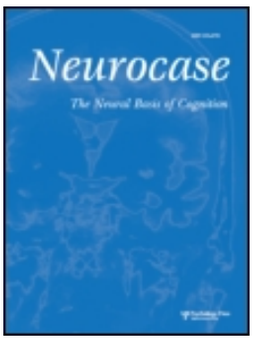

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Synaesthetic Consistency Spans Decades in a Lexical–Gustatory Synaesthete

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Developmental synaesthesia is typically characterised by the consistency of synaesthetic pairings, in that stimuli tend to generate the same synaesthetic responses over time (e.g., if *A* is red, it is always red). Although studies have illustrated consistency over many months and even several years, little is known about the longevity of reports outside the practical time-constraints of laboratory testing. Here we provide the first objective empirical evidence of synaesthetic consistency spanning from the 1970s to the current day (27 years) and use this longevity to identify the likely roots of such cross-modal associations.

Keywords: Consistency; Cross-modal; Memory; Synesthesia; Taste.

Introduction

Synaesthesia is a familial condition which causes involuntary cross-modal experiences. For example, hearing a tone can trigger the perceptual experience of colour (e.g., Ward, Simner, & Auyeung, 2006), or tastes can elicit tactile sensations against the hand or face (Cytowic, 1993). The stimulus that triggers the experience is known as the *inducer*, while the resultant experience is termed the *concurrent* (Grossenbacher, 1997) and in the lexical–gustatory variant investigated here, the inducer and concurrent are words and flavours respectively. Hence, for lexical–gustatory synaesthetes, hearing, saying or reading words (or in some cases, even thinking about words) gives rise to associated food experiences (Simner & Ward, 2006; Ward & Simner, 2003; Ward et al., 2005). In all cases, these food experiences are complex constructs, rather than generic tastes of bitter/sweet etc., and are often highly specific and rich in detail. For synaesthete JG for example, the name *Adrian* tastes of lettuce coated with Caesar salad dressing, and for CS, *part* tastes of chicken noodle soup (Ward et al., 2005). Associations can incorporate temperature and texture as well as flavour, so for synaesthete JIW for example (our case-study here), the word *jail* generates the taste of cold, hard bacon (Ward & Simner, 2003), while *tambourine* is very crumbly biscuit (Simner, in press).

The lexical–gustatory variant is rare, even within the sphere of synaesthesia, and although 12 cases have now been reported in the contemporary literature (Cytowic, 1989, Gendle, 2007; Simner & Ward, 2006; Ward & Simner, 2003; Ward et al., 2005) along with four from historical sources (Ferrari, 1909, 1910; Pierce, 1909) no cases emerged in the population recruited for the most extensive prevalence study based on random sampling (Simner et al., 2006). This suggests that the prevalence of lexical–gustatory synaesthesia is less than 0.2% of the population (and may be considerably lower). The synaesthetic flavours of JIW (see also Ward et al., 2005 for other cases) are felt in and around the mouth, and he describes these as being phenomenologically identical to veridical taste perception in all ways, other than having a substance to roll on the tongue. Indeed, the perceptual nature of JIW's synaesthesia has been illustrated in functional magnetic resonance imaging (fMRI), which showed bilateral activation of the primary gustatory cortex (Brodmann's area 43) when JIW listens to words but not tones (David Parslow, unpublished data; see Ward & Simner, 2003). No similar activity was found in control participants (Nunn et al., 2002) suggesting that JIW's reports are both genuine and perceptual.

