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Research report

Selecting food. The contribution of memory, liking, and action ☆

Valentina Parma [a,*], Umberto Castiello [a], Egon Peter Köster [b], Jos Mojet [c]

[a] Department of General Psychology, University of Padova, Padova, Italy
[b] Psychology Department, Helmholtz Institute, Utrecht University, Utrecht, The Netherlands
[c] Wageningen-UR, Food and Bio-based Research, Wageningen, The Netherlands

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ABSTRACT

The goal of the present experiment was twofold: identifying similarities and differences between flavour memory and visual memory mechanisms and investigating whether kinematics could serve as an implicit measure for food selection. To test flavour and visual memory an 'implicit' paradigm to represent real-life situations in a controlled lab setting was implemented. A target, i.e., a piece of cake shaped like either an orange or a tangerine, covered with either orange- or a tangerine-flavoured icing, was provided to participants on Day 1. On Day 2, without prior notice, participants were requested to recognize the target amongst a set of distractors, characterized by various flavours (orange vs. tangerine) and/or sizes (orange-like vs. tangerine-like). Similarly, targets and distractors consisting of 2D figures varying in shape and size were used to assess visual memory. Reach-to-grasp kinematics towards the targets were recorded and analysed by means of digitalization techniques. Correlations between kinematic parameters, memory and liking for each food item were also calculated. Results concerned with memory recollection indices provided evidence of different key mechanisms which could be based either on novelty of flavour memory or visual memory, respectively. To a moderate extent, kinematics may serve as an implicit index of food selection processes.

Introduction

All living beings experience the necessity to elaborate and to organize sensory information in order to create a coherent representation of the external world. This representation, stored in one's memory, is then used to adaptively solve common environmental problems, such as programming and executing actions. It is, therefore, evident that perceptual, cognitive and motor processes are tightly linked to each other and all contribute to the explanation of complex daily behaviours. As an example, when eating a piece of cake, sensory features (mainly visual and chemosensory) firstly and crucially contribute to trigger the formation of a specific 'cake-experience' memory. Then, in conjunction with sensory specifications, broadly-tuned information concerning motivation – in the form of food preference and motoric aspects necessary to act upon the selected food – are also stored.

The aim of the present study was twofold. In the first instance, the link between sensory and cognitive information of food items was addressed. Specifically, we compared the mechanisms underlying visual memory and flavour memory. In the second instance, the experiment aimed at investigating whether hand kinematics, representing the motor component involved in complex daily behaviours, could serve as an implicit index to evaluate food selection. For the sake of clarity, the state of the art concerning the central issues of the present work, namely food, visual memory and motor-mediated food selection processes will be separately overviewed.

Although memory is involved in most every-day-life activities, we are not always aware that we are relying on it. Consider the example of buying a food item at a supermarket: when seeing the packaging and then eating the food, it is rare that one consciously decides to memorize either the food item or the visual appearance of the packaging (Issanchou, Valentin, Sulmont, Degel, & Köster, 2002). It is more likely that one acquires knowledge regarding both the food and the visual characteristics of the packaging without any particular attentional or learning effort. This information is stored implicitly and ready-to-use when

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* Corresponding author.
E-mail address: valentina.parma@unipd.it (V. Parma).

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appropriate (Castelhano & Henderson, 2005; Mojet & Köster, 2005). In this perspective, it might be assumed that food choice (and intake) is modulated to a certain extent by the food expectations based on previous experience. The same reasoning may also be applied to the visual domain. Indeed, as natural products of scene perception, visual items are able to produce visual representations that lead to the formation of expectations (Bressler, 2004).

