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Learning to associate compatible and incompatible pictures with food and non-food odours, within a stimulus equivalence paradigm

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ABSTRACT

Within consumer research, it is acknowledged that influential and perhaps unconscious associations to products exist, which require indirect as well as direct methods of investigation. We examine the potential usefulness of one such indirect method, an application of the stimulus equivalence matching-to-sample paradigm [Sidman, M. (1971). Reading and auditory–visual equivalences. *Journal of Speech and Hearing Research, 14*, 5–13].

Two experiments are reported ($n = 15$, $n = 20$). Both used three, 3-membered stimulus sets: A (food and non-food odours); B (nonsense syllables); and C (pictures), two of which were either 'compatible' or 'incompatible' with the corresponding items in the A set. Each participant took part in both 'compatible' and 'incompatible' conditions. First, (A → B), participants were trained to choose one of the three nonsense syllables when presented with one of the odours. Second, (B → C), those who had learned the first task ($n = 10$, $n = 14$) were trained to choose one of the three pictures when presented with one of the nonsense syllables, and finally, in a test phase (C → A), to choose one of the three odours when presented with one of the pictures. In both experiments, B → C trials to criterion and response times were significantly greater in the 'incompatible' condition, and the error structure differed between conditions. In other phases, no consistent inter-condition differences were found. We discuss the use of this paradigm in consumer research on odours and tastes as a very indirect way of measuring pre-existing associations.

1. Introduction

Within consumer research, there is now some acknowledgement that an understanding of product attributes and consumer preferences may require more subtle or indirect investigation as well as conventional direct probing. For example, Berridge and Winkielman (2003) and Winkielman and Berridge (2004) showed that unconscious emotions induced by subliminally presented images influenced drinking behaviour in their thirsty participants, while overt, subjective mood ratings were not changed. As noted by Köster (2007), this provides a good argument in favour of exploring new methods that do not rely on conscious awareness. This argument is consistent with the methodology adopted by behavioural psychologists, who favour examination of the relationships between behaviours, rather than focussing on what people say. Köster (2007) also dismisses the view that human behaviour is rational and determined by conscious choices. Thus, the practical question of interest within the food or fine fragrance industries, for example, is to develop more indirect methods for characterising new products (e.g. a new perfume or wine) to complement or replace the rather explicit consumer analysis used currently. It is likely that pre-existing and perhaps non-conscious and thus not readily reportable, associations to products exist which may influence the consumer behaviours.

A number of methods such as the repetition priming paradigm may be viable (see e.g. McAtamney (2004) and Annett, Richardson, and Behan (in preparation)). However, one particularly promising approach is the stimulus equivalence paradigm, which has its origins in behaviourist psychology. This will be the focus of this paper. Stimulus equivalence (see Sidman (1971)) attempts to provide a non-cognitive account of human behaviours (Barnes-Holmes, Barnes-Holmes, Smeets, Cullinan, & Leader, 2004; Roche & Barnes 1996) ranging from how we use language (Hayes, 1989, 1991; Sidman, 1986, 1990, 1994) to how we behave in new situations (Sidman, 1994; Spradlin, Saunders, & Saunders, 1992). It describes the relationship between two stimuli which have never been *directly* associated, such that one can evoke the same response or behaviour as the other. These stimuli are said to be 'interchangeable' (Grant & Evans, 1994). The type of procedure normally used to demonstrate stimulus equivalence is called 'matching-to-sample' (see Sidman (1990)).

The term 'equivalence' comes from algebra. A relation Θ is said to be an equivalence relation if, for any x, y, z: $x \Theta x$ (reflexivity); x

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Θ y implies y Θ x (symmetry); x Θ y and y Θ z imply x Θ z (transitivity). The further relation z Θ x follows from symmetry and transitivity. In the typical stimulus equivalence paradigm, this is applied as follows, and Θ could be 'goes with'. Suppose that A, B, and C are three sets of stimuli each with three members: so A consists of a1, a2, a3; B consists of b1, b2, b3, and C consists of c1, c2,c3. In Phase 1 (A → B), at each trial, one member of A (sample) is presented, and all members of B (comparison stimuli). The participant has to select one member of B; b1 is reinforced as a correct response to a1, b2 to a2, and b3 to a3. Phase 1 has ended when some learning criterion is reached; e.g. an unbroken sequence of a given number of correct responses. In Phase 2 (B → C), an identical procedure is used to train choice of c1, c2, c3 to b1, b2, b3, respectively. Phase 3 (C → A) is then used to test for one or more of the emergent properties associated with equivalence relations that have *not been directly trained* (reflexivity, symmetry and transitivity). For example, the participant might be shown one of the C set and asked to choose one from the three members of the A set (note that the members of A and C have never been directly paired in the experiment). If, in this case, participants choose a1 given c1, a2 given c2 and a3 given c3, they are treating Θ as an equivalence relation; that is 'equivalence has been established'.

Usually the sets A, B, and C are of disparate types, the experimenter's choice of which responses count as 'correct' is arbitrary and the stimulus sequences are fully or partially random. Sometimes each set has two members, not three. In summary, Phases 1 and 2 are used *to train* pairings, and Phase 3 is used *to test* a pairing that has never *directly* been trained. Once equivalence has been established, it would appear that under some circumstances it is difficult to reverse (see e.g. Pilgrim, Chambers, and Galizio (1995) and Smeets, Akpinar, Barnes-Holmes, and Barnes-Holmes (2003)).

Stimuli used in stimulus equivalence research tend to be words, nonsense syllables (typically consonant–vowel–consonant trigrams) or shapes, presented visually (see Hayes, Tilley, and Hayes (1988) and Leslie et al. (1993)). Less common has been the use of sounds (Sidman, 1971), tastes (Hayes et al., 1988; Rehfeldt & Dixon, 2005) or haptic sensations (Bush, 1993; Tierney, De Largy, & Bracken, 1995). One study has included drugs as interoceptive stimuli (DeGrandpre, Bickel, & Higgins, 1993), and to date the only study using odours is Annett and Leslie (1995).

Stimulus equivalence procedures have been applied in diverse areas: developing reading skills (e.g. De Rose, de Souza, Rossito, & de Rose, 1992); treating language deficits (e.g. Cowley, Green, & Braunling-McMorrow, 1992); explaining behaviours such as gender-role stereotyping (Kohlenberg, Hayes, & Hayes, 1991; Roche, Barnes-Holmes, Smeets, Barnes-Holmes, & McGeedy, 2000) and children's preferences among soft drinks (Barnes-Holmes, Keane, Barnes-Holmes, & Smeets, 2000; Smeets & Barnes-Holmes, 2003). Despite this diversity of application, there is much that is not understood about equivalence class formation, in particular, the role of verbal labelling and verbal rules. The word "verbal" here does not necessarily imply the use of overt speech. Some authors (e.g. Dugdale & Lowe, 1990; Randell & Remington, 2006) favour a role for linguistic processes, while others (e.g. Schusterman & Kastak, 1993; Sidman, 1990) claim to have demonstrated equivalence class formation by animals or by humans who lacked language. In any case, even if equivalence classes can be formed without the use of language in some circumstances, it does not follow that language is not involved when the participants are linguistically competent humans. Nevertheless, there has been no conclusive evidence as to whether labelling is an asset in equivalence formation. The adoption of nonsense syllables as meaningless stimuli is widely accepted as valid within the stimulus equivalence literature. Although not strictly relevant in this case, the interested reader is referred to a discussion of the possible linguistic variability of these and possible influences on memory tasks, which dates back to their first reported use by Ebbinghaus in 1885 (see e.g. Jenkins (1985)).

It has often been assumed that odours are more difficult to name than other types of stimuli (Engen, 1982). For example, Davis (1977, 1975) found that it was more difficult to form odour-number associations than picture-number associations. Since labelling may be important in stimulus equivalence formation, and odour naming may be difficult, it follows that stimulus equivalence class formation with odours may not necessarily be easy.

This issue was investigated by Annett and Leslie (1995). Twenty participants were assigned to one of the two conditions, where odours were either easy or difficult to name. In the 'easy' condition, odours were easy to discriminate and easy to label: whiskey, methylated spirits and a commercially available perfume. In the 'difficult' condition, participants were asked to choose three easily discriminated perfumes from a set of seven; it was believed that these particular perfumes were not easy to name. The visual stimuli were the nonsense syllables zid, yim and vec, and abstract stimuli consisted of three abstract visual forms. A 'matching-to-sample' procedure was used. The experiment involved training odour to nonsense syllable (A → B) and nonsense syllable to visual form (B → C), and testing visual form to odour (C → A). They found that successful stimulus class formation did take place with odours, in both the easy and difficult conditions, although some participants in the more difficult perfumes condition failed to reach criterion responding on the A → B training phase. However, it is possible that verbal labels could have been used by the participants in the difficult condition, even if these labels were not standard and not identical across participants. In addition, no attempt was made to manipulate the degree of compatibility between the odours and all other stimuli.

However, if, for example, an odour is in some sense already 'associated' with e.g. a visual image, does that make it more difficult for it to become part of an equivalence class with another, disparate image? Reports of difficulty in producing reversal of equivalence might suggest this (c.f. Smeets et al., 2003 above). Or to ask a related question, is it easier to induce the equivalence between an odour and some 'compatible' images than it is to do so between the odour and other 'incompatible' images? If the answer to these questions is positive, and ease of learning is dependent on the compatibility of the image, can this provide an empirical measure of compatibility between an odour and an image? Clearly, such an approach would provide a very indirect measure of people's perceptions of an odour and its associations.

These questions are investigated in these two experiments in the context of a stimulus equivalence paradigm. This paradigm was chosen because the relatively long process of learning, typically required by it, might provide a good basis for not merely detecting any such effects, but measuring their extent, via trials to success criterion, or response times, or some function of both.

Thus the two experiments reported here have two aims. First, they try to consolidate and extend the theoretical literature by showing the formation of equivalence classes with odours as one stimulus set (c.f. Annett & Leslie, 1995), but giving additional detailed analysis of error type, and using a computer-administered task allowing better experimental control and more accurate measurement of response time. Second, as discussed earlier, an understanding of product attributes and preferences may require more subtle or indirect investigation as well as conventional direct probing. It is also likely that pre-existing (perhaps non-conscious) associations to products exist. Therefore, as the second aim, the experiments address this mainly practical question of interest to those in the food and fragrance industries, and do so by the manipulation of the degree of compatibility between the odours and other experimental stimuli.