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Original Article

Effects of dietary restraint on flavour-flavour learning

Jeffrey M. Brunstrom[a], Christine R. Downes[a] and Suzanne Higgs[b]

[a]*Human Sciences, Loughborough University, Loughborough, UK;* [b]*School of Psychology, University of Birmingham, Birmingham, UK*

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Flavour preference learning in 21 restrained and 21 unrestrained females was explored using an evaluative conditioning paradigm. Each participant was exposed to an adapted version of the procedure used by Johnsrude *et al.*, (1999, *Learning & Motivation* **30**, 250–264). During conditioning, participants sampled 10 instances each of three novel flavours presented in a semi-randomized order. After sampling a flavour they were instructed to eat a sweet according to three different flavour-reinforcement contingencies. One flavour was accompanied by a sweet on 90% of trials and was presented alone on 10% of the trials, while the remaining flavours were rewarded at ratios 50% : 50% and 10% : 90%, respectively. The conditioning phase occurred in conjunction with a counting task requiring continuous use of working memory, and was immediately followed by the participants making hedonic ratings of each flavour. Very few participants showed awareness of the purpose of the experiment or the specific reward contingencies. Despite this, the ratings given by the unrestrained eaters were highly correlated with the reward ratio experienced during conditioning. In contrast, restrained eaters exhibited no evidence for evaluative learning. These findings may explain the equivocal nature of results from previous studies of positive flavour-flavour learning (FFL) and may offer a novel theoretical context within which to study dietary restraint.

Introduction

The term "evaluative conditioning" (EC) (Levey & Martin, 1975) is used to describe the process whereby likes and dislikes are acquired. EC can be demonstrated when the valence of a novel "target" (the conditioned stimulus [CS]) comes to be altered by the valence (positive or negative) of stimuli or events (the unconditioned stimulus [US]) that are presented contingently or spatio-contiguously with the CS. Despite the fact that EC has been demonstrated using a range of stimuli, including odors (Todrank *et al.*, 1995), faces (Baeyens, Eelen & Van den Bergh, 1990a), and tactile stimuli (Hammerl & Grabitz, 2000), it is a phenomenon that is not produced reliably (see Rozin, Wrzeniewski & Byrnes, 1998, for a review). This study sought to explore factors affecting the reliability of a type of EC known as *flavour-flavour learning*.

In flavour-flavour learning (FFL), repeated compound-presentation of a novel flavour (CS) with a liked or disliked flavour (US), causes the affective value of the novel flavour to change in the direction of the US. In this way, "positive" FFL was first demonstrated in humans by Zellner *et al.* (1983) using a sweet taste (sucrose) as the US. Compared to non-sweet-paired neutral flavours, their results showed an enhanced liking for the sweet-paired flavour. However, subsequent attempts to demonstrate positive FFL have produced equivocal results. Rozin *et al.* (1998) failed to produce a convincing replication of Zellner *et al.*'s original study. Similarly, Baeyens *et al.* (1990b) found that a sweet US produced a marginal but non-significant tendency for a CS flavour to become liked.

More recently, FFL has been explored using a disliked US called Tween20 (*Polysorbate20*) (Baeyens *et al.*, 1996, 1998). Baeyens *et al.* (1990b) found that this disliked US produced a more robust conditioning effect

Address correspondence to J.M. Brunstrom, Human Sciences, Loughborough University, Loughborough, Leics LE11 3TU, UK. Email: J.M.Brunstrom@1boro.ac.uk

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than a liked US. Baeyens and his colleagues reasoned that flavour dislikes may be easier to condition than flavour likes because sweet USs are not universally liked to the extent that negative USs are disliked (Baeyens *et al*., 1990b, 1995).

Although Baeyens *et al*.'s use of a disliked US is strategically pragmatic, it is probably premature to assume that FFL only influences our propensity to avoid unpleasant tastes. After all, many dietary decisions are, to some extent, based on a learned liking for the taste of certain foods. Thus, an intriguing question is whether or not variation in liking for sweetened foods is the only factor that determines the success of attempts to demonstrate positive FFL.

