
REVIEW

Odour-evoked Autobiographical Memories: Psychological Investigations of Proustian Phenomena

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Abstract

Folk wisdom dictates that odours are especially powerful reminders of autobiographical experience, an effect which has become known as the Proust phenomenon. This paper reviews the relevant literature to determine whether there is any substantive evidence to support this view. Different methodologies have been adopted in addressing this issue, but the most revealing and ecologically valid have been the few studies which have examined naturally formed autobiographical memories. From these data, there is at least preliminary evidence that olfactory stimuli can cue autobiographical memories more effectively than cues from other sensory modalities. Explanations for these effects can be invoked from accepted principles in contemporary cognitive psychology.

Introduction

Interest in psychology and olfaction grows annually. Traditionally, research on vision and audition has tended to dominate the behavioural sciences. Nevertheless, while research concentrating on these sensory modalities continues, attention is now being directed towards the olfactory modality and particularly to the psychological effects of this sense. This impetus has been fuelled both by the growing public interest in olfaction in general and by its potential as a relatively untapped area of scientific investigation in comparison to other sensory modalities. The psychology of olfaction, or aroma-chology as it has become known, has involved several different foci, including topics as wide ranging as effects of odour on specific behaviours (e.g. interpersonal and consumer behaviour), the ability of odours to affect emotional and physiological changes (e.g. changes in mood state, electrical brain activity) and the influences of odour manipulation on cognitive abilities (e.g. memory, task performance) (Van Toller and Dodd, 1988, 1992).

Interest in olfaction and memory in particular has been stimulated by folk wisdom concerning the power of odours to vividly remind one of particular past experiences. One often-quoted example is a literary anecdote from Proust (1922/1960) in which the author is vividly reminded of childhood experiences by the smell of a tea-soaked pastry:

And soon, mechanically, weary after a dull day with the prospect of a depressing morrow, I raised to my lips a spoonful of the tea in which I had soaked a morsel of the cake. No sooner had the warm liquid, and the crumbs with it, touched my palate than a shudder ran through my whole body, and I stopped, intent upon the extraordinary changes that were taking place. . . . I was conscious that it was connected with the taste of tea and cake, but that it infinitely transcended those savours, could not, indeed, be of the same nature as theirs. (p. 58)

Proust's experiences formed the basis of what has become known as the Proust phenomenon, the ability of odours spontaneously to cue autobiographical memories which are highly vivid, affectively toned and very old. However, such experiences are not merely limited to the realms of artistic licence—many individuals report similar experiences with odours, although few could describe their experiences as poetically and articulately as Proust. The largest-scale smell survey to date, the *National Geographic* survey (Gilbert and Wysocki, 1987), gave readers a set of six odours on scratch-and-sniff cards. From a sample of 26 200 respondents (taken randomly from over 1.5 million responses), ~55% of respondents in their 20s reported at least one vivid memory cued by one of the six odours and this fell to just over 30%

of respondents in their 80s, remarkable proportions with such a small number of odours.

Approaches to the study of odour-cued memories

The approaches which have been taken in the study of odour-cued memories fall into two categories: those which apply rigorous experimental control throughout all aspects of the study and those which instead approach the study from a more ecological standpoint. Examples of the former (Cann and Ross, 1989; Parker and Gellatly, 1997) could be described more accurately as studies in odour-cued context-dependent memory, rather than autobiographical memory. Context-dependent memory is the well-known memory effect whereby retrieving information in the same environment in which it was encoded leads to better memory performance than encoding and retrieving in different contexts (Smith, 1979, 1984; Eich, 1985). Studies have commonly used manipulations of physical context, presenting a wordlist for incidental learning in one room for example, and giving a surprise recall test either in the same or in a different room. Investigators such as Schab (Schab, 1990) have advanced these lines of enquiry using ambient odour as a context, demonstrating that reinstating at test the same odour as that present at study, does appear to improve performance over conditions where the ambient odour is not reinstated at test. Schab's findings are supported by those of several other investigators (Cann and Ross, 1989; Smith *et al.*, 1992; Herz, 1997a,b; Parker and Gellatly, 1997), who found that ambient odours do indeed function effectively as environmental contexts in context-dependent memory studies. Further, Herz (Herz, 1997b) showed that more distinctive odours yielded greater context effects by manipulating odours which were appropriate or inappropriate to the situation. Her results suggested that odours which were out of place in the experiment situation were associated with the best memory performance when reinstated at retrieval.

