.

### The Effect of Mental Imagery on Emotion Assessed Using Picture-Word Cues

Kosslyn, Ganis, and Thompson (2001) proposed that “mental imagery occurs when perceptual information is accessed from memory, giving rise to the experience of ‘seeing with the mind’s eye’, ‘hearing with the mind’s ear’ and so on.....” (p. 635). A long-standing assumption within psychology is that preferential links exist between emotion and mental imagery relative to other forms of processing (e.g., Conway, 2001; Kane, Bleckley, Conway, & Engle, 2001; Kosslyn, 1994; Kosslyn, Ganis, & Thompson, 2001; Williams, Watts, MacLeod, & Mathews, 1997). Of particular interest is the hypothesis that images evoke stronger affective responses than do verbal representations. However, as previously noted (Holmes & Mathews, 2005) empirical evidence for this assumption seems surprisingly sparse. Mental imagery and verbal processing have been compared in other domains; for example, exploring their relative impact on memory (e.g., Pavio, Smythe & Yuille, 1968). Other research has compared different types of imagery with each other; for example, images of real memories versus fantasies (Kealy & Arbuthnott, 2003) or across different viewer perspectives taken in an image (McClassac & Eich, 2004). However, to our knowledge no other researchers have systematically compared verbal and imagery processing in terms of any differential effects on emotion - the primary aim of the studies reported in this paper.

Why investigate this issue? In theoretical terms, information about the nature of the relationships between the affective and other processing systems seems vital to enhancing understanding of both, most especially at the interface between basic science and applied psychology. The assumption of a facilitative relationship between imagery and emotion held by cognitive psychologists (e.g., Kosslyn, 1994) is also widely endorsed in clinical psychology. Using mental imagery is assumed to provide a particularly effective route to accessing and modifying emotion in therapy, that is superior to verbal means (e.g., Foa & Kozak, 1986; Holmes & Hackmann, 2004; Lang, 1979). Consequently, imagery use is increasingly used in treatment

strategies for many disorders including posttraumatic stress disorder (American Psychiatric Association, 1994), where flashback trauma images are a hallmark symptom, borderline personality disorder (Giesen-Bloo et al., 2006), and cravings in substance misuse (Kavanagh, Andrade, & May, 2005). Thus, understanding the links between imagery and emotion would both provide an enhanced theoretical context for existing therapies and, critically, sharpen evidence-based therapy methods (Harvey, Watkins, Mansell, & Shafran, 2004).

A recent review (Holmes & Mathews, 2005) emphasized the importance of comparisons between imagery and alternative types of encoding, such as verbal-semantic, in order to address the notion of a facilitative imagery/emotion relationship. However, the majority of previous studies pertaining to this issue have either not explicitly included such comparisons or introduced confounds such as a failure to counterbalance conditions, as in the frequently cited work of Vrana, Cuthbert and Lang (1986). Thus, although evidence of imagery's special effect on emotion is often assumed to exist, on careful examination the existing data are unconvincing. Contrasts between imagery and verbal encoding of the same material were therefore planned, initially in a naturalistic study with participants free to use either encoding method, and subsequently using instructional manipulations within a counterbalanced experimental design.

Previously, using auditory descriptions of emotional events, we have found that instructions to form mental images led to greater changes in self-reported mood than did verbal processing instructions (Holmes & Mathews, 2005; Holmes, Mathews, Dalgleish, & Mackintosh, 2006). With a Cognitive Bias Modification of Interpretation (CBM-I) paradigm, when initially ambiguous events were resolved in a negative manner using imagery, anxiety increased more than ambiguity resolution using verbal processing (Holmes & Mathews, 2005). Likewise, when ambiguous events were resolved in a relatively positive way, positive emotion were enhanced more by imagery than verbal processing (Holmes et al., 2006). It was concluded that imagery had a more powerful impact on emotion than does verbal processing of the same material.

However, because these methods provided verbal descriptions of events, to be further processed via imagery or for their verbal meaning, such conclusions were open to challenge. Emotional differences could have arisen merely by recruitment of an additional mental representational system in the imagery condition (Baddeley, 1979; Craik & Lockhart, 1972; Johnson, 1983; Johnson & Multhaup, 1992; Power & Dalgleish, 1999). That is, since the event is necessarily first represented in verbal form, the imagery condition supplements this initial verbal representation with an alternative processing mode, whilst this addition is absent from the verbal condition. One way to avoid this problem would be to combine pictorial and verbal cues as the initiating events, requiring participants to integrate both in a single image or a sentence. In the current studies, pictures and words (e.g., a picture of a high bridge accompanied by the word “leap”) could either be combined within an image, or using a verbal description. It would then be difficult to argue that emotional differences due to these encoding conditions depended on one using “more” representational forms than the other. Furthermore, by selecting pictures and words that were relatively neutral in isolation, any resulting emotional differences between the imagery and verbal conditions should be attributable to the mode of their integration, since the (neutral) individual verbal and pictorial cues would be common to both.

Experiment 1 investigated spontaneous integration of negative picture-word pairs when no explicit instructions were given. As well as providing information about natural encoding preferences, Experiment 1 allowed us to examine whether variations in the spontaneous use of imagery might be related to emotion variations in the way we predicted. Additionally, the anticipated facilitative differential relationship between imagery and emotion could be explored under circumstances when experimental demand was minimized. The first hypothesis for Experiment 1 was therefore that greater self-reported use of imagery would be associated with a greater emotional response than verbal processing of the same material.

We have previously discussed why imagery might have an especially strong relationship with emotion (Holmes & Mathews, 2005), as have others before us (Lang, 1979, 1987). However, in Lang's (1987) view the focus appears to be that "the essence of imagery is response production" (p. 408), implying that imagery primes the production of motor events appropriate to the actual occurrence of the imagined event. However, while not disagreeing with this idea, recent neuroimaging evidence provides stronger support for the view that the neural processes supporting imagery overlap very considerably with those involved in the perceptual processing of the equivalent real events, as well as (optionally) the activation of responses to those events (e.g. O'Craven & Kanwisher, 2000).

In our view, images may thus be linked with emotion for at least three related reasons. First, because basic emotion systems in the brain evolved early, prior to language, it has been argued that such systems are more responsive to sensory-perceptual inputs (e.g., Öhman & Mineka, 2001), suggesting that images may more readily trigger emotions than language-based representations. Second, mental imagery shares neural processes involved in perceiving "real" events (Kosslyn, Ganis, & Thompson, 2001); indeed, memories for imagined events are sometimes confused with or assimilated into memories of actual events (e.g. in failures of "reality-monitoring", Johnson & Raye, 1981, , 2000). Such confusions are more likely when using imagery rather than verbal techniques (Hyman & Pentland, 1996). Third, it has been argued that autobiographical episodic memories are largely stored in the form of images, including associated emotional states (Conway, 2001). Images may thus be particularly effective cues for re-activating related episodes in memory, together with their prior associated emotion. Conway has argued that after highly emotional, traumatic events, moments of particular self-relevance will predominantly be recalled as images rather than verbally (Conway, Meares, & Standart, 2004). Furthermore, imagining the future depends on much of the same neural machinery as remembering the past (Schacter, Addis, & Buckner, 2007).

The second aim of Experiment 1 was to acquire data pertaining to these theoretical views about why imagery should be especially likely to elicit emotion. In particular, we predicted that integrating the word-picture stimuli using imagery would be associated with greater self-involvement with the stimuli and stronger associations to autobiographical memories. More specifically, we speculated that self-involvement and autobiographical recall could mediate the relationship between use of imagery and strength of reported emotion. That is, self-involvement would likely emerge as a mediator if enhanced emotion were due to images being experienced in terms of putative real events happening to oneself. Likewise, emotional effects should be mediated by rated occurrence of memories if they depend on the extent to which imagery construction draws upon prior episodes in memory.

### Experiment 1

The first aim of Experiment 1 was to examine whether higher self-reported spontaneous use of imagery would be correlated with stronger negative emotion ratings in the absence of any explicit instructions about the method for integrating negative picture-word pairs. The second aim was to test predictions about mediation of the imagery-emotion relationship by autobiographical memories or by perceived self-involvement. All volunteers viewed 20 picture-word combinations designed to elicit emotionally negative representations, presented in random order. To test our predictions, each item was rated for: (a) extent of imagery experienced; (b) extent of verbal thoughts; (c) intensity of emotional response; (d) memory recruitment; and (e) self-involvement.

### *Method*

#### *Participants*

Fifty-five mature student participants were recruited during a University Summer School. One participant was excluded as English was not his/her first language, and one for failure to complete all ratings. The final sample of 53 participants comprised 46 females and 7 males, with a mean age of 36.56 years ( $SD = 8.52$ ; range 21 – 54).

### *Materials*

The 20 pictures used were either photographed by the first author using a Finepix 40i Fujifilm digital camera or were downloaded from the internet (non-copyrighted). Words were chosen so that their combination with the picture suggested a potential negative physical outcome for a person, e.g., a picture of a flight of stairs and the word “fall” (for further examples see the negative consequences column of Table 1). The picture dimensions were approximately 17.5 cm by 13.0 cm, displayed on individual pages of a booklet with the word caption beneath. Individual picture-word pairs were presented in a different random order for each participant.

The six rating questions used 9-point response scales. One question was “how emotional did you find the combination of this picture and word?” to be rated from 1 (not at all) to 9 (extremely). Three questions concerned the style of thinking: “When you combined this picture with its word, how much did you find yourself thinking in mental images (i.e., in mental pictures and sensory impressions)?”; “... in words or sentences (i.e., in verbal thoughts)?”; “... in a manner that neither seemed like having mental images nor verbal thoughts?” Two questions concerned memory and self-involvement: “How much was your picture-word combination a real memory of events you have actually experienced?” and “How much did your picture-word combination appear as if it was happening to you, that is, that you were involved in it?” The latter 5 questions were rated from 1 (not at all) to 9 (totally).

Rating questions, below which participants wrote their answers, appeared on a separate sheet in the same booklet on the page following each picture-word pair. The order of ratings was pseudo-randomized by creating six different rating orders, which in turn were randomly allocated to picture-word combinations, to minimize any order effects. To check participants’ ability to combine picture and word, they were asked immediately after each item to respond “yes” or “no” to “were you able to combine the picture and the word?”. “No” ratings were to be discarded but none was recorded.

### *Procedure*

All participants received information about the study and gave their written informed consent to taking part. Participants were told that each booklet page would contain a word and picture and that their task was to combine the two, spending no more than a few seconds on each. They were then to answer the rating questions for that picture-word combination, before moving on. No specific instructions were given as to how to combine the pictures and words.

### *Results*

Alpha was set at 0.05 for all tests. Statistical tests examining a priori directional hypotheses were one-tailed. All other analyses were two-tailed.

#### *Extent of Reported Imagery and Verbal Thoughts*

For all participants, mean imagery use score on the 1-9 scale was 5.6 ( $SD = 1.6$ , range = 1.5 to 9) and the mean verbal use score was 3.8 ( $SD = 1.8$ , range = 1 to 8.0). A paired sample  $t$ -test indicated greater use of imagery than verbal processing,  $t(52) = 4.46$ ,  $p < .001$ ,  $d = 1.06$ . There was a negative relationship between reports of imagery and verbal use,  $r(51) = -0.41$ ,  $p = .001$ . That is, higher ratings of imagery were associated with lower ratings for verbal use, and vice versa.

Participants were also asked if they combined the pictures and words in a manner that seemed like having *neither* mental images nor verbal thoughts (mean score was 2.3,  $SD = 1.2$ , range 0 – 6.6). This score was negatively correlated with use of imagery,  $r(51) = -0.50$ ,  $p = .001$ , but not with verbal use,  $r(51) = 0.14$ ,  $p = .33$ . In debriefing, most participants found it hard to describe what they were doing when it seemed like having *neither* mental images nor verbal thoughts, but some reported that it involved “physical feelings” or a “sense” of combining of the stimuli. For example, individual participants said: "the only other thing I thought of was the sensation of pain", "...provoked feelings rather than words or imagery", "some of the combinations I felt like I could feel them, they made me wince".

*Associations With Emotion*

The mean emotion rating for the stimuli was 4.4 ( $SD = 1.3$ , range 1.7 – 6.8). The correlation between mean reported imagery use and mean emotion ratings was significant,  $r(51) = 0.37, p = .006$ , but the correlation between mean reported verbal use and emotion ratings was not,  $r(51) = -0.20, p = .16$ . Fisher Z-transforms (Papoulis, 1990) showed a significant difference between these correlations  $p = .003$ . There was no significant correlation between ratings for using “neither imagery nor verbal” and emotion ratings,  $r(51) = -0.07, p = .62$ . These data support our first hypothesis that spontaneous use of imagery is indeed associated with the extent of emotion experienced when integrating pictures with words.

*Self-Involvement and Memory Ratings*

Ratings of self-involvement and ratings for picture-word combinations being autobiographical memories were correlated,  $r(51) = 0.64, p < .001$  (mean self involvement = 3.2,  $SD = 1.3$ , range = 0.0 – 6.7; mean memory = 3.3,  $SD = 1.2$ , range = 1.5 – 6.3). Both self-involvement and memory variables were associated with emotion ratings: for self-involvement,  $r(51) = 0.56, p < .001$ ; for memory,  $r(51) = 0.60, p < .001$ . As predicted, use of imagery was associated with the occurrence of memories,  $r(51) = 0.29, p = .034$ , whereas use of verbal thoughts was not,  $r(51) = -0.19, p = .17$ , and the difference between these two coefficients was significant,  $p = .014$ . However, contrary to expectations, neither ratings of imagery nor verbal thought was associated with rated self-involvement,  $r(51) = 0.16, p = .26$ ;  $r(51) = -0.12, p = .40$ , respectively.

*Mediation Analyses*

To examine the hypothesis that the relationship between self-reported use of imagery (the predictor) and self-reported emotion (the dependent variable) would be mediated by the occurrence of autobiographical memories we initially performed analyses in line with the criteria laid down by Baron and Kenny (1986). The results indicated that imagery predicted emotion

(Criterion 1),  $\beta = .29$ ,  $S.E. = .10$ ,  $t = 2.79$ ,  $p = .008$ , that imagery predicted occurrence of memories (Criterion 2),  $\beta = .21$ ,  $S.E. = .10$ ,  $t = 2.18$ ,  $p = .03$ , that occurrence of memories predicted emotion, after controlling for imagery (Criterion 3),  $\beta = .61$ ,  $S.E. = .13$ ,  $t = 4.70$ ,  $p < .001$ , and that the introduction of the occurrence of memory into the regression of imagery on emotion reduced the path coefficient (Criterion 4),  $\beta = .17$ ,  $S.E. = .09$ ,  $t = 1.79$ ,  $p = .08$ .

According to Baron and Kenny (1986) these findings indicate that occurrence of memory partially mediates the relationship between imagery and emotion. A stronger test of mediation is that the indirect effect of imagery on emotion via the occurrence of memories is significantly different from zero. To examine this, a Sobel test (Baron & Kenny, 1986) was performed which assesses the magnitude of the indirect effect compared to a zero value. This revealed an indirect effect of imagery on emotion via the occurrence of memories, Sobel coefficient =  $.13$ ,  $S.E. = .07$ ,  $p = .026$ .

This analytic approach was repeated for self-involvement ratings. As the correlations above make clear, the results indicated that imagery did not significantly predict self-involvement (Criterion 2),  $\beta = .12$ ,  $S.E. = .09$ ,  $t = 1.38$ ,  $p = .17$ , thus precluding an effect of partial mediation according to the Baron and Kenny (1986) criteria. We nevertheless examined whether there was an indirect effect according to the Sobel Test and this was also non-significant, Sobel coefficient =  $-.08$ ,  $S.E. = .06$ ,  $p = .10$ .

### *Discussion*

In Experiment 1, participants received no specific instructions about using imagery or verbal processing when integrating negative picture-word pairs. As predicted, reported involvement of imagery was positively correlated with ratings of the intensity of experienced emotion. In contrast, there was no such significant association for the involvement of verbal thoughts (with the correlation in fact going in the opposite direction), and the two correlation coefficients differed significantly.

For this stimulus set, more imagery than verbal processing was reported. However, it appeared that imagery was not used to the exclusion of other types of representation, so that it was possible to gain some insight into whether imagery report tended to be characterized by other properties that might account for the relationship with emotion. We had predicted that images would be more likely to involve the self, and the recall of episodic memories, than would verbal processing. Furthermore, we hypothesized that involvement of autobiographical memories and the self could mediate the relationship between imagery and reported emotion. The results revealed positive correlations between both these ratings and reported emotion, such that higher ratings for self-involvement and memory recall were associated with more emotion. Contrary to expectation, however, reported imagery was not significantly associated with ratings of self-involvement, although it was significantly associated with personal memories (whereas ratings of verbal use were not). Finally, involvement of memories (but not the self) significantly mediated the relationship between imagery and reported emotion, consistent with the possibility that the recruitment of personal memories during image construction may partly underlie imagery's emotional effects (Conway, 2001).

In summary, these findings provide support for the hypothesis that the extent of spontaneous use of imagery, relative to verbal representation, is associated with degree of reported emotional response. Support was also obtained for the hypothesis that the relationship between use of imagery and emotion is significantly mediated by the involvement of personal memories.

Of course, the correlational approach adopted in this first study limits the possible conclusions. In particular, although there are clear theoretical reasons to propose a causal relationship between imagery and emotion, this remains to be demonstrated empirically. For this reason, in Experiment 2 used similar material but manipulated the manner in which pictures and words were to be combined by providing different instructions to randomly assigned groups, in

order to examine causality. An additional concern regarding Experiment 1 is possible demand effects. It may be that participants reported increased emotion in association with increased use of imagery, either because of an inference that this is what the experiment sought to show, or because of a priori beliefs concerning the nature of this relationship. Experiment 2 sought to circumvent potential demand effects in a number of ways.

### Experiment 2

Experiment 2 had four aims. First, to provide a conceptual replication of the key finding from Experiment 1 that the relationship between imagery and emotion is stronger than the relationship between verbal processing and emotion, for the same material. Second, to extend the initial findings to a community sample, to different measures of emotion, and beyond the domain of negative affect.

The assessment of emotion was extended in three different ways. First, rather than requesting Likert scale emotion ratings after each picture-word pairing, emotion was assessed after blocks of pairings using a standardized questionnaire measure. The Spielberger State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) was used in the expectation that the content of negative picture-word cues were most likely to elicit negative affect, and particularly anxiety, which was considered particularly relevant due to the use of imagery in the treatment of anxiety states. In fact, the STAI is believed to reflect other negative emotions such as depression, as well as anxiety (Bieling, Antony, & Swinson, 1998), so that in the current study it was selected as a clinically-relevant measure of negative affect, including anxiety. For convenience, however, the term anxiety will be used when referring to the STAI. Second, evaluative learning effects associated with imagery and verbal processing were examined, employing techniques used previously (Fulcher & Cocks, 1997; Fulcher, Mathews, Mackintosh, & Law, 2001). Evaluative learning refers to changes in the response to (e.g., liking for) a stimulus due following its pairing with others of positive or negative emotional valence (De

Houwer, Thomas, & Baeyens, 2001; Martin & Levey, 1978). Typically, after initial ratings of liking for novel, neutral items, they are presented several times, consistently paired with others that are either liked or disliked, leading to the neutral items paired with disliked stimuli tending to become relatively disliked while (albeit less reliably) those paired with liked stimuli being more liked – the so called evaluative learning effect. To implement this methodology in the present study, each (neutral) picture was rated for liking, without a paired word, both before and after the experiment. This allowed investigation of whether systematic pairings of picture-word pairs in emotion-eliciting ways during the intervening experiment would lead to a greater evaluative learning effect (as measured by liking change) for participants integrating the picture-word pairs using imagery, as compared with those using verbal processes. For the third type of emotion assessment, an additional sample of participants (“content analysis sample”) described the images / sentences they used to integrate the picture-word pairs. These narratives were then evaluated by independent raters who were blind to experimental condition, to examine whether the content of images differed from that of sentences.

To extend the research beyond negative affect, the negative picture-word combination stimuli used in Experiment 1 were supplemented with a set of benign picture-word combinations. Our prediction was that integrating the benign picture-word pairs using imagery should bring about a greater *reduction* in anxiety compared to integration using verbal means. In the context of potential therapeutic applications, it is clearly important to investigate the capacity of imagery to differentially reduce negative affect (or boost positive affect), relative to verbal processing (c.f., Holmes et al., 2006).

The third and most important aim of Experiment 2 was to directly test the causal hypothesis that the enhanced experience of emotion is a consequence of using imagery, rather than more emotion causing greater imagery use, or being due to another variable correlated with both emotional reactivity and a preference for imagery use. To achieve this, a between-subjects

experimental design was used, in which participants were given instructions to use imagery or a verbal description to combine the picture-word stimuli. To check that spontaneous use of imagery in everyday life (irrespective of assignment to experimental condition) was comparable across experimental groups, a mental imagery questionnaire was administered.

Our main prediction was that participants in the imagery condition, relative to the verbal condition, would experience greater increases in self-reported anxiety following the negative picture-word pair blocks, along with greater anxiety reductions following the benign blocks. We also predicted that imagery participants would evidence a greater change in their liking ratings (evaluative learning) for pictures after the negative block than after the benign block, compared with participants in the verbal condition. Finally, for the sample of participants reporting aloud on the content of their images or sentences, we predicted that blind raters would rate the content of images as more emotionally-laden than descriptions produced in the verbal condition.

The fourth and final aim of Experiment 2 was to further investigate the relationship between use of imagery, self-involvement and recruitment of autobiographical memories, to follow up the finding from Experiment 1 that recruitment of personal memories mediated the relationship between imagery and emotion. Accordingly, reported content was also rated for self-involvement, recruitment of personal memories, and a number of other pertinent variables. Our predictions were that images would be rated as having greater recruitment of personal memories, and greater self-involvement, as well as including more emotional content, relative to sentences.

We also sought to address the question of potential demand effects. As outlined above, both independent assessment of content and the evaluative conditioning procedure was intended to provide convergent evidence of emotional change. Further correlation analyses were used to examine relationships between beliefs and expectations about the experiment (“demand questions”) and the actual results (cf. Baddeley & Andrade, 2000; Holmes et al., 2004) to check for relationships between the two.

## *Method*

### *Overview and Design*

In the main sample, participants were randomly allocated to one of two groups, one being given instructions to combine the pictures and words using images, and the other being told to combine them using a descriptive sentence. In each group, half of the participants first completed a block of pictures-word pairs designed to elicit an emotionally negative representation, followed by a block in which the pairs were designed to elicit more benign representations, and half completed the blocks in the reverse order, within a fully counter-balanced design. Thus, there was one between-subjects factor of instruction condition (imagery vs. verbal), and two within-subjects factors of picture-word combination valence (negative vs. benign) and block order (negative - benign vs. benign - negative).

Ratings of either image vividness or ease of sentence construction after each picture-word stimulus were used to promote compliance with task instructions. The primary measure of emotional response was provided by changes on the Spielberger State Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) across each block of trials. For the evaluative learning manipulation, liking for pictures was rated before and after the experimental phases. A cued recall test for the words seen with each picture was included to investigate whether liking for the pictures at retest might have been influenced by differential ability to recall the words accompanying them. Finally, participants were asked questions about the experiment to assess possible demand effects.

The supplementary set of 16 participants (content analysis sample) were similarly randomly allocated to either an imagery or a verbal description group, but asked to describe aloud either their image, or their descriptive sentence. Recordings of these descriptions were used to develop content ratings to be made by judges who were blind to group allocation.

### *Participants*

The 32 participants in the main part of the experiment comprised 24 females and 8 males, with a mean age of 48.8 years ( $SD = 11.9$ , range 19 - 62), recruited through the department's participant panel (of approximately 2000 community volunteers), and paid a small honorarium for participation. To meet the requirements of the local ethical committee, we did not test volunteers with high levels of anxiety (above 45 on the STAI trait measure), based on the concern that such individuals might be upset by the negative picture-word combinations used here. A score of above 45 was used as pilot testing indicated this was approximately more than one SD above the mean, and this cut off has been consistently adopted in previous work in our laboratory (e.g., Holmes & Mathews, 2005). Five additional participants were excluded from the final analysis and replaced because post-experimental reports indicated non-compliance with instructions (e.g., systematically avoiding forming negative images). There were no significant differences between the final 32 participants and the 5 who were replaced in terms of reported trait anxiety, state anxiety, mental imagery use,  $t < 1$ , or gender. However, non-compliers were younger ( $M = 30.4$ ,  $SD = 16.7$ , vs.  $M = 48.8$ ,  $SD = 11.9$ ). The content analysis sample comprised 10 females and 6 males (mean age = 37.1 years;  $SD = 16.6$ ), recruited from the same source.

### *Materials*

*Picture-word stimuli.* The experiment was programmed using E-Prime software (Schneider, Eschman, & Zuccolotto, 2002), version 1.1 (1.1.4.1). Stimuli were presented on a video display unit, Dell P791. The set of digital pictures used in Experiment 1 was expanded to a total of 108, either photographed by the first author using a Finepix 40i Fujifilm digital camera or downloaded from the internet (non-copyrighted). The picture dimensions were approximately 640 x 480 pixels saved as 24-bit Bitmap files. They were displayed, centered on the VDU, such that their height took up 85% of the VDU height. When viewed to be rated for liking, the pictures were displayed alone on the screen.

Half of the words used were intended, when paired with the relevant pictures, to create a negative emotional consequence. The remaining words were intended to create an emotionally benign consequence when paired with the same pictures. Thus, there are two potential captions for each picture, and 216 possible picture–caption pairings (see Table 1 for examples). Each participant viewed a total of 108 pairings across two blocks, one of 54 negative and another of 54 benign picture-caption combinations. Each picture was seen only once with its relevant caption by each participant. The emotional valence for each picture (achieved through its caption word) was fully counterbalanced across participants, as was block order (benign - negative vs. negative - benign). Within each block, the order of picture-word combinations was randomized for each participant.

In the course of developing the caption sets, emotionality ratings for the words when presented in isolation were obtained to establish that those negative versus benign conditions were comparable. In the final selection there was no significant difference in ratings of mean emotional valence between the benign versus negative caption words alone. Each caption was displayed centrally beneath the picture in black Courier New font point size 30, for 3500 ms.

*Questionnaire measures.* Trait and state anxiety were measured using the Spielberger State-Trait Anxiety Inventory (STAI; Spielberger et al., 1983). The trait portion consists of 20 items rated according to “how you generally feel” on a 4 point scale - almost never, sometimes, often, or almost always. The State portion has 20 items to indicate feelings “right now, that is at this moment” on a 4 point scale - not at all, somewhat, moderately so, or very much so. The majority of items focus on feelings related to anxiety, but some are expressed in reverse form (e.g., I feel happy), and low scores on such items may indirectly reflect depression. These widely used measures have satisfactory reliability and validity (Spielberger et al., 1983). For example, administration of the STAI State scale to samples of working adults and college students resulted in Cronbach’s alpha coefficients of above 0.90, indicating good internal consistency.

Use of imagery in everyday life was assessed using the Spontaneous Use of Imagery Scale (SUIS: Reisberg, Pearson, & Kosslyn, 2003). This questionnaire has 12 items: for example, "When I think about visiting a relative, I almost always have a clear mental picture of him or her". Each item is rated on a 5-point scale, with the instructions "If a description is always completely appropriate, please write "5"; if it is never appropriate, write "1"; if it is appropriate about half of the time, write "3"; and use the other numbers accordingly". Reisberg et al., (2003) found that the mean score (average across all items) for 150 participants was 3.1, with a range of 1.2 to 4.7.

*Liking ratings.* Liking ratings for all pictures (in the absence of captions) were obtained before and after the main experimental task. Participants rated how much they liked or disliked each picture on a scale of 1 to 9, from extremely disliked (1) to extremely liked (9). Pictures were presented via computer as in the main task, and responses made using a standard keyboard.

*Memory questions.* After the second set of picture liking ratings, participants were given an unannounced cued-recall test. A single test set of 12 pictures was randomly selected from the experimental set of 108 pictures, such that there were six that had been paired to make negative combinations, and six to make benign combinations. Participants were asked if they remembered the word that went with each picture and to say the word aloud if so, with guessing encouraged. If any response was offered, participants rated how confident they were that the word was correct from not at all confident (1) to extremely confident (9). These 12 pictures were presented in random order.

*Subjective experience questions.* Participants were asked a series of questions about their subjective experience of performing the picture-caption combination task. They were asked to rate the ease of performing the task (where 1 = extremely difficult, 5 = neither easy nor difficult, 9 = extremely easy); how much they used imagery (mental pictures and sensory impressions) and how much they used verbal thoughts such as words and sentences (both where 1 = not at all, 5 = half the time, 9 = all the time); and how much their imagery appeared as if it was happening to

themselves (1 = not at all as if it were happening to me, 5 = halfway, 9 = as if it were happening to me). In Experiment 1, participants were simply asked about the extent to which they had experienced personal memories when integrating words and pictures. In the present experiment, in order to assess more directly whether use of memories was greater during imagery, participants were explicitly asked how much their resulting images were of real memories, and similarly how much their verbal descriptions were of real memories (both where 1 = none were of real memories, 5 = half, 9 = all were of real memories).

*Demand questions.* To explore experimental demand, three types of question were asked. First, an open ended question about whether they had guessed the purpose of the experiment was asked. Next, participants indicated whether, during the experiment, they had thought that combining the words and pictures would affect their feelings or emotions (coded as yes / no / unsure). The alternative condition, received by participants in the other group, was then described to make the contrast between imagery and verbal processing explicit. Participants were asked to guess how emotion might differ between conditions by selecting: a) no difference; b) verbal task would have a stronger impact; or c) imagery task would have a stronger impact. Finally, they rated the extent that each task condition would influence their feelings more or less than just looking at the picture-caption pairs with no instruction. Ratings were made on a scale from very much decrease feelings (-10), through do nothing (0), to very much increase feelings (+10).

### *Procedure*

Participants were randomly allocated to their experimental conditions and after giving informed consent first completed the trait anxiety and mental imagery questionnaires. All 108 pictures were then viewed, without captions, for 2500 milliseconds each, in a separate random order for each participant. After each, participants made a liking rating (maximum time allowed was 15 seconds). The first state anxiety questionnaire was completed and afterwards either imagery or verbal instructions were given (as detailed below).

*Imagery task instructions.* Participants received imagery practice, during which they were asked to imagine a lemon, and to rate their image vividness on a scale from 1 (not at all), to 9 (extremely, as clear as vision). They were invited to imagine shining a bright light on the lemon to examine the skin (vividness rating), to watch it while cutting it with a knife, to smell the zest / juice (vividness rating), to hold it closer to their eye, and squeeze it, and finally to imagine the feeling as juice squirts into their eye (vividness rating). These instructions were intended to illustrate deliberate mental imagery generation and the fact that images can be in any sensory modality. Next, four practice items similar to those in the main picture-caption set were presented on the computer. Participants were told that they were to produce a mental image combining the picture with the caption word. Instructions on the computer screen for 1500 ms stated “imagine the combination of the next picture and word”. The picture and word then appeared for 3500 ms, followed by a new screen saying “imagine” for 2000 ms. Then a beep sounded and participants were asked to describe their images aloud (time limit 40 s) while the experimenter checked that that the description contained reference to both picture and word. The participant then continued to the remaining practice items.

*Verbal task instructions.* Participants assigned to this condition performed practice designed to be equivalent to the imagery condition, except that images were replaced by the construction and reporting of grammatical sentences combining picture with caption word. In the first example participants were shown a picture of a lemon, together with the word “cut”. They were asked to construct a sentence combining the two, to report it aloud, and then to rate the ease of its construction (1 = extremely difficult, 9 = extremely easy). A second example was given with a picture of a slice of lemon, and the word “tonic”. After that, four practice items resembling the experimental stimuli were presented by computer. Participants were instructed that in each case they should produce, and report aloud (during the practice only), a sentence linking the picture with the caption word, the sentence should include the caption or a very similar word (e.g., swim could

be changed to swimming) together with words describing the picture, and should be grammatically correct. Instructions, on the computer screen for 1500 ms, stated “make a sentence about the next picture and word”. The picture and caption then appeared for 3500 ms, followed by a new screen saying “make sentence” for 2000 ms. After these two seconds a beep sounded and participants were prompted to say their sentence aloud (time limit 40 s) while the experimenter checked that the instructions about sentence content were being followed. The participant then continued with the remaining practice items.

It is important to note that in both conditions for the main sample, descriptions were only reported for practise trials, whereas in the content analysis sample descriptions continued to be generated throughout the main experimental task in both conditions.

*Main experimental task.* Participants then began the first block of 54 either negative or benign picture-word combinations, according to their assigned condition. Instructions, presented on the computer screen for 1500 ms, stated “imagine the combination of the next picture and word” or “make a sentence about the next picture and word”, accordingly. The picture-caption combination was displayed for 3500 ms, followed by the displayed instruction to “imagine / make a sentence” for 2000 ms, which, after a beep, was replaced by a reminder to focus on the image / sentence and to try not to change it, displayed for 4000 ms at the end of which another beep signalled the end of the interval. The space bar was pressed to continue. To promote compliance with instructions, participants in the imagery condition rated each image’s vividness on a scale from not at all vivid (1) to extremely vivid (5). Those in the verbal condition rated the difficulty of constructing the sentence on a scale from not at all difficult (1) to extremely difficult (5).

After the first block of trials, participants completed the second state anxiety questionnaire. After a short break, four more practice trials were given before the second block of trials, designed to elicit the alternative emotional valence. Participants then completed the third

state anxiety questionnaire. They once again viewed each pictures (without captions) presented randomly, as before, with instructions to give liking ratings reflecting only their current feelings.

*Memory for words.* Participants then received instructions for the surprise cued recall test: “You will see a few pictures you have already seen. Please then say aloud the word you think went with it”. After each picture they were asked “Do you remember the word that went with this picture? If you do, say it into the microphone now. If you do not know the word please try to guess. If you cannot guess the word, please say ‘don't know’”.

*Subjective experience and demand questions.* Participants rated questions about their experience during the picture-caption task concerning the ease of the task, time spent thinking verbally or in images, the experience of something similar happening to the self, and the extent to which the content brought to mind an autobiographical memory. Participants finally received the series of questions to explore possible influences of experimental demand.

*Content analysis.* For the supplementary content analysis sample ( $N = 16$ ), all aspects of the procedure above were retained with the following exceptions. First, participants were required throughout to report aloud the sentence used to combine the picture-caption pairs, or to provide a short description of their imagery into a microphone. As before, participants viewed the picture-word stimulus for 3500 ms with instructions to imagine or make a sentence, however after the beep the modified instructions “describe your image” or “describe your sentence” appeared. Participants then pressed the space bar when they had done so, with a maximum time limit of 40 s allowed before continuing to the next trial. These descriptions replaced the vividness and difficulty ratings described in the previous section “Main experimental task”. Second, the demand ratings of likely effects of imagery or verbal thinking on emotion were omitted for these participants.

### *Results*

### *Main Experiment Sample*

*Randomization checks.* Comparisons across groups revealed no significant differences in terms of gender (there were 4 men and 12 women in each condition); age,  $t(30) = 0.22, p = .83$ ,  $M = 48.78, SD = 11.87$ ; trait anxiety scores,  $t(30) = 0.86, p = .40$ ; initial state anxiety scores  $t(30) = 1.38, p = .18$ ; the spontaneous use of imagery scale,  $t(30) = 0.64, p = .53$ ; or baseline liking ratings for the pictures  $t(30) = 1.67, p = .11$  (for mean scores see Table 2).

*State anxiety.* State anxiety scores before and after each block are presented in Table 2. There was no difference between conditions at baseline, so change scores were computed by subtracting the STAI state score at the end of a block from that at its beginning (see Figure 1). These scores were analyzed in a mixed model ANOVA having one within-subjects factor of valence (negative vs. benign) and two between-subjects factors of condition (imagery vs. verbal) and block order (benign - negative vs. negative - benign).

There was no main effect of condition or of block order,  $F_s < 1$ . However, there was a main effect of valence (negative vs. benign),  $F(1, 28) = 20.85, MSE = 29.08, p < .001, \eta^2 = 0.43$ , with greater increases in anxiety for the negative versus benign block. This main effect of valence was qualified by an interaction with condition,  $F(1, 28) = 12.25, MSE = 29.08, p = .002, \eta^2 = 0.30$ . No other interactions reached significance: block order by condition,  $F(1, 28) = 1.86, MSE = 11.35, p = .18$ ; block order by valence,  $F(1, 28) = 2.41, MSE = 70.14, p = .13$ ; valence by condition by block order,  $F < 1$ .

The interaction between valence and condition was decomposed using independent samples  $t$ -tests between the imagery and verbal conditions for the anxiety change scores, for the negative and benign blocks separately. For negative blocks, anxiety increase was greater in the imagery than in the verbal condition,  $t(30) = 2.81, p = .005, d = 1.04$  (see Figure 1). For benign blocks, there was a difference in anxiety change between conditions,  $t(30) = 3.03, p = .003, d = 1.20$ , with a decrease in anxiety for the imagery condition that was not seen in the verbal

condition (see Figure 1). This supports our hypothesis that there would be greater anxiety *increase* following the negative blocks in the imagery than verbal condition, and relatively greater anxiety *reduction* following the benign blocks in the imagery than verbal condition.

*Liking ratings.* Since no significant difference between conditions existed at baseline we again examined change scores. Liking rating change was computed by subtracting ratings obtained after the experimental phase from initial ratings, on a picture-by-picture basis. Mean change scores are shown in Table 2, in which a positive score indicates a decrease in negative rating (i.e., becoming more liked), and a negative score indicates becoming less liked.

We had predicted that imagery instructions would generate an enhanced differentiation between negative and benign blocks compared with the verbal condition (that is, greater evaluative conditioning). To examine this hypothesis we calculated an index of the difference in rating change across blocks by subtracting the benign block change score from that following the negative. Group comparisons (imagery vs. verbal) revealed a greater evaluative conditioning effect in the imagery than in the verbal group, in line with predictions,  $t(30) = 1.86, p = .036, d = .66$ , see Table 2. For both groups the index was significantly different from zero, imagery group:  $t(15) = 3.67, p = .001, d = .92$ ; verbal group,  $t(15) = 3.08, p = .004, d = .77$ , indicating an evaluative learning effect in the expected direction across each condition separately.

*Memory for words.* Cued recall accuracy for picture captions was examined using a mixed model ANOVA with a between-subjects factor of condition (imagery vs. verbal) and a within-subjects factor of valence. There were no main effects of condition or valence,  $F_s < 1$ , and no significant interaction,  $F(1, 30) = 1.59, MSE = 0.80, p = .22$ . The mean number correctly recalled captions (out of 12) was 8.00 ( $SD = 2.6$ ). Thus, there was no evidence that difference in explicit memory for captions could account for the between group liking effects.

*Subjective experience questions.* Responses in imagery and verbal conditions were compared using independent samples t-tests (unless otherwise reported, see Table 2). There was

missing data for one participant's frequency of real memories reported during verbal thoughts due to computer error. There was no difference in ratings for the ease of the task,  $t(30) = 0.28, p = .78$ . As expected, ratings of using imagery were higher in the imagery than the verbal condition,  $t(30) = 5.45, p < .001, d = 1.93$ . Likewise, ratings for amount of thinking verbally were higher in the verbal group,  $t(30) = 5.50, p < .001, d = 1.94$ . These results serve as a manipulation check for the different instructions across conditions.

Unsurprisingly, the results also indicate that the group given verbal instructions nevertheless reported experiencing some imagery, and likewise those given imagery instructions sometimes reported verbal thoughts (see Table 2). On a repeated measures ANOVA of memory ratings, with condition (imagery vs. verbal) as a between-subjects factor, and type of rating (frequency of real memories reported during imagery use versus during verbal thoughts) as a within-subjects factor, the only significant finding was of a main effect of rating type  $F(1, 29) = 7.88, p = .009, MSE = 2.84, \eta^2 = 0.21$ . This effect was not qualified by an interaction with condition ( $F < 1$ ). Thus, both groups rated that, when they experienced images, these appeared more often to be of a real memory ( $M = 5.39, SD = 2.60$ ) than was the case with their verbal thoughts ( $M = 4.19, SD = 1.97$ ), consistent with the findings of Experiment 1. However, because participants were asked about recruitment of memories during imagery and verbal processing separately in Experiment 2, it was not possible to carry out mediation analyses on these data as had been done in Experiment 1.

*Demand questions.* In response to the first, open-ended question about the experiment's purpose, three participants (out of 32) gave a reply somewhat related to the proposed hypotheses: "whether people can just picture nice things but not horrible things"; "what images people would get and how they would react emotionally"; and "whether words and thoughts spoil images and influence feelings". Further questioning about the latter's response (in the verbal condition)

revealed that she meant the visual images seen on the computer screen, not mental images. Thus their responses did not reveal a clear distinction between imagery and verbal processing.

Next, participants were asked whether the task (irrespective of processing type) might affect feelings. Twenty (of the 32) thought it would (11 in the imagery group and 9 in the verbal), 3 were unsure, and 9 thought it would have no effect. When asked if they thought emotion would differ if given the imagery versus the verbal task, 18 thought that imagery would have a greater impact (9 from each group); 7 (4 from the imagery group) thought the verbal task would have a greater impact, and 7 (3 from the imagery group) thought there would be no difference. Thus, while no participant guessed the main hypothesis, when given a forced choice, 60% said that they thought the imagery task would have a greater emotional effect than the verbal task, with choices being similar for both conditions, Fisher's exact,  $p > .9$ .

Finally, ratings for the magnitude of expected effects were analyzed using a mixed model ANOVA with a group factor of condition (imagery vs. verbal), and a within-subjects factor of prediction topic (prediction about imagery vs. prediction about verbal). There was no main effect of prediction topic,  $F < 1$ . The mean prediction rating for imagery effects was 3.9 ( $SD = 3.4$ ), and for verbal effects was 3.5 ( $SD = 4.0$ ). There was no main effect of condition nor an interaction between prediction topic and condition,  $F_s < 1$ . These results are consistent with there being no reliable differences between the expected impact of the imagery and verbal combination tasks.

The associations between these ratings and actual changes in anxiety over the negative and benign blocks were investigated using correlations. For both conditions combined, no significant correlations were found, the largest being  $r(30) = .20, p = .26$ , being between the verbal prediction rating and anxiety change for the negative block. There were no significant correlations within either condition alone, (imagery condition, largest  $r(30) = .18, p = .49$ , for verbal prediction and anxiety after negative block; verbal condition, largest  $r(30) = .41, p = .11$ , for verbal prediction and anxiety after the negative block). In addition to being non-significant, the

latter correlation is in the opposite direction to the actual results. It seems unlikely that the anxiety change reports are simply accounted for by participants' predictions about emotional effects.

### *Content Analysis Sample*

*Randomization checks.* There were no significant differences between these additional participant groups in terms of gender (there were 3 men and 5 women in each condition); age,  $t(14) = 0.45, p = .67, M = 37.19, SD = 16.61$ ; trait anxiety scores,  $t(14) = 0.18, p = .86$ ; initial state anxiety scores  $t(14) = 0.51, p = .62$ ; the spontaneous use of imagery scale  $t(14) = 0.71, p = .43$ ; or baseline liking ratings for the pictures  $t(14) = 0.81, p = .43$ .

*State anxiety.* To verify that the finding supporting a preferential link between imagery and emotion from the main part of the experiment was replicated in the content analysis participants, changes in state anxiety were again submitted to a mixed model ANOVA similar to that described above. Mean changes in anxiety are shown in Table 3.

There was no main effect due to condition (imagery vs. verbal),  $F < 1$ . Within-subjects, there was a main effect of valence (negative vs. benign),  $F(1, 14) = 6.61, MSE = 68.07, p = .022, \eta^2 = 0.32$ , with greater anxiety increases in the negative than benign blocks. This main effect of valence was qualified by an interaction with condition,  $F(1, 14) = 6.61, MSE = 68.07, p = .022, \eta^2 = 0.32$ , consistent with expectation of a greater changes in anxiety due to imagery.

The predicted interaction between valence and condition was decomposed using independent sample  $t$ -tests of anxiety change between the imagery and verbal conditions, for the negative and benign blocks separately. For the negative block, anxiety change was greater in the imagery than verbal condition,  $t(14) = 2.58, p = .011, d = 1.30$ . For the benign block, there was a trend for greater anxiety reduction in the imagery versus the verbal condition, but this difference did not reach significance,  $t(14) = 1.52, p = .08, d = 0.81$ .

These data confirm the findings in the main part of the experiment that combining pictures and words into a negative representation was associated with greater increases in anxiety when

imagery was used rather than a descriptive sentence. Although the findings with positive representations were less clear in the smaller content-analysis groups, the trend seen was consistent with the main part of the experiment, and the effect size was large.

*Content of images and sentences.* There were 216 picture-word combinations and transcripts were available for 14 of the 16 participants. Two participant's transcripts were missing due to technical error giving a total of 1512 experimental transcribed descriptions. In addition there were transcripts from 112 practice items (4 prior to each block).

The development of rating categories was based on inspection of the practice items (rather than those from the main experiment) to avoid contamination of the final to-be-rated set.

Illustrative practice examples included the following: in response to a picture of metal rungs with the caption "slip", a participant in the imagery condition said "Climbing up the ladder, losing my footing and slipping down, trying to cling on". In contrast a verbal condition participant said "The instructor told the man not to slip when he was climbing up the frame". In response to a picture of someone swimming in the sea and the caption "race", an imagery condition participant said "Swimming in the sea, very, very cold, racing with other people coming up behind me" while another in the verbal condition said "The swimmer was having difficulty finishing the race across the channel". For a picture of ocean waves and the caption "fun", a participant in the imagery condition said "It's a summer's day, it's brilliantly hot, we're all standing on the end of the pier, the waves are crashing in it's feeling cool and great" while someone in the verbal condition said "They had a lot of fun today because the waves were quite high".

Seven coding scales were developed using a mixture of deduction from the existing literature and previous experimental results (e.g., relationship to real memories) and induction from inspection of the current data (e.g., use of sensation terms) in line with the recommendations of Joffe and Yardley (2004). The seven scales derived were labelled emotional valence, self involvement, similarities to memory, use of emotion terms, event specificity, use of sensation

terms, and descriptions of action (see Table 4). All practice items were then independently rated by two assessors on each of the 7 scales. All disagreements between ratings for any item in this practice set were discussed in order to refine the categories and improve the shared understanding of them between assessors.

The data analysis procedure used for the final coding involved bootstrapping using quota sampling (Everitt, 1996). In this procedure, items were randomly selected from the total set of 1512 experimental transcribed picture-word combination descriptions, by selecting from 4 quota samples (representing imagery negative, imagery benign, verbal negative and verbal benign combinations). Random selection was used so that the sample could be considered representative of the total set. The bootstrap distribution was obtained by repeatedly re-sampling from the sets of observations. Twenty sets of 10 repeated sample observations were then independently rated by both coders, on each of the seven scales, blind to assignment to experimental condition. Inter-rater reliability was then calculated for these 10 observations on each scale using Cohen's kappa. This procedure was repeated for each of the twenty sets, to yield a set of 20 kappa values per scale, from which a mean kappa value was calculated. Inter-rater reliability was assumed to be "fair" if the mean kappa was in the range 0.4 – 0.6, or "good" between 0.6 – 0.75 (Robson, 1993). The description of action scale was discarded as falling below the "fair" range (Cohen's  $\kappa = 0.37$ ). The mean Cohen's kappa values for the other variables are reported in Table 4.

Mean ratings in the imagery and verbal conditions per bootstrap were compared for the remaining six scales using independent samples *t*-tests. The mean values for each scale are given in Table 4. Analyses indicated that descriptions in the imagery condition generally received higher ratings than those in the verbal condition: that is, greater rated self-involvement in imagery,  $t(38) = 7.27, p < .001, d = 2.32$ ; closer rated resemblance to a real memory,  $t(38) = 5.53, p < .001, d = 1.76$ ; greater specificity,  $t(38) = 3.95, p < .001, d = 1.29$ ; greater use of

sensation terms,  $t(38) = 4.32$ ,  $p < .001$ ,  $d = 1.39$ ; and greater use of emotion terms,  $t(38) = 2.32$ ,  $p = .026$ ,  $d = 0.75$ .

Because the valence scale was bipolar, with negative valence at one end and positive at the other, more extreme valence ratings for imagery in opposing directions at both extremes would be obscured in a combined analysis; therefore, negative and positive blocks were examined separately, revealing greater (negative) emotional effects of imagery in negative blocks,  $t(18) = 3.44$ ,  $p = .002$ ,  $d = 1.55$  and a more positive effect of imagery in positive blocks,  $t(18) = 2.08$ ,  $p = .026$ ,  $d = 0.94$ . There was no significant overall difference between conditions with emotional valence combined,  $t(38) = 0.47$ ,  $p = 0.64$ .

### *Discussion*

Conceptually replicating the data from Experiment 1 showing associations between emotion and type of processing, the current experimental study demonstrated that, compared to verbal instructions, imagery instructions generated (1) greater anxiety *increases* after negative picture-caption combinations, and (2) greater anxiety *reductions* after benign picture-caption blocks. Similarly, liking rating differences for negatively-paired versus benignly-paired pictures were greater in the imagery than verbal condition, indicating enhanced evaluative learning. Presumably, the heightened emotion experienced during imagery enhanced evaluative learning. Finally, content analysis showed imagery descriptions to be more strongly emotionally valenced than sentences. Together this evidence strongly suggests that mental imagery has a more powerful impact on emotion, both in a positive or negative direction, than does verbal processing of the same material. The present results extend those of Experiment 1 by demonstrating imagery has causal effects on emotion. Experiment 2 further extends results to a community sample, different measures of emotion, and to reduction of negative emotion, as well as its augmentation.

The lack of significant group differences in expectations about the experiment make it unlikely that these results arise through perceived demand, especially in the absence of significant

correlations with study findings. The evaluative learning, despite employing only single stimulus pairings, provides additional convergent evidence together with data from self-report and observer rated emotion.

In line with Experiment 1, regardless of condition, more image-based (relative to verbal) picture-caption combinations were rated as corresponding to real memories. This connection with autobiographical memory was supported by the content analysis. Compared to sentences, image descriptions were more likely to take a form that resembled personal memories, were more likely to describe a specific event, include more personal involvement, and describe sensations.

The finding of greater rated self-involvement in image descriptions seems to contrast with the absence of such an association in Experiment 1. One possibility arises from the fact that images can vary in viewpoint from “field” perspective (as if from one’s own eyes) to an “observer” perspective (seeing oneself as others see one). Field perspective images are more common and associated with emotion, presumably because they mimic the way real events are perceived (Berntsen & Rubin, 2006; Holmes, Coughtrey, & Connor, in progress; McIsaac & Eich, 2004). The requirement in Experiment 1 to rate whether the event appeared “as if happening to you” may promote ambiguity, as from a field perspective the participant is not “in” the image per se. In contrast, in Experiment 2 content analyses, judges may more likely rate participants as being involved, even if only as an implicit observer of events.

### General Discussion

The primary aim of the current studies was to investigate the overarching hypothesis from both the clinical and experimental psychology literatures that imagery is particularly effective in eliciting emotion. The results provided the clearest evidence of which we are aware that imagery does indeed have a significantly stronger impact on emotion, relative to verbal processing. This is in line with our previous proposal that imagery may have a special relationship with emotion (Holmes & Mathews, 2005).

As noted in the Introduction, previous findings based on reading emotional texts suggested that mental imagery instructions were associated with greater emotional effects than verbal processing instructions for the same material (Holmes & Mathews, 2005; Holmes, Mathews, Dalgleish, & Mackintosh, 2006). However, because the stimuli in these previous experiments were verbal descriptions, it remained possible that the emotional difference might not be due to imagery having more powerful effects than verbal processing, but rather to summing the combined effects of both types of representation (Baddeley, 1979; Craik & Lockhart, 1972; Johnson, 1983; Power & Dalgleish, 1999). This concern motivated the development of the current paradigm, using complex stimuli that combine perceptual (pictures) and verbal (words) aspects, such that any emotional differences could be attributed to the type of processing (imagery versus verbal), rather than the number of different processes used to integrate stimulus components.

In Experiment 1, self-report ratings were used to investigate how pictures and words would be combined without specific instructions, and whether individual differences in “naturalistic” use of imagery or verbal strategies might be associated with differential emotional responses. Overall, for this exclusively negative picture-word stimulus set, the prediction of an association between levels of imagery usage and emotion ratings was supported. Mediation analyses further suggested that a link with autobiographical memory may be (at least in part) responsible for the emotional consequences of imagery use.

Experiment 2 manipulated the use of imagery or verbal encoding to provide stronger evidence that imagery utilization was a cause rather than merely correlated with enhanced emotional experience. Increases in state anxiety due to negative picture-word combinations were greater following imagery rather than verbal encoding instructions. Converse effects arose with benign picture-word combinations, thus extending the findings beyond negatively valenced material. Experiment 2 replicated the key finding of an enhanced effect of imagery on emotion, extending this across different measures of emotion: strength of evaluative learning, independent

judgements of transcripts describing the images, and a standardized questionnaire (STAI).

Replication of the key findings using evaluative learning methodology and observer-ratings, rather than self-report alone, also argues against demand effects. While demand effects cannot be ruled out entirely, efforts to identify such influences suggested they were either absent or too small to account for the observed effects on emotion. The search for possible extraneous factors differentiating imagery from sentence production, other than their emotional properties, failed to proffer alternative explanations.

Some evidence emerged from the content analysis of Experiment 2 suggesting that reported content of imagery differs from that of verbal representations in ways that might illuminate the observed emotional differences. Both participants and judges rated image descriptions as being more like memories than were sentences, while Experiment 1 supported the idea that links with memory may mediate the observed emotional effect. Further, the link between images and emotion could also be mediated by self-involvement (which is, of course, implicit in autobiographical remembering).

#### *Possible Limitations*

As noted, care was taken to assess emotion in a variety of ways across the two studies. One of these specifically asked about aspects of a categorical emotion – anxiety - and the others were more generic and dimensional (evaluative conditioning, ratings of how "emotional" the material was, and content ratings of degree of positive and negative valence). This decision to use a range of measures was designed to reflect the theoretical uncertainty in the literature about whether emotions are best conceptualized in dimensional or categorical terms (e.g., Barrett, 2006). However, although the measures were all sensitive to experimental manipulations, it may be that other emotion categories and/or other emotion dimensions (such as arousal) would have generated stronger effects. Future research might resolve exactly which aspects of emotion response are more or less differentially related to imagery processing. As the STAI may also

reflect levels of depression as well as anxiety (Bieling, Antony, & Swinson, 1998), this separation could be usefully explored. Indeed, the current findings may reflect a broader and more general affective response. Despite assessing emotion in a number of different ways in the present study, all measures relied ultimately on participants' self-report. Objectivity could be strengthened by the inclusion of objective measures such as psychophysiological recording or facial expression analysis in future research.

### *Implications of the current findings*

#### *Imagery and Emotion Systems in the Brain*

Reviews of neuro-imaging studies suggest that certain basic emotions depend in part on specialised neural circuitry (Daglish, 2004b; Murphy, Nimmo-Smith, & Lawrence, 2003; Phan, Wager, Taylor, & Liberzon, 2002). Supporters of this position (e.g., Murphy, Nimmo-Smith, & Lawrence, 2003) have argued that some brain systems activated in fear (such as the amygdala) differ from those activated in disgust or anger, whereas the distribution of activation in happiness and sadness appears to differ less (though there is considerable debate in the literature surrounding these issues; e.g. see Barrett, 2006). Theoretically, it seems plausible that such specialized emotion systems might have preferential links to brain regions involved in perception and imagery, relative to brain regions subserving other types of representation, such as language, that evolved later.

In this vein, Öhman and Mineka (2001) have argued that a so-called “fear module” is more sensitive to representations encoded in evolutionarily older forms, such as those used by sensory or perceptual systems, than to those encoded within more recently developed representational systems involved in higher cognitive processes, such as those based on language. Öhman and Mineka (2001) do not discuss mental imagery per se, but their line of reasoning suggests that if imagined percepts are indeed similar to the perception of real events (as discussed in the next section), then when such images involve threatening situations they may be more

likely to trigger fear responses than would verbal representations of the same situation. Although we have no new evidence directly supporting this view, our findings of greater anxiety in response to fear-related images are at least consistent with such a position.

Similar arguments about a facilitative relationship between image-based representations (and the neural systems subserving them) and emotion systems have been made in the posttraumatic stress literature (Brewin, 2001; Brewin, Dalgleish, & Joseph, 1996; Dalgleish, 2004a; Holmes, Brewin, & Hennessy, 2004; Orr, Pitman, Lasko, & Herz, 1996; Rauch et al., 1996). A number of theoretical models in this domain have discussed the possibility that image-based representations of the person's trauma have stronger links to affective systems than do verbal-based representations of the trauma, providing a conceptual context for therapeutic approaches that seek to help clients create verbal narratives of the traumatic event as part of the process of lessening the associated affect (Ehlers & Clark, 2000; Foa & Rothbaum, 1998).

#### *Imagery and Perceptual Representations*

Images appear to share properties with perceptual representations derived from direct sensory experience (Denis, Mellet, & Kosslyn, 2004; Kosslyn, Ganis, & Thompson, 2001). If images have similar properties to actual percepts, then they may be responded to, at least in part, as if they were the corresponding real object or event. Neuroimaging experiments (Kosslyn, Ganis, & Thompson, 2001) have shown that mental imagery can activate many of the same neural regions as actual perception in the same modality. For example, Kosslyn, Thompson, Kim and Alpert (1995) showed that visualizing line drawings of objects resulted in more activation in visual cortex (area 17) than did a control condition using identical auditory cues but no imagery. Imagining objects of larger size shifted activation to more anterior parts of the calcarine sulcus, a shift that is also found in the direct perception of larger objects. Similarly, O'Craven and Kanwisher (2000) found activation in the fusiform face area (FFA) when participants were asked

to imagine faces, but in the para-hippocampal place area (PPA) when participants were asked to imagine indoor or outdoor scenes.

It seems plausible that this overlap between imagery and perception, in terms of their relevant neural substrates, is one of the reasons why brain regions involved in imagery may be more strongly inter-connected with emotion systems in the brain, than brain regions subserving verbal processing, as discussed in the preceding section. In other words, it may be that processing the affective properties and consequences of events happening in the immediate sensory environment is prioritized in the brain and, consequently, any mental operations that rely on the same brain regions (such as imagery) are also afforded higher affective priority.

#### *Imagery and Autobiographical Memory*

The model of autobiographical memory proposed by Conway and colleagues (e.g., Conway & Pleydell-Pearce, 2000), distinguishes between episodic memory (that contains sensory-perceptual information), and those memory processes that store conceptual knowledge of general events and life time periods. According to the model, specific emotional episodes of events that have happened to the self (unlike generic classes of events) can be stored in the form of images, and thus imagery is thought to be the preferred form in which highly affective experiences are recalled (Conway, 2001). In the context of trauma, Arntz, de Groot and Kindt (2005) have also argued that emotion specifically promotes perceptual memory. Imagery may therefore have relatively stronger emotional effects because it has privileged access (compared with language) to representations of specific emotional episodes stored in autobiographical memory.

The present results provide support for this view. In both experiments, participants rated their images as being more often of actual memories than were verbal thoughts, and in Experiment 1 scores on these memory ratings mediated the emotional effects of imagery. Judges ratings of content in Experiment 2 also suggested that images more often appeared to take the

form of specific memory-like events (although, of course, judges cannot know if these were veridical memories).

The three explanations for links between imagery and emotion offered above are clearly not mutually exclusive and may each capture part of a more complete explanation. Although the present data point most strongly to associations between images and autobiographical memories as a cause of the stronger emotional effects of images, this does not rule out the other candidate explanations. Indeed, both the resemblance of imagery to real events, and the possibility that emotion representations preferentially utilise non-verbal codes are entirely consistent with the explanation that images have links with autobiographical memory. After all, autobiographical memories are of real events (or for events perceived as being real) and such memories often include sensory and perceptual information, including those relevant to emotional reactions.

#### *Conclusions and Future Directions*

The present findings have provided the strongest evidence, to our knowledge, that imagery has a significantly greater impact on emotion than verbal representations of the same material. Additional self-report data suggest that images may exert these differential emotional effects in part because they are more likely to appear similar in form to actual percepts, may recruit episodes in autobiographical memory, and include personal involvement in events.

The present data contribute to cognitive psychology by revealing the powerful emotional effects of imagery, and providing some clues as to why they might occur. Much mainstream cognitive research on imagery seems to operate in an “affective vacuum” whereby the emotion-related consequences of experimental manipulations are not addressed, or are assumed but not examined. The data also contribute to the affective science literature by elucidating the nature of the relationships between mental systems involved in cognition-emotion interactions. Consequently, the findings might provide evidence relevant to the further development of multi-

level and multi-component cognitive-affective theories (e.g., Johnson & Multhaup, 1992; Teasdale & Barnard, 1993).

Finally, the present findings speak to issues in clinical psychology by contributing to an empirically grounded evidence-base, (e.g., Dadds, Bovbjerg, Redd, & Cutmore, 1997; Harvey, Watkins, Mansell, & Shafran, 2004; Salkovskis, 2002) and more specifically to the clinical practice of using imagery-based techniques to help clients to control unwanted emotions in cognitive behavioral therapy (e.g., Arntz & Weertman, 1999; Hirsch, Mathews, Clark, Williams, & Morrison, 2005; Holmes, Arntz, & Smucker, 2007; Holmes & Hackmann, 2004; Smucker & Dancu, 2000).

A number of potentially fruitful future research directions are suggested. Evidence implicating differential brain region involvement across emotions (e.g., Murphy et al., 2003) indicates the importance of investigating a range of emotions, both 'basic' such as sadness, disgust and anger, and more complex, such as shame and guilt, to establish a more complete picture of the imagery-emotion relationship. This is important because it may be that any therapeutic benefits of using imagery are restricted to particular emotions. Our findings might suggest that employing imagery, with its enhanced recruitment of autobiographical memory, as means to access and modify emotional experiences could lead to greater positive affective change. However, the focus on negative imagery in Experiment 1, and on changes in anxious mood in Experiment 2, leaves open the question as to whether imagery always has a stronger link to overtly positive emotion experience (such as joy, happiness, contentment) than does verbal processing. This would be useful both for therapy innovation to improve negative mood, and even for understanding those psychological disorders where extreme variations of positive affect states may be problematic, e.g. substance abuse cravings (Kavanagh, Andrade, & May, 2005) or possibly in bipolar disorder. The therapeutic potential of training in imagery for positive material

(e.g. Holmes, Lang, & Shah, 2008) promises to be a profitable direction for future experimental psychopathology research.

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Table 1

*Examples of Picture-Caption Combinations with both Negative and Benign Consequences, for Experiment 2*

Picture	Caption to yield	
	negative consequence	benign consequence
rock climber	slip	stable
man sawing plank	finger	shed
hand holding needle	prick	sew
skier at top of slope	tumble	traverse
person in lake	sink	swim
cliff edge	trip	outlook
flight of stairs	fall	ascend
burning barbeque	touch	cook
people in hot air balloon	pop	sail
car driving on road	impact	fetch
knife	slip	slice
person riding bicycle	ice	bell

Table 2

*Participant Characteristics, State Anxiety Scores, Picture Liking Ratings and Subjective Experience Ratings in the Imagery and Verbal Conditions of Experiment 2, Main Experiment Sample (N = 32)*

Measure	Imagery		Verbal	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Trait anxiety ratings: STAI	33.31	4.66	34.88	5.54
SUIS	39.00	6.58	40.75	8.84
Baseline state anxiety ratings: STAI	27.31	4.33	30.00	6.50
Baseline picture liking ratings	5.59	0.36	5.36	0.40
State anxiety change: STAI				
After negative block	7.06	5.84	2.43	3.01
After benign block	-3.81	5.94	1.00	2.22
Picture liking ratings change				
After negative block	-0.73	0.85	-0.37	0.46
After benign block	0.07	0.32	-0.07	0.23
Subjective experience ratings				
Ease of task	6.43	1.63	6.25	2.08
Using imagery	7.91	1.10	4.59	2.17
Using verbal	3.94	2.35	7.78	1.51

*Note.* There were 24 female and 8 male participants (age:  $M = 48.8$  years,  $SD = 11.9$ ).

STAI = Spielberger State-Trait Anxiety Inventory. SUIS = Spontaneous Use of Imagery Scale.

In STAI change scores, a positive score indicates an increase in state anxiety, and a negative score a decrease. For liking ratings change, a positive score indicates becomes more liked, and a negative score indicates becoming less liked.

Table 3

*Participant Characteristics and State Anxiety Scores in the Imagery and Verbal Conditions of Experiment 2, Content Analysis Sample (N = 16)*

Measure	Imagery		Verbal	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Trait anxiety ratings: STAI	33.50	5.10	34.00	5.98
Baseline state anxiety ratings: STAI	27.75	4.59	26.50	5.21
Baseline picture liking ratings	5.53	0.43	5.36	0.38
SUIS	3.14	0.82	2.85	0.78
State anxiety change: STAI				
After negative block	12.00	8.10	2.63	6.34
After benign block	-3.00	9.16	2.63	5.04

*Note.* There were 10 female and 6 male participants (age:  $M = 37.1$  years,  $SD = 16.6$ ). STAI = Spielberger State-Trait Anxiety Inventory. SUIS = Spontaneous Use of Imagery Scale. In STAI change scores, a positive score indicates an increase in state anxiety, and a negative score a decrease.

Table 4

*Final Agreed Rating Scales for Coding of Picture-Word Combination Descriptions and Mean Scores in Imagery and Verbal Conditions in Experiment 2, Content Analysis Sample (N = 16)*

Rating Scale	Description of scale (and anchor points)	Cohen's $\kappa$	Imagery		Verbal	
			<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Valence	Positive / negative content (-2 = very negative, -1 = slightly negative, 0 = neutral, 1 = slightly positive, 2 = very positive)	0.50	-0.47	0.97	-0.36	0.47
	Negative combinations only		-1.32	0.43	-0.75	0.29
	Benign combinations only		0.38	0.47	0.04	0.20
Self involvement	Personal involvement in event (0 = not at all personally involved: abstract description or detached; 1 = some extent involved; 2 = very involved: person is experiencing or witnessing event)	0.59	1.06	0.48	0.14	0.29
Memory	Extent description could be a memory of an event (0 = not at all: the description is not a specific memory of an event; 1 = to some extent: this is plausibly a memory; 2 = clearly a memory: this seems to be a specific memory of an event)	0.43	0.84	0.31	0.33	0.27
Emotion	Use of emotions terms e.g., scared,	0.73	0.36	0.34	0.14	0.24

terms	angry (0 = none, 1 = one used, 2 = more than one used)					
Specificity	Event specificity or generalizability (0 = general statement, 1 = specific event)	0.50	0.83	0.23	0.50	0.28
Sensation	Use of sensation terms, e.g., see, feel, smell, taste (0 = none, 1 = one used, 2 = more than one used)	0.63	0.43	0.36	0.06	0.11

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Figure Caption

*Figure 1.* Changes in state anxiety (on the STAI) over negative and benign picture-word combination blocks for the imagery and verbal conditions in Experiment 2, for both the main experiment sample and content analysis sample.

Figure 1