One factor that is known to have a pervasive effect on food and flavour choice is the extent to which an individual consciously restricts his/her caloric intake. "Restrained eaters" (Herman & Mack, 1975) tend to be preoccupied with thoughts concerning food and weight (Laessle *et al*., 1996) and this can be associated with feelings of depression (Rosen, Gross & Vara, 1987), stress (Kagan & Squires, 1984), maladjustment (Edwards & Nagelberg, 1986), and low self esteem (Polivy, Herman & McFarlane, 1994). Restrained eating is also associated with certain behavioural effects. Most notably for the present study, impairments in cognitive performance including slower reaction times, poorer vigilance and biased attentional processing (Green and Rogers, 1993; Green *et al*., 1994, 2000). [In most cases equal or greater decrements in performance measures have been found in individuals who are dieting to lose weight (e.g. Green and Rogers, 1998).] It has been suggested that these impairments may be due to reduced cognitive processing capacity resulting from the activation of food-related schema (Green *et al*., 2000). It is possible therefore that in a learning task involving food-related stimuli, restrained eaters may demonstrate similar impairments. Hence, previous difficulties in demonstrating robust positive FFL may have resulted from a failure to take this variable into account.

It is also possible that previous studies have failed to produce positive FFL because they have all used a methodology that does not provide the best context within which this kind of learning can be evidenced. In this study we decided to employ an adapted version of a methodology that has been used previously to condition reliable changes in the affective quality of abstract patterns (Johnsrude *et al*., 1999, 2000). In Johnsrude *et al*.'s original version, three different abstract and novel patterns were used as CSs. These CSs were presented in equal proportions, in a semi-randomized order, over 180 trials. Each pattern was followed by a confectionary reward, either 90%, 50%, or 10% of the time. During this conditioning period the participants engaged in a counting task in which they were required to memorize the number of occasions that they successfully located a red circle in each of three locations on a computer screen. After conditioning, Johnsrude *et al*.'s participants made a series of paired comparisons, indicating each time which of the two patterns they most preferred. Using this technique, Johnsrude *et al*. (1999, 2000) found a correlation between pattern preference and the level of reward (*contingency ratio*) allocated to each pattern during conditioning.

Johnsrude *et al*.'s procedure is somewhat different from the methods that have been used in previous EC studies, particularly those employed in FFL. Nevertheless, their procedure may offer certain advantages, which can be summarized as follows. First, the counting task was relatively demanding and required continuous use of working memory. This served to minimize both the participants' awareness of the CS–US contingencies, and demand characteristics relating to the aim of the study. Second, the patterns were not rewarded on an all-or-nothing basis. (i.e. 100% or 0% of trials). This also served to make the CS–US contingencies more difficult to deduce. Finally, Johnsrude *et al*. offered their participants a choice of sweet reinforcer. This is likely to greatly improve the probability that each participant will experience a reinforcer that they find to be rewarding.

In summary, previous studies of positive flavour-flavour learning have produced equivocal results. Here we argue that cognitive processing of the stimuli in relation to a US may prime thoughts (related to food choice and eating behaviour) that interact with the learning process. Restrained eaters are likely to be more preoccupied with these thoughts than unrestrained eaters. Thus, one way to test this hypothesis is to compare evidence for FFL between restrained and unrestrained eaters.

Method

Participants

A total of 42 female volunteers participated. Of these, 23 were undergraduates at Loughborough University and 19 were recruited from the East Midlands region.

Apparatus

Throughout the experiment participants received instructions via a microcomputer running software custom written in Visual Basic 6.0. Sound files were produced at a sampling rate of 16 kHz, and were played with a precision of 16 bits via either a 16-bit A3DX-Xstream sound card and Sennheiser HD-570