In lexical–gustatory synaesthesia, the nature of both the flavour concurrent, and the linguistic inducer, is known to be shaped by experience. The most frequent

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synaesthetic flavours are those that are eaten most often in the synaesthetes' diets – particularly in their early diets. For example, foods consumed during JIW's childhood (e.g., chocolate) are 10 times more likely to occur as his synaesthetic concurrents, compared to those consumed only in later life (e.g., coffee; data adapted from Ward & Simner, 2003). This over-representation of childhood foods suggests that synaesthetic associations are set by experience during early development. The role of experience is seen, too, in the nature of the linguistic inducer. Words that sound alike (e.g., *college*, *message*, *village*) tend to taste the same, and their shared phonemes tend to also be present in the name of the food itself (e.g., for JIW, *college*, *message* and *village* all taste of sausage). Hence, word–taste pairings are influenced by knowledge of food names. Although the examples presented here are relatively transparent, the full range of rules that make up this system are highly complex, and are not consciously known to the synaesthete. For example, while some phoneme triggers have been shown to derive from food names (e.g., the phoneme / ʤ / relates to JIW's taste of sausage) others have less obvious roots (e.g., / *f* / is associated with the taste of sherbet). Moreover, even within synaesthesia's known rule-system, synaesthetic associations are sensitive to fine-grained phonological constructs of which the synaesthete has no conscious awareness (Ward & Simner, 2003). Different flavours can be associated to different allophones (i.e., acoustic/articulatory variants) of the same phoneme, even though the synaesthete is unaware that such linguistic distinctions exist. For example, JIW tastes both fingernails and potato from the phoneme / l /, but the former flavour is associated, specifically, to the 'dark' allophone (which has a secondary articulation in which the back of the tongue is raised towards the velum, as in *deal*) while the latter flavour is associated to the 'clear' (unvelarised) allophone (as in *like*). JIW's synaesthesia also responds to further distinctions within these allophones: for example the taste of Rice Krispies© is associated with a 'syllabic' dark / l / (i.e., one that fills the peak of an unstressed syllable, as in *bottle*; Ward & Simner, 2003). Hence, although the relationship between words and tastes has a number of known rules, these rules are both complex and apparently with exceptions.

Like other variants, lexical–gustatory synaesthesia is characterised by the consistency of synaesthetic reports over time, and this has been documented across a range of developmental synaesthesias (e.g., lexical–gustatory, letter–colour, number–colour, taste–shape, sound–taste, ordinal linguistic personification, visuo-spatial forms; e.g., Beeli, Esslen, & Jäncke, 2005; Sagiv, Simner, Collins, Butterworth, & Ward, 2005; Simner & Holenstein, 2007; Simner et al., 2006; Smilek, Dixon, Cudahy, & Merikle, 2002; Ward et al., 2005). Hence, inducer stimuli consistently tend to generate the same synaesthetic responses over time (e.g., if *A* is red, it is always red; e.g., Baron-Cohen, Harrison, Goldstein, & Wyke, 1993). Studies have used this consistency over time as a hallmark of the condition, and the test of consistency has been described as the 'behavioural gold-standard' for establishing genuineness. Typically, synaesthetes score between 80 and 100% consistent over many months, and their scores are compared to those of control participants who are asked to generate analogous associations (e.g., *A* = red; *B* = blue). Synaesthetes typically out-perform controls by a significant margin, even where these latter have been tested over far shorter time intervals (e.g., 2 weeks) and even where controls have been given monetary incentives, or strategic suggestions to perform well (e.g., Ward & Simner, 2003).

While the consistency of responses has been used to distinguish synaesthetes from controls, little is known about the longevity of reports outside the practical constraints of laboratory testing (i.e., beyond the usual time-frame of the average experiment), and there has been little discussion of the roots of this synaesthetic 'superior recall'. In anecdotal accounts, synaesthetes report that their experiences remain unchanged for as long as they can remember, although pragmatic constraints in testing mean that these first-hand accounts have very rarely been objectively verified. Although empirical studies have shown consistency over months (e.g., Ward & Simner, 2003) and sometimes several years (e.g., Mills et al., 2002; Simner et al., 2006) the longest unbroken period of consistency reported for an active case of synaesthesia in the contemporary peer-reviewed literature (i.e., excluding instances where associations have been repeatedly elicited in experimental settings during a given period) is 2:10 years for grapheme–colour synaesthesia (Mills et al., 2002), and 3:1 years for lexical–gustatory synaesthesia (JIW; from Simner and Ward, 2006). For one earlier synaesthete with the grapheme–colour variant, however (Hollingworth & Weischer, 1939) consistency was reported across an unbroken period of 10:1 years, although the consistency measure in this historical work represents an account of self-report, in that the synaesthete was also the experimenter/author. Finally, a case reported by Devereux (1966) demonstrates the retest of a name–posture synaesthete (who experienced a compulsion to generate bodily movements in response to proper names) across 25 years. However, this participant's synaesthesia had died out over time, and was extinct by the occasion of the retest session. As such, his 'retest reports' were simply the memory recall of his earlier experiences. Furthermore, many of these experiences were highly analogical in nature (e.g., the name of his barber, *Sostarics*, was associated with the motion of using hair-clippers) which may have given him a mnemonic advantage in recall. Here we present objective evidence of enduring ('active') synaesthetic consistency

lasting into three decades, and use this longevity to distinguish between two possible sources for synaesthetes' superior consistency.

We consider two possible accounts of how synaesthetic word–taste associations might be generated. First, inducer-concurrent relationships might involve token-recall from episodic memory, in that synaesthetes experience their associations by explicit recall of specific occasions when inducer-concurrent pairings were first established; they recall the event and this in turn activates recall of other aspects of that event allowing a re-experiencing, or ecphory (Tulving, 1983) of the original word–taste association. Alternatively, inducer-concurrent pairings might represent something closer to a semantic association that might have arisen from development of concepts linked with specific linguistic tokens (e.g., Medin, Lynch & Solomon, 2000). In this case, there would be no explicit recall of an event when presented with the inducer, but there would be largely automatic cueing of the concurrent. We test these alternative views by showing that synaesthetic associations endure well beyond the time limits of episodic retrieval that is typically found for large numbers of paired-associates in healthy adults. We will demonstrate remarkable synaesthetic consistency spanning almost 30 years, and use this longevity to suggest that explicit retrieval of episodes is unlikely to lie at the heart of synaesthetes' performances. In other words, the longevity and range of synaesthetes' reports speak to the roots of their associations, simply because they would be difficult to explain on the basis of episodic recall of paired associates in individuals with otherwise normal memory ability.

Case description

JIW is a 46-year-old right-handed male of 'bright/normal' intelligence (Ward & Simner, 2003) who experiences lexical–gustatory synaesthesia. For example, for JIW the word *this* tastes of bread soaked in tomato soup, while the name *Philip* tastes of unripe oranges (Ward & Simner, 2003). Tastes are perceived in response to approximately 56% of words from JIW's own speech, the speech of others, inner speech and reading, and tastes are subjectively located on the tongue and in the mouth (Ward et al., 2005). Certain synaesthetic flavour experiences can be particularly strong and persist for some time, often until the taste is overridden by another, and the intensity of the experience can make it difficult for JIW to read or concentrate during conversations. JIW also reports tinnitus but has no family history of any other neurological condition (Ward & Simner, 2003).

Ward and Simner (2003) first verified the consistency of JIW's reports over time by eliciting word–taste associations in one session, and again in a surprise retest 4 months later. JIW scored 96% accuracy, compared to 18% from control participants making analogous associations, and who were tested after only 2 weeks. JIW's retest data were subject to a strict coding strategy, such that his resultant 'errors' were in fact representative of alternative labellings of the same taste (e.g., Time 1: biscuit; Time 2: wafer). JIW's consistency was also tested for stimuli that do not elicit synaesthetic experiences (i.e., taste associations artificially generated for synaesthetically tasteless words) and in this test he was found to have a normal memory span, equivalent to that of controls. Researchers gave JIW the opportunity for maximal success, by forewarning him about the retest, instructing him to create easy-to-remember associations (e.g., *fair*=candy floss/cotton candy), retesting him after only 2 weeks, and giving him time to rehearse. Nonetheless, his consistency for these non-synaesthetic learned paired-associations was no different to control participants, and was significantly lower than his own score for synaesthetic associations over 4 months. The current study aims to extend this 4 month consistency to 27 years.

Experimental investigation

In four investigations, we assessed JIW's consistency in a retest of word–taste associations first elicited in the late 1970s. These associations (n = 38) were recorded in a notebook in 1979, by a third-party associate of JIW, who recovered the document and returned it to him in April 2006. JIW has considerable interest in the scientific study of his condition, especially relating to questions of his consistency over time, and has played a significant role in the advancement of knowledge within this field by serving as experimental participant in a number of contemporary studies (see Simner & Ward, 2006; Ward & Simner, 2003; Ward et al., 2005). JIW also has a prominent role in the education of others regarding synaesthesia, and has given considerable time to researching and disseminating accurate information about the condition. Given this interest, JIW passed the 1979 document to the authors of the current paper, who retested him without his reference to these past notes, and in four ways. These methods were designed to establish, beyond a reasonable doubt, that the word–taste associations elicited in 1979 have remained unchanged across the subsequent three decades into the 21st century.

Investigation 1. Retest across 27 years

JIW was given a questionnaire in 2006 containing all target words from the original 1979 list in a randomised order and was asked to write his associations, some 27 years after these were initially elicited. His score was

compared to a group of 10 controls (five males, five females; mean age = 42.0) who were given the same word-list and asked to generate analogous associations. Before beginning the task, controls were forewarned that they would be immediately retested as soon as they had generated the last of their word–taste pairings. They were instructed to make easily recallable associations, and were given as much time as they wanted to generate their list. In the immediate retest, their mean consistency, over a delay of approximately 10 s, was compared to that of JIW over 27 years. JIW scored 100% consistent and this score was significantly higher ($Z = 3.18$, $p < .02$) than the mean of controls (47.9%; $SD = 16.4$), notwithstanding the considerable difference in re-test intervals. Taken at face value, this finding suggests that JIW has a recall performance different to that achieved by the conscious, episodic retrieval of paired-associations by controls. However, JIW's data was also subjected to three additional tests, to rule out the possibility that he may have inadvertently glanced at his 1979 associations when these were returned to him in 2006, or that he might have committed to memory, with rehearsal, (no more than) 38 words in 1979.

Investigation 2. Retroactive retest across 23 years

In the event that JIW may have inadvertently seen/learned his list of 1979 associations when these were returned to him in 2006, we presented additional tests to verify his consistency. First, we sought each 1979 item from within a 2002 database ($n = 1195$) of JIW's word–taste associations, held jointly by the Universities of Edinburgh and Sussex (see, e.g., Ward & Simner, 2003). This database offered the opportunity to verify JIW's consistency from the 1979 list, with word–taste associations elicited some 4 years before the list came to light. The 2002 corpus contained 89.6% of target words ($n = 34$) from the 1979 list, and JIW's consistency across corpora was again 100%. Since the 2002 corpus was generated 4 years before the 1979 list was returned to JIW, it is not possible for him to have inspected this latter prior to producing the 2002 associations tested here.

Investigation 3. Pattern matching in the 1979 corpus

A third test of JIW's consistency arises from the fact that lexical–gustatory synaesthetes are known to exhibit non-random associations between combinations of phonemes and probabilistic synaesthetic tastes (see above). For JIW, for example, words containing the phonemes [k] are significantly likely to taste of either egg or Minstrels© (branded chocolate candy), although JIW himself has no explicit knowledge of this fact. As described above, the underlying linguistic system is highly complex and involves a number of fine-grained phonological properties (e.g., allophony, phonological feature clusters) while JIW himself has only average phonological awareness (Ward & Simner, 2003) and cannot verbalise the features of this system. We examined all word–taste combinations elicited in 1979 for which JIW's critical trigger phoneme has since been established (see Ward & Simner, 2003; Ward et al., 2005). This amounted to 74% of the 1979 target-list ($n = 28$), and each of these word–taste associations was scored according to whether the word contained the 'correct' probabilistic phonological component for its corresponding taste (e.g., *count* – Minstrels©; critical phoneme=/k/) or did not (e.g., *like* – yoghurt; critical phoneme=/g/). Seventy-nine percent contained the 'correct' critical phoneme, which was significantly higher than the 25% found in a randomised re-pairing of his words and tastes ($\chi^2(1)=16.1$, $p < .001$). This result suggests that the associations produced by JIW in 1979 are based on the same implicit, complex phonological system that has since been shown to underlie his synaesthesia (but of which JIW has no conscious knowledge).

Investigation 4. Random-selection of retest materials (from n = 1195)

Finally, in order to rule out the possibility that JIW assigned to memory (no more than) 38 word–taste associations in 1979, we retested him in 2006 on a series of randomly sampled words ($n = 50$) from the corpus of word–taste associations elicited in 2002. This corpus contained over a thousand word–taste pairings, and by randomly selecting a subset, we are able to estimate his memory for all 1195 tokens. His consistency from this corpus was again 100%, suggesting that his 27-year retest was unlikely to represent the conscious memorising of a small number of items.

Discussion

We have provided the first empirical evidence of retest consistency in word–taste associations across three decades, and provided four types of assessment to verify JIW's remarkable consistency over time. Both the initial test session and the retest 27 years later were conducted by third parties, and did not rely on anecdote or self-report. JIW was 100% consistent on three different measures of consistency: across 27 and 23 years for items elicited in 1979 (the latter test taken as a precaution in case the 27-year timeline had been compromised) and across 4 years from a far larger stimulus set ($n > 1000$), this latter measure to ensure that the longer reports had not arisen from the conscious memorising of a small number of items. Additionally, we illustrated that the

word–taste pairings attested in 1979 followed the same implicit rule system that was uncovered by research almost 25 years later (e.g., Ward & Simner, 2003).

There are three principle conclusions to be drawn from these findings. The first is that anecdotal accounts of long-term consistency might now be considered genuine, at least in as much as they are compatible with the instance that has been empirically verified here. Second, the type of long-term consistency of word–taste pairings illustrated here appears to fall well outside the usual constraints of normal explicit, episodic memory recall for unrehearsed materials. JIW performed in a way that was far superior to the normal performance of control participants in an immediate episodic memory task in the present study. Given the memory load in this result task, it is possible that control participants may even have regenerated associates to the cue words rather than attempting to recall their associations from earlier in the experiment. This result suggests that JIW's consistency does not arise simply because the cue words somehow artificially constrain the associates that might be generated in response or that the associates have some mnemonic value. Nor was JIW's performance the result of a generally superior memory ability. This fact was illustrated by Ward and Simner (2003) who showed that when JIW generates word–taste pairings by normal (associative/memory, but not synaesthetic) mechanisms (i.e., by free-associating tastes for words that do not elicit synaesthesia) he recalls those pairings with the same limited success as controls. At the same time, JIW significantly out-performs these controls with synaesthetic associations after 4 months (Ward & Simner, 2003), and the current paper extends this time period to 27 years. The sheer length of this extended time-frame counters the suggestion that synaesthetic consistency and explicit recall from episodic memory might arise from the same (whole or shared) mechanisms. The activation of these gustatory pathways does not appear to require mediation from conscious, effortful episodic retrieval, since this would preclude the extraordinary longevity of the consistent associations reported here. Instead, our evidence supports the alternative hypothesis, that inducer-concurrent pairings represent something closer to a semantic association that might have arisen from development of concepts linked with specific linguistic tokens (e.g., Medin et al., 2000).

If inducer-concurrent pairings do represent semantic associations from linguistic concept development, the phenomenon may be similar to the associations recently reported for all people between lexical items and other types of sensory information. For example, Bak, O'Donovan, Xuereb, Boniface, and Hodges (2001; also Bak et al., 2005) demonstrated that specific impairments of verb processing are linked with the motor control difficulties in patients with motor neurone disease. Post-mortem and genetic analyses indicated that the neural substrate underlying verb representation is connected to anterior cortical motor systems. Furthermore, in healthy adults, Hauk, Johnsrude, and Pulvermuller (2004) demonstrated that verbs such as *lick*, *pick* and *kick*, which denote actions of the tongue, finger and legs, respectively, may activate the corresponding sensory-motor cortices for those respective body parts. It seems then, that across all individuals, words with sensory connotations have been shown to involve areas implicated in the very *sensation* of those experiences. It has thus been argued previously that lexical items with taste connotations (e.g., food names) may also activate corresponding sensory regions (i.e., in the gustatory cortex), and that the perceptual experiences of word–taste synaesthetes might be an extreme manifestation of this sensory association (Simner & Ward, 2006). Support for this proposal comes from findings that synaesthetes' associations appear to cluster around food names (e.g., Simner & Haywood, under review; Ward & Simner, 2005) and that non-synaesthetes, too, show gustatory cortical activation when merely thinking about tastes (Levy, Henkin, Lin, Finley, & Schellinger, 1999). Other variants of synaesthesia, too, have been shown to operate from mechanisms shared by all people (e.g., sound–colour synaesthetes as well as non-synaesthetes tend to pair higher sounds with lighter colours) and as such, synaesthetes and non-synaesthetes appear to lie on a continuum of cross-modal experiences. Hence, although cognitive-sensory associations are not experienced *perceptually* in the most healthy adults (i.e., people do not feel sensations in their fingers when they read *pick*, or experience taste when they read *banana*) it is possible that synaesthesia might represent the extreme manifestation of such associations. The fact that JIW (and other types of synaesthetes) report sensations similar to veridical sensory experiences (and show activation in the related sensory cortices; e.g., Nunn et al., 2002; also David Parslow, unpublished data) provides an indication that these experiences are indeed perceptual, as do studies showing that synaesthetic percepts (e.g., coloured photisms) act like, and interact with, veridical percepts (e.g., Ramachandran & Hubbard, 2001b; Smilek, Dixon, Cudahy, & Merikle, 2001). By showing here that synaesthetic word–taste associations are less like episodic memories, and more like the semantic memories of the type involved in concept formation for words, we draw a parallel between the implicit, word-triggered sensory activation occurring in all people, and the explicit (i.e., overtly experienced) word-triggered sensory activation in synaesthetes.

We point out that a non-synaesthete might attempt to replicate the performance of a lexical–gustatory synaesthete by continued rehearsal of the (many thousands of) word–taste associations experienced by JIW. Indeed studies by Ericsson and colleagues (e.g., Ericsson &

Kintsch, 1995; see also Logie, Wright, & Decker, 1992) have shown how healthy adults can acquire superior memory skills within domains in which they have acquired significant expertise through extensive practice and experience. However, JIW, and the other ≈500 synaesthetes who have completed our synaesthesia questionnaire (see Ward & Simner, 2003), report that the origins of their synaesthesia are unknown to them, and were not achieved by rehearsal. Moreover, studies have shown qualitatively different patterns of neuronal activity from non-synaesthetes with highly rehearsed (i.e., over many years) cross-modal associations compared to the associations of synaesthetes (Elias, Saucier, Hardie, & Sarty, 2003). Both lines of evidence support our claims that synaesthesia is the result of something other than consciously-learned or over-rehearsed paired associations. Additionally, Hochel et al. (2007) and Ramachandran and Hubbard (2001a) have reported colour-anomalous synaesthetes (with limited abilities in discriminating reds and greens, or blues and purples) who see colours that they cannot experience in the real world. Furthermore, Gray et al. (2002; also Gray et al., 2006) describe the *Alien Color Effect* in which some synaesthetes experience synaesthetic colours that conflict with real-world lexical semantics (e.g., the word *red* is synaesthetically green). Both these phenomena represent instances where it is unlikely, or even impossible, for the synaesthete to have encountered like-stimuli in everyday life, suggesting that synaesthesia does not arise from superior explicit recall of learned associations[1].