In order to investigate flavour memory, an innovative implicit memory paradigm has been developed (Mojet & Köster, 2002) and recently used in a number of studies (Köster, Prescott, & Köster, 2004; Laureati et al., 2008; Mojet & Köster, 2005; Morin-Audebrand et al., 2009, 2012; Møller, Mojet, & Köster, 2007; Sulmont-Rossé, Møller, Issanchou, & Köster, 2008). Without any reference to memory, participants were presented with food targets during an ecologically valid situation (e.g., a meal). After a variable retention interval (from hours to a week) and without prior notice, participants were requested to recognize previously eaten targets amidst distractors, consisting of slightly varied versions of the targets formerly presented. Using this kind of recognition paradigm provided a number of advantages. First, the paradigm gives the possibility to study flavour memory within a natural context. Presenting food targets within a meal prevented participants from paying too much attention to food sensory properties, mimicking what usually happens in real-life situations. Second, distractors used later in the test were similar to the target in their basic features, while being just-noticeably different in some sensory aspects (Morin-Audebrand et al., 2012). They therefore belonged to the same product type as the target and in this way the possible influence of verbal memory in recognising them was excluded. Although the mechanisms underlying implicit flavour memory are still largely unexplored, knowledge regarding implicit visual memory is well documented. Research conducted in the mid-1990s described the features of the memory trace determined by a visual object. Evidence of long lasting (e.g. a month) and highly detailed representations of novel bi-dimensional shapes – uninfluenced by attention – was found (DeSchepper & Treisman, 1996). Similarly, complex 3D scene representations – closer to real-life experience – seemed to produce analogous evidence (Castelhano & Henderson, 2005). It was then suggested that implicit memory traces may reflect the same stored material as explicit memory traces, but could be retrieved by following different routes (Treisman & DeSchepper, 1996). This issue takes part in the classic debate on dual-process memory judgements supporting the existence of two mechanisms either based on recognition or familiarity (Rotello, Macmillan, & Reeder, 2004; Yonelinas, Dobbins, Szymanski, Dhaliwal, & King, 1996). Within the familiarity domain, a series of findings explained in the framework of the signal detection theory (SDT) supported the idea that implicit memory relies on the 'feeling of knowing' (Kelley & Jacoby, 1996). That is, participants were better able to recognize whether the presented object was the target instead of one of the distractors. Expressed in SDT terms, participants obtained a higher number of hits (saying 'yes' when the target was present) when compared to the number of correct rejections (saying 'no' when the target is absent).

In this respect, evidence from flavour memory studies has shown a reversed pattern of results (Morin-Audebrand et al., 2012). In incidentally learned food memories, distractors are most of the times correctly rejected while targets are poorly recognised (i.e. not better than chance guessing). In other words, participant's answers are better explained in terms of 'feeling of not knowing' rather than in terms of 'feeling of knowing'. Taken together, these results seem to suggest that flavour memory judgments are based on a novelty detection mechanism rather than guided by detailed representations of the target, as proposed for visual memory judgments (Morin-Audebrand et al., 2012; Rotello et al., 2004). However, to the best of our knowledge, no direct comparison between flavour memory and visual memory has been previously reported.

Assessing food-related behaviours from an integrated perspective calls for an involvement of the motor aspects characterizing the actions necessary to interact with food items. Previously-published research has shown that the "activation of the motivational systems initiates a cascade of sensory and motor processes, enhanced perceptual processing, and preparation for actions that have evolved to assist in selecting appropriate survival behaviours" (Bradley, 2009). Along these lines, a number of studies have focused on the oral movements performed when the food is already into the mouth, providing compelling evidence of their effect on sensory food perception (de Wijk, Engelen, & Prinz, 2003; de Wijk, Wulfert, & Prinz, 2006). Nevertheless, to analyse the cascade of motor processes activated by an appetitive attitude, it is worth considering a different approach. In this respect, the selection-for-action theory seems an appropriate theoretical framework (Allport, 1987). Allport (1987), considering the problem from a sensorimotor point of view, suggested that specific attentional mechanisms select the motor program needed to accurately act upon a particular object (i.e. the target) and simultaneously maintain at a lower threshold the motor programs for irrelevant objects (i.e. the distractors) which are present within the same reaching space. The classical example of the bowl of fruit might help to clarify this issue. When a bowl contains many different fruits, we can see and reach all of them. But only one fruit that motivates us – namely, our target – will guide our action. This means that the specific kinematic pattern to successfully grab the target will be pushed into operation (for review see Castiello, 1999).

Only recently research has provided evidence of specific chemosensory influence on the kinematics of visually-guided reach-to-grasp movement towards food targets (Castiello, Zucco, Parma, Ansuini, & Tirindelli, 2006; Parma, Ghirardello, Tