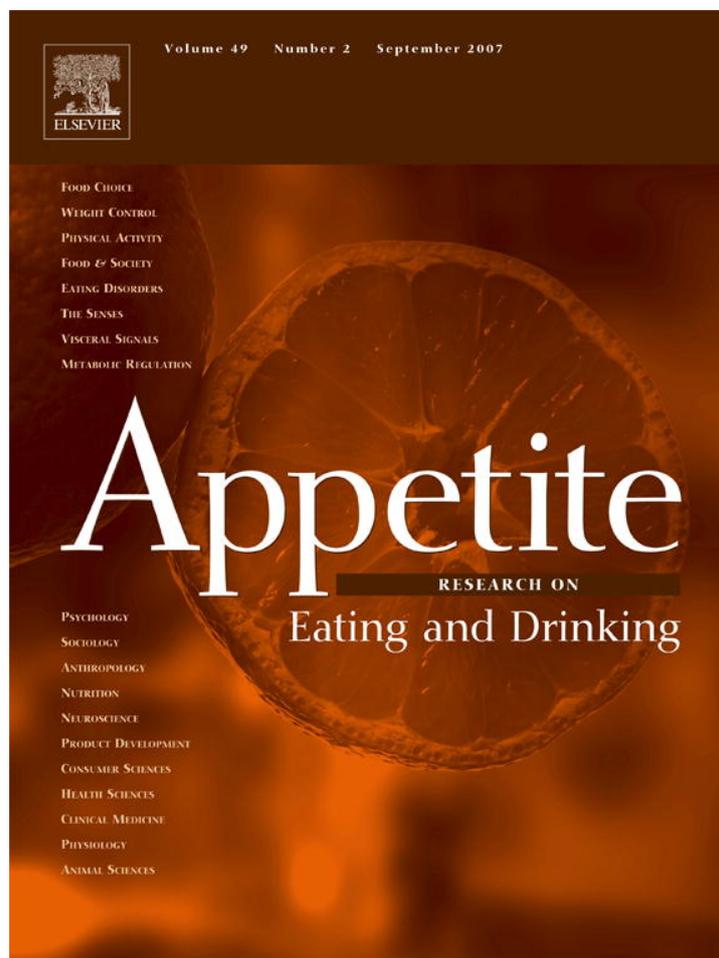


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## Short communication

# Rated salience of internal and external cues in cases of self-reported hunger and illness

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**Abstract**

An event contingent diary method compared the rated salience of ambient external and internal cues reported in association with instances of feeling hungry and ill, to test whether environmental and psychological factors might be differentially identified in conjunction with these states. In cases of hunger but not illness, external and internal events were equally salient cues. However, within the general category of external cues, for those feeling hungry, smells were rated more salient than sounds. Within the category of internal cues, in both cases of hunger and illness, cognitions were rated as more salient than moods. We consider Pavlovian conditioning as a mechanism for these effects.

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*Keywords:* Salience; Internal cues; External cues; Hunger; Illness

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**Introduction**

Both hunger and illness are familiar and aversive internal states; both produce physical as well as psychological symptoms. Everyday cases of mild ‘non-specific’ illness can often be medically unexplained, in which case there is by definition no identified physiological basis to the symptoms reported (Kroenke & Price, 1993). Similarly, much human eating behaviour is without physiological basis in that it is anticipatory, in advance of metabolic or stomach signals, thus driven by environmental cues (Berthoud, 2004; Levitsky, 2005). Here we compare the extent to which environmental cues versus thoughts or feelings are rated in conjunction with instances of hunger compared with mild illness or malaise.

In terms of an underlying mechanism, classical or Pavlovian conditioning links cues and outcomes through

learning. The conditioned response allows humans and other animals to show behavioural anticipation of important outcomes such as the arrival of food. Indeed this was the basis of Pavlov’s original observations: his experimental animals came to salivate (as a conditioned response) to an environmental event (conditioned stimulus) that predicted the availability of food. In other words environmental stimuli regularly associated with eating prompt that behaviour. Feelings of hunger can also be generated by internal stimuli, for example related to mood or time of day. This classical conditioning of hunger has been demonstrated in humans as well as other animals (Birch, McPhee, Sullivan, & Johnson, 1989; Weingarten, 1983). It is now known that a wide range of our psychological and physiological processes including non-specific illness are modulated by associative learning (Ferguson & Cassaday, 1999; Ferguson & Cassaday, 2001/2002; Ferguson, Cassaday, & Bibby, 2004; Ferguson, Cassaday, Erskind, & Delahaye, 2004; Maier & Watkins, 1998; Pezzone, Lee, Hoffman, Pezzone, & Rabin, 1993; Schafe et al., 1995), hence the use of illness as a comparison state in the present study. The incidence of serious illness in a healthy sample is low, indeed we specifically excluded participants with long-term medical problems, but the low

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level non-specific symptoms that we asked participants to report on have a relatively high frequency (Kroenke & Price, 1993).