In discussing our data, we note a recent finding that suggests a surprising longevity for implicit memory recall in the normal population. Mitchell (2006) demonstrated high levels of fragment-completion performance in non-synaesthetes based on pictures that had been viewed in an experiment more than 17 years earlier. This memory performance is highly unlikely to be the result of explicit recall of the original event during which the pictures were presented; many of the participants could not recall anything about their participation in that original experiment. It is more likely that these are judgements of familiarity without explicit recall of the original source. Ward (under review) refers to this as an implicit memory mechanism, which he suggests might play a role in synaesthetic consistency. The current study is compatible with this theory (since it argues only against the role of effortful, explicit, episodic memory) although it would be an open question whether synaesthesia does indeed involve this type of implicit activation of semantic knowledge, given that the resultant phenomenology is so notably different to that demonstrated by Mitchell (2003), and that synaesthesia is more akin to cued recall than to recognition or familiarity judgements. Specifically, long-term perceptual (taste) information is 'recalled' in synaesthesia not when cued by associated perceptual information in the environment (as in implicit memory tasks; Mitchell, 2006) but from a qualitatively different type of stimulus, namely words. Furthermore, the output from synaesthetic 'recall' enters conscious awareness (since synaesthetes are able to report their associations), unlike the implicit memory performance demonstrated by Mitchell (2006). Finally, the fact that these are cognitive triggers (see Simner & Ward, 2006) suggests that synaesthetic experiences might yet be separate from implicit memory as studied in the literature on non synaesthetic adults because this latter is known to be reduced for cognitive versus perceptual triggers (Roediger & Geraci, 2005).

A third conclusion drawn from our study is that the lexical-sensory pathways that we have assumed underlie synaesthesia are not easily removed once formed, at least in some individuals. Very little has been written about the strength and longevity of synaesthesia over considerable time intervals, although the findings here suggest a robust hard-wiring of associations that are fixed during childhood (necessarily after language acquisition) and which can endure through a notable portion of the average lifespan. Although we have shown that these pathways are long-lasting in certain individuals, they may yet be susceptible to modification in others. The synaesthete reported by Devereux (1966) had synaesthetic sensations in adolescence that subsequently died out, and in anecdotal accounts, too, other adults have reported synaesthesia in childhood that diminished in later life. It appears then that longevity of associations is not a universal feature of all synaesthetic accounts, although current research has yet to address this aspect of the synaesthetic experience.

Although we suggest here that superior consistency over long periods does not result from explicit memory recall, there are instances in which synaesthesia can have a positive consequence for such explicit memory. Smilek et al. (2002) describe case C, a digit–colour synaesthete, who shows enhanced recall over 48 h for matrices of achromatic digits, compared to control participants, although only average performance for stimuli that do not trigger synaesthesia (abstract shapes). Similar findings have been presented in Mills et al. (2006) and in Yaro and Ward (2007), and these researchers suggest that the synaesthesia might allow for more robust memory traces because it provides an additional dimension (colour) to encode the verbal stimuli (e.g., Mills et al., 2006). Moreover, the (grapheme–colour/word–colour) participants of Yaro and Ward (2007) also showed superior performance in remembering colours per se. Given this, JIW may show not only high consistency for word–taste

[1]We thank Edward M. Hubbard for bringing this argument to our atttention.

associations, and potentially superior recall for 'tasty words', but he might even show enhanced abilities in taste recall, and these questions are currently under investigation in our lab.

In summary, we have illustrated remarkable synaesthetic consistency in word–taste associations, which was first elicited in the 1970s, and subsequently remained throughout the 1980s, 1990s and into the 21st century. The opportunity for a prolonged empirical retest period is extremely rare, and arose here only by the fortuitous convergence of circumstances in the current study. We have used this opportunity to illustrate the marked difference between synaesthetic 'recall' from what appears to be semantic memory, and the types of abilities attainable from the mediation of explicit episodic memory, thereby pointing to the likely roots of the superior and unusual patterns of associations demonstrated by synaesthetes.

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