The implications of these findings—that ambient odours at the time of an event can be encoded along with event details and subsequently be used as cues in the retrieval of those event details—are encouraging to autobiographical memory researchers who seek to investigate the effects of odour on memory retrieval. Clearly, these studies show that ambient odours can function effectively as memory retrieval cues. Nevertheless, the kinds of memories which are commonly reported in relation to Proustian phenomena are those which are especially old, vivid and emotional. Thus, in terms of methodology, there are some critical differences between these odour-context studies and the Proustian phenomena which are the target of our investigations. Primarily, the age of the experiences is limited to the delay between study and test (which, commonly, is only a few minutes). In addition, the target event is predetermined by

the investigators, rather than allowing the subjects freely to select an autobiographical episode which comes to mind in response to an odour. Further, subjects' attention is not always drawn to the presence of the odour during the retrieval phase of the study. Subjects in odour-context experiments are sometimes not aware that the ambient odour is present, whereas most examples of Proustian recall involve an awareness of the odour and, moreover, that it is the odour which cues the retrieval of the prior experience. Thus, while these studies make a substantial contribution to the literature on odour and memory, they do not address the crux of Proustian phenomena. In fairness, the odour-context studies mentioned here were not specifically designed to test Proustian hypotheses concerning odour and memory retrieval. Rather, their aim was to highlight the effectiveness of ambient odours as environmental context cues. For empirical substantiation of the Proust phenomenon, however, we must seek other paradigms which more closely match a Proustian situation.

A different approach has been to use a standard paired-associate learning paradigm, where odours and other stimuli are associated with target information and, later, the efficacy of each cue type is compared in a cued recall test. Herz and Cupchik (Herz and Cupchik, 1995) asked subjects to associate emotional paintings with odours or odour labels. When subjects were later presented with the odours or words and asked to describe the painting with which each had been associated, the recollections of paintings cued by odours were found to be more emotionally toned than those cued by words. This type of methodology successfully circumvents criticisms concerning subjects' awareness of odour as a cue; here, subjects actively use odour as an aid to retrieval of a previous experience. However, another problem arises from this method of study, namely the active association of target experiences. Autobiographical memories are usually formed through a passive encoding process; that is, individuals do not actively try to associate central details of an event with more peripheral aspects of the experience while the event occurs. Rather, separate experiential aspects of an episode become associated without any purposeful effort on the part of the subject. The paired-associate learning paradigm described above requires active association of two stimuli by the subject and, compared to naturally acquired autobiographical memories, there are likely to be important differences in fundamental processes recruited during encoding and the nature of the resulting mnemonic representation. Thus, while the paired-associate learning paradigm can shed some light on the power of odours as associative cues, it cannot be relied upon to illuminate the mechanisms underlying Proustian phenomena.

Studies of 'true' autobiographical memories

If Proustian phenomena essentially involve naturalistically formed autobiographical memories, then any study which

aims to investigate these phenomena must, by definition, study these types of memories. Historically, autobiographical memory has been a difficult area of psychological investigation, owing to the many problems which arise in terms of traditional quantitative measurement and the application of close experimental control. It is not surprising, then, that when one looks for literature which directly examines Proustian phenomena, only a few studies emerge. However, those which have been carried out have utilized ingeniously simple designs which are, none the less, effective in clarifying the area.

The first published study examining memories of this type was published by Laird (Laird, 1935), writing about the work of a colleague in his laboratory, H.B. Fitzgerald, who had carried out a survey of odours 'as revivers of memories and provokers of thoughts in 254 living men and women of eminence' (p.126). Laird wrote lyrically about the 'paralyzing . . . power' and 'organic reverberation' (p.129) of odour-cued memories. More than four out of five of all the people surveyed reported olfactory-cued memory experiences. Qualitatively, the kinds of memories that Laird reports seem to be vivid, emotional and old. Seventy-six per cent of women and 46.8% of men claimed that odour-cued memories were amongst their most vivid, while only 7% of women and 16% of men claimed that these memories were hedonically neutral. While the average age of subjects at the time of the survey was 52.5 years, the average age of the subjects at the time of their earliest odour-cued memory was 16.5 years.

While Laird's report is interesting in terms of describing the kinds of memories which are retrieved in response to olfactory cues, it makes no progress in illuminating the possibilities which arose from Proust's writings; that is, whether odours are especially potent reminders of autobiographical episodes. Laird's report details a survey of individuals rather than describing any empirical data which were collected to examine this question. Several investigators have taken a more scientific approach and have carried out empirical studies in order to provide evidence supporting the widespread beliefs concerning odour and autobiographical recall. The usual methodology employed in these studies has simply been to collect data on the memories which are retrieved in response to odours and make direct comparisons with those retrieved in response to stimuli from other sensory modalities, a technique which we term the single-cue comparison method.

The first empirical study of this phenomenon was carried out by Rubin *et al.* (Rubin *et al.*, 1984), who drew comparisons between odour and label cues in their Experiment 1 and odour, photograph and label cues in their Experiment 2. In each, subjects were asked to describe a specific autobiographical memory which was brought to mind by each cue, to date the memory, and to rate each memory on vividness, pleasantness and the number of times that the episode had been thought of and spoken of prior to the

experiment. Results from both studies showed that odour-cued memories were thought of and spoken of with less frequency than those cued by other stimuli. Contrary to Proustian expectations, no differences in the age or vividness of memories were found between different cue-types and analyses of the pleasantness of memories yielded mixed and inconclusive results.

The age of the retrieved memories here was not found to be significantly different when odour and label cues were compared. This is a surprising finding given that one of the central beliefs surrounding Proustian phenomena is that retrieved episodes are usually more aged. However, the observed null effect may relate to the analytical methods employed by Rubin *et al.* They adopted two approaches. First, the age of memories was examined by directly comparing the odour and verbal cue conditions using an analysis-of-variance (ANOVA) technique, with memory age as the dependent variable. No significant difference between the conditions emerged. Second, Rubin *et al.* proceeded to transform the age of memories in each condition on log-hours-ago scales and plot them as power functions (Croviitz and Schiffman, 1974) with the finding that the curves plotted for each condition were similar. While both of these analyses are correct, they are not the most sensitive and informative analyses to use when attempting to discern differences in memory age between conditions. Rubin *et al.* do not report the means and standard deviations of memory ages for each condition, but the variation in age of memory within a condition can be expected to be large and, when using an ANOVA, this would undoubtedly serve to obscure statistically any subtle differences in mean age between conditions. Also, the use of logarithmic scales tends to obscure differences at the low end of the age range, precisely the range where one might expect to find differences in this study. Thus, subtle differences between ages of memories in different conditions cannot be highlighted using these statistical techniques. In order to show differences in the age of memories cued by different stimuli, a more sensitive method of analysis may be necessary.

We (S. Chu and J.J. Downes, submitted for publication) have recently addressed this question by examining the distribution of odour-cued autobiographical memories as a function of age. Specifically, we wished to know whether these are typically from younger periods of life than memories cued by other cue types, an hypothesis which follows directly from Proust. Subjects in their late 60s and early 70s were presented with olfactory or verbal cues and asked to relate an associated autobiographical experience which came to mind. When these were dated in terms of how old the subject was at the time and plotted as a distribution of autobiographical memories across the lifespan, clear differences were found between odour- and verbal-cue conditions. While the peak in memories for the verbal-cue group came in the period when subjects were between the ages of 11 and 25—a standard finding known as the 'reminiscence

bump' (Rubin *et al.*, 1986)—the peak for the odour-cued group came between the ages of 6 and 10, demonstrating that odour-cued memories are older than verbally cued autobiographical episodes.

The focus of another (Herz and Cupchik, 1992) investigation was to formulate a characterization of odour-evoked memories rather than to compare the efficacy of different cue-types. As such, their investigation did not utilize the single-cue comparison method and only used odour conditions. Their study involved two odour groups which differed in the orienting instructions they were given. Subjects were asked to rate each of 20 odours from either a subjective (emotional) or objective (analytical) orienting set. There were five rating scales (pleasantness, familiarity, intensity, arousal, degree of interest) and subjects were also asked to name each odour and indicate whether each odour evoked a personal memory. When a memory was evoked, subjects were asked to describe this briefly and rate it on each of five ratings scales (emotionality, clarity, specificity, rarity, age). Herz and Cupchik's results characterize odour-evoked memories as highly emotional, vivid, specific, rare and relatively old. However, the absence of comparison data related to other cue-types means that Proustian hypotheses cannot be evaluated. Odour-cued memories may well be vivid, for example, but the critical question is: are odour-cued memories more vivid than verbal- or visual-cued ones?

These considerations aside, there are several points arising from Herz and Cupchik's data which are worth highlighting because they support common beliefs concerning Proustian phenomena. Specifically, memories of this type are emotional, vivid and old. A majority of the memories (60.4%) were rated as highly emotional (either positively or negatively) and half of them (50.9%) were rated as 'very clear' (rating of six or seven on the seven-point ratings scale) while only 14% were rated as 'very vague' (point 1/2 on the scale). Concerning the age of memories, 27% fell within the past 12 months (an expected recency effect), but of the remainder of memories which fell into a specific time period, the largest proportion (25.6%) fell in the earliest category, 'early childhood'.

More recently, Aggleton and Waskett (Aggleton and Waskett, 1999) provided an excellent demonstration of the potency of olfactory cues. The focus of their experiment was a Viking museum (York) in which unusual odours were used to enhance the impact of the museum displays. Aggleton and Waskett wondered if presenting these Viking odours to individuals who had visited the museum a number of years ago would allow them to remember more about the museum displays than individuals presented with non-Viking odours or a no-odour control group. To test this proposal, questionnaires were given which asked about the content of the museum displays. As the average time since the last visit to the museum was 6.7 years, the design of the study needed to take account of the expected large variability in subjects' memory for the displays [a problem similar to that

encountered by Rubin *et al.* (Rubin *et al.*, 1984) discussed earlier]. Directly comparing memory performance using different single cues (the single-cue comparison method) would result in large within-group variation in memory performance; when statistically comparing results, large within-group variance might obscure statistical differences between groups and Aggleton and Waskett therefore decided to run a within-subject comparison in addition to the between-subject analysis. This methodology bears close resemblance to Tulving and Bower's (Tulving and Bower, 1974) reduction method, which was developed to examine the relative effects of two different retrieval cues by comparing the effectiveness of each when presented before and after the other. In Aggleton and Waskett's study, memory was tested in two phases across three groups of subjects. Two of these groups were presented with odours at each phase, whereas a third control group was instructed to remember in the absence of any sensory cues. The odours used were either Viking or non-Viking, and the two groups differed merely in the sequence in which the odours were presented

Results showed that, after the first odour presentation, the mean memory performance for those receiving the Viking odour was numerically higher than for those receiving the non-Viking odour and the no-odour control group, but the difference failed to reach statistical significance (due to the expected large variation in performance). Memory scores from the second phase, however, showed that the group receiving the Viking odour was the only group to increase memory performance significantly. The other groups accrued little or no benefit from their second cue.

This type of design comes close to a fully ecologically valid approach to the study of Proustian phenomena. Naturally occurring experiences are used and the association between experience and ambient odour is passively formed. The clear-cut results strongly support the notion that odours are effective reminders of autobiographical experience, but while the Aggleton and Waskett study shows the importance of congruent over incongruent olfactory cues, this study still lacks the crucial comparison with cues from other modalities. The heart of the question concerning the Proustian phenomenon does not merely concern whether odours are effective cues, but whether or not odours are more effective than verbal or visual cues, or cues from other sensory modalities. As we go on to show, other recent studies have addressed the issues of ecological validity and multiple cue comparisons with success.

Our own approach to the investigation of Proustian phenomena involves translating the essence of Proust's anecdotal literary descriptions into testable scientific hypotheses using the language of contemporary cognitive psychology. With this solid theoretical base, we were able to propose several alternative hypotheses to explain Proustian phenomena (S. Chu and J.J. Downes, submitted

for publication). The hypothesis which represented the folk wisdom view of the Proustian phenomenon most accurately was referred to as the ‘differential cue affordance value’ hypothesis. According to this interpretation, cues from different sensory modalities vary in terms of cue affordance value, or the efficiency with which they access autobiographical memory event details, and olfactory cues are assumed to have a higher cue affordance value than other cue types. There is a strong alternative hypothesis however, which we have referred to as the ‘differential encoding bias’ hypothesis. In contrast to the first hypothesis, cues do not differ in terms of their efficacy in retrieving event details, but in terms of the types of event with which they become associated and consolidated in memory. Olfactory details may become associated only with more complex (emotional, personal, unusual) autobiographical episodes and it follows, therefore, that the presentation of an olfactory cue will bias retrieval towards these more complex autobiographical episodes.

In testing these hypotheses, we use a double-cueing methodology similar to that employed by Aggleton and Waskett (Aggleton and Waskett, 1999) and described earlier. Subjects were initially given verbal cues corresponding to the names of an odorous object, and asked to describe the first autobiographical event of which they were reminded. Subsequently, subjects were given a second cue—either the corresponding odour, a picture of the odour source, an unrelated odour or the original verbal label—and encouraged to retrieve any further details. The efficacy of each cue type is determined simply by comparing the change in memory performance from the first to the second cue. Using this methodology, we have shown that subjects in the congruent odour condition exhibited greater changes in affective ratings of their memories after the second cue than in any other condition (S. Chu and J.J. Downes, submitted for publication). In a second experiment, it was also shown that significantly more discrete details about the original autobiographical episode emerged in the congruent odour condition. Because the differential encoding bias hypothesis can only relate to autobiographical memories which are cued directly by olfactory stimuli, the double-cueing methodology here effectively negates this as an explanation for these effects. Thus, we present data in strong support of the differential cue affordance value hypothesis.

What factors underlie Proustian effects?

If Proustian retrieval is simply that olfactory cues are effective reminders of autobiographical experiences, then popular concepts in cognitive psychology, such as encoding specificity (Tulving and Thomson, 1973), can be invoked to explain such phenomena. Indeed, this has been a common practise amongst researchers interested in these effects (Aggleton and Waskett, 1999). At a basic level, this principle proposes that consolidated memory traces include

not only target information, but also salient contextual features in the immediate environment in which the episode was experienced. The later presentation of such contextual features (which includes odour) can therefore act as retrieval cues for related details which comprise the original episode. However, if the proposition in question is that olfactory cues are superior autobiographical memory cues, then encoding specificity alone is insufficient as an explanatory concept because, according to this principle, all cue types would function in the same manner and with equal effectiveness.

Another frequently proposed explanation for Proustian phenomena is based on neuroanatomical considerations. Thus, it is known that the process of olfaction is mediated by a number of anatomical structures which are also heavily implicated in memory and emotion. The olfactory bulb, for example, projects to a number of structures, including the amygdala, hippocampus and thalamus (Nieuwenhuys *et al.*, 1988; Dodd and Castellucci, 1991), structures which have been shown to be involved in memory function and the modulation of emotions. While it can be dangerous to infer function purely on the basis of structural relationships, there are strong supporting grounds for proposing a link between olfaction and memory. Studies suggest that memory for odour is very persistent [for reviews, see (Herz and Engen, 1996) and (White, 1998)]. While tests of immediate recognition memory for odours can produce numerous errors—typical recognition performance is ~70% correct, compared with almost 100% for short-term visual recognition—studies of longer term memory show that very little olfactory information is subsequently forgotten. Engen and Ross (Engen and Ross, 1973), for example, tested up to a year after acquisition of the odour, finding no significant decrease in odour recognition performance. Recognition performance for visual stimuli can fall to chance levels after such a long retention period. Results such as this have prompted some researchers to propose the existence of a separate olfactory memory system (Annett and Leslie, 1996; Herz and Engen, 1996). Leaving aside the precise mechanism underlying the longevity of odours in memory, the fact that odours can persist when memory traces from other types of stimuli degrade implies that the olfactory components of autobiographical memories may be longer lasting than other facets of the same experience. If the olfactory components of autobiographical experiences are more enduring, it follows that they are more likely to serve as effective retrieval cues. This is especially true in the case of more aged memories, where it is possible that the non-olfactory components of the memory trace for an autobiographical experience may have decayed to the point of being ineffectual as retrieval cues, but are still strong enough to be retrieved when cued by other facets of the same autobiographical experience.

Proustian effects may also be linked to the ability of odours to elicit affective reactions. Hinton and Henley

(Hinton and Henley, 1993) found that when they compared reactions to stimuli presented in visual, lexical and olfactory modalities, odours elicited by far the most affective reactions. Several researchers (Herz, 1997b; Aggleton and Waskett, 1999) have attributed the efficacy of odours in memory retrieval, at least in part, to the accepted link between emotional arousal and the information associated with such affective reactions (Cahill and McGaugh, 1996; Guy and Cahill, 1999). This link is likely to be mediated by the action of the amygdala (Cahill *et al.*, 1995, 1996) which is involved in olfaction, memory and emotion. It is probable that stimuli which are affectively arousing may be especially effective retrieval cues and, all things being equal, olfaction is widely believed to be the most affectively arousing of all the sensory modalities. The range of empirical studies examining Proustian phenomena are limited, but the more ecologically valid studies would appear to have the most to say about the true nature of odour-evoked autobiographical memories. While the precise nature of the mechanisms underlying this phenomenon have yet to emerge, it is likely that accepted principles in cognitive psychology, such as encoding specificity and the link between memory and affect, play a part.

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