Hitherto, studies have focused on the role of external environmental cues such as odour as potential Pavlovian associates of outcomes such as hunger and illness. However, internally generated stimuli produced by moods or cognitions (i.e. how the participant is feeling, or what they are thinking about) can also act as conditioned stimuli (Borden & Lister, 1994; Childress et al., 1994; Robbins, Ehrman, Childress, & O'Brien, 1999). Therefore, the present study uses self-report data from an event contingent diary study to systematically compare the rated salience of internal versus external cues for hunger and illness. We made further planned comparisons to test for differences in the types of cue within the general categories of internal and external. For internal cues, we compared the rated salience of cues categorized as mood or cognition. For external cues, we compared the rated salience of cues categorized as odour or sound. Finally, in addition to the symptom diaries, locus of control (LoC) was measured by a personality questionnaire, using a shortened version of Rotter's (1966) Internal–External LoC scale (Ferguson, 1993). The LoC scale was developed to assess the extent to which an individual possesses internal or external reinforcement beliefs and was therefore predicted to moderate the extent to which participants would rate internal or external cues as salient.

## Method

### *Participants*

Potential participants were recruited by advertisements and 41 undergraduates from the Universities of Nottingham and London completed the study. This final sample included 26 females and 15 males, (mean age = 23; SD = 7.76; range 18–52). None of the participants had any long-term medical problems. Participants were not required to come into the laboratory to complete the diaries under supervision. Rather the diaries were completed at their convenience, wherever they chose. There was no financial incentive to participate. As a total of 110 diaries were distributed to those who volunteered in principle, the effective response rate was 37.3%. The diaries were event contingent and there was no further inclusion criterion based on the reported incidence of hunger or illness (see below).

### *Procedure and measures*

All participants gave their written consent to participate in the study. They were required to fill out a symptom diary twice a day for 8 days. Both am (defined as before 12pm) and pm (defined as 12–5 pm) the structured diary required a yes/no response for: “Did you feel hungry?”; and “Did you feel ill?”; with the further instruction “If yes, please fill

out only the boxes you feel are appropriate.” On those occasions that participants reported feelings of hunger or any mild illness they were required to complete rating scales to indicate the salience of concurrent environmental and internal cues, in each case within two general categories. They were required to rate smells and sounds on a 5 point scale that ranged from ‘not at all strong’ (1) to ‘extremely strong’ (5) for smells, and from ‘not at all loud’ (1) to ‘extremely loud’ (5) for sounds. Moods and cognitions were similarly reported by category in response to structured prompts: “What particular thought stands out in your mind at this time?”; “How would you describe your mood at this time?”; followed by the salience rating for the mood or cognition, on a 5 point scale ranging from ‘not at all significant’ (1) to ‘extremely significant’ (5).

The LoC measure was a 10 item scale, on which high scores represented internal perception of perceived control. This was used to dichotomise participants into ‘internals’ and ‘externals’: a score of 5 or above put the participant into the internal category; a score of 4 or below put them in the external category.

### *Statistical analysis*

In cases of identified hunger or illness in the absence of any associated cue (whether smell, sound, mood or cognition), the salience score was 0. Thus, in each case the dependent variable was a salience score that could range from 0 to 5. Each diary comprised 16 potential entries (as it was completed twice a day over eight days). All analyses were conducted on the average salience score for each participant and type of cue, firstly in the overall category of internal versus external, secondly by cue type within these categories. These average scores were calculated separately for each participant because they were dependent on how many individual cases of hunger and illness were recorded.

The overall salience scores were entered into analysis of variance (ANOVA) in a within-subjects design with the factors of Cue Locus (internal or external) and State (hunger or illness). This analysis was repeated with LoC Personality as a between subjects factor with two levels (internals or externals). Paired comparisons *t*-tests were used to explore the interaction between Cue Locus and State. Further planned comparisons by *t*-test were used to test for differences in rated salience within the general categories of internal and external cues separately for each state (hunger and illness).

## Results

The mean total reported incidences over the 8 days of the diary (each day twice sampled am and pm) was 11.10 (range 4–16) and 3.41 (range 0–10), for hunger and illness, respectively, out of the maximum possible of 16 counts in each case. Thus, as would be expected, hunger was experienced more frequently than illness. Qualitatively too, there were obvious differences in identified cues. For

example, hunger ‘cognition triggers’ were frequently based on planning for the day or week ahead (18.1%), whereas this was never once the case for illness. However, there were also some similarities in the potential triggers cited in instances of hunger and illness. For example, the most common ‘mood’ reported in association with both hunger and illness was tiredness (20.1% and 35.7%, respectively).

Statistical analysis of the averaged salience ratings showed a main effect of State,  $F(1, 40) = 15.02$ ,  $p < 0.001$ . Participants reported an overall higher salience rating for both internal and external cues when they were feeling ill than when they were feeling hungry. There was also a significant main effect of Cue Locus,  $F(1, 40) = 38.05$ ,  $p < 0.001$ . In general, people tended to rate cues as more salient when making internal attributions than when making external attributions.

However, the cues rated as salient clearly depended on state because there was a significant interaction effect between State and Cue Locus,  $F(1, 40) = 42.13$ ,  $p < 0.001$ . This arose because while the average salience of internal cues was significantly higher than that of external cues in cases of illness,  $t(40) = 6.82$ ,  $p < 0.001$ , there was no difference between the rated salience of internal and external cues in cases of hunger,  $t(40) = 1.62$ . Moreover, the rated salience of internal cues for illness was higher than the salience of either internal or external cues for hunger, minimum  $t(40) = 5.85$ ,  $p < 0.001$  (see Fig. 1).

The dichotomised LoC scores divided participants into ‘internals’ ( $n = 22$ ) and ‘externals’ ( $n = 19$ ). The above analyses were then repeated with this derived factor of LoC. However, counter to expectation, the interaction between Cue Locus and LoC Personality was insignificant,  $F(1, 39) = 1.18$ , and none of the other interactions involving LoC Personality were significant, maximum  $F(1, 39) = 1.64$ . Therefore, in the present study, the rated salience of internal versus external cues finds no account in terms of participants’ general tendencies to make external versus internal attributions.

Within the general category of internal cues, in both cases of hunger and illness, cognitions were rated as more

Table 1

Mean salience ratings ( $\pm$ SEM.) of concurrent internal (mood or cognition) versus external (smell or sound) cues for every day experiences of hunger and illness

	Hunger	Illness
<i>Internal</i>		
Mood	1.67 ( $\pm 0.16$ )	1.80 ( $\pm 0.24$ )
Cognition	2.25 ( $\pm 0.19$ )	2.49 ( $\pm 0.25$ )
<i>External</i>		
Smell	1.89 ( $\pm 0.17$ )	1.32 ( $\pm 0.22$ )
Sound	1.57 ( $\pm 0.19$ )	1.23 ( $\pm 0.23$ )

salient than moods, minimum  $t(40) = 2.69$ ,  $p = 0.01$ . Within the general category of external cues, for those feeling hungry, smells were rated more salient than sounds,  $t(40) = 2.26$ ,  $p < 0.05$ , but there was no such difference in cases of illness,  $t(40) = 0.40$  (see Table 1).

## Discussion

To our knowledge, this is the first systematic comparison of rated salience of internal versus external cues associated with hunger and illness using an event contingent diary method. Cues were rated as being more salient overall when people were ill, consistent with illness generally being a more aversive condition than hunger. Overall, more salience was attributed to internal cues. However, the rated salience of internal cues was clearly different in the case of illness compared with hunger: the most salient cues were internal stimuli associated with illness. The internal state of illness most likely differs from hunger because internal cues coincident with illness should be more obvious contenders in terms of any likely causal relation than external events.

We made this comparison because everyday experiences of hunger and mild illness are familiar aversive states that result in potential discomfort. Both motivate the individual to seek remedy or, better still, take prophylactic measures. Of course, there are differences between hunger and illness in terms of the range of symptoms that these states encompass. A person feeling ill may have a headache, nausea, muscle pains, and we did not in the present study differentiate symptoms. Hunger acts as a motivation to eat and is readily remedied with food. Thus to argue, for example, that ‘illness’ covers a broader category of bodily states, or that hunger and illness have different motivational effects, would in principle constrain the comparisons that we wish to make here. However, hunger too is mediated by a variety of physiological symptoms, and both hunger and illness can result fatigue and dizziness. Cases of mild illness can be remedied with rest. Moreover, the rated salience of particular categories of cue is the focus of the present study, not the particular symptom displayed, nor its incidence (see below).

In general terms, these results point to the need to expand the event contingent diary approach to the study of internal cues as well as environmental events as potential

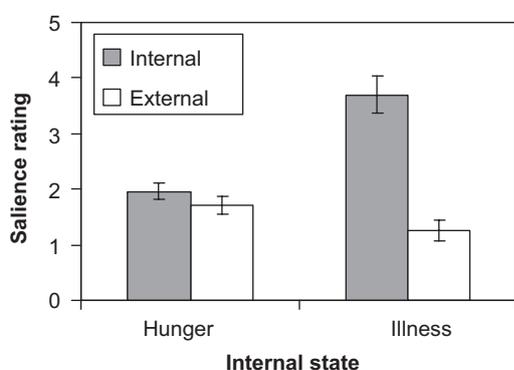


Fig. 1. The mean rated cue salience for the aversive internal states of hunger and illness, separately for the general categories of internal and external cues. Error bars show S.E.M. for approximation between groups comparisons.

triggers for eating, and other health-related behaviours, in both normal and patient populations. Large scale questionnaire studies can similarly be used to identify beliefs about origins of symptoms and how these may vary with different general categories of symptom and personality characteristics (Kroenke & Price, 1993; Pennebaker, 1994; Salmon, Woloshynowych, & Valori, 1996). Completion of an event contingent diary (here twice a day for eight days) is somewhat inconvenient and necessarily places greater reliance on the motivation and compliance of participants. The 37.3% response rate refers to the 41 diaries returned—out of the 110 diaries sent out—and is not unreasonable under these circumstances. Therefore, the sample was necessarily biased towards inclusion of participants who were more conscientious in their reporting. However, there was no further inclusion criterion: the salience scores were averaged across the reported instances of hunger and illness and are thus unaffected by ‘missing’ data that arise because of differences in the baseline incidence of hunger and illness.

Therefore, although the sample of respondents could not be random, sampling bias cannot explain the consistency with which different categories of cue were selected in conjunction with states of hunger and illness. Moreover, we found no evidence in the present study, for any moderating role of LoC, the most likely personality characteristic to confound our results.

The demand characteristics of the diary study method may necessarily affect the reported incidence of the states of illness and hunger. However, the baseline incidence of these states is not at issue here as we examine average rated salience on an event contingent basis. In particular, we are interested in differences in the category of cue (internal mood or cognition versus external smell or sound) to which these states are attributed and these find no obvious account in terms of the demand characteristics of the study. A more serious limitation on the use of event contingent diaries arises in that, despite the high ecological validity of such studies, inevitably they can tell us nothing about the causal direction of the observed associations. In the present case, internal states of hunger and illness could well moderate awareness of both internal and external cues.

Pavlovian conditioning (Birch et al., 1989; Weingarten, 1983) has not been directly demonstrated in the present study. However, it provides a highly likely mechanism by which external and internally generated environmental cues can moderate the development of somatic responses and symptoms. Consistent with this interpretation, smells were rated more salient than sounds as cues reported in association with hunger. Environmental events might normally be expected to overshadow more subtle internal cues (Pennebaker, 1994). However, in the case of hunger, external and internal events seemed to provide equally salient cues. This was not simply because participants failed to make this distinction in their ratings because, in the case of illness, the expected pattern was

reversed in that internal cues were given higher rated salience. In terms of Pavlovian conditioning as a possible moderator of these distinctive somatic states, this observed difference in salience ratings is consistent with the fact that conditioned stimuli are known to vary in their associability with different unconditioned outcomes (Mackintosh, 1983).

In terms of the implications for the regulation of human feeding behaviour, the overall equivalent salience ratings for internal and external cues, suggests that internal cues should be considered alongside environmental stimuli as potential triggers for eating that can in principle act through the same (Pavlovian) as well as alternative mechanisms (Berthoud, 2004; Kelley, Schiltz, & Landry, 2005; Levitsky, 2005; Petrovich, Setlow, Holland, & Gallagher, 2002). In line with this conclusion, appetite awareness training already distinguishes internal hunger and satiety cues from non-appetitive internal cues such as negative affect (Craighead & Allen, 1995). In the present study, we find evidence that cognitions should be just as potent in this respect as mood states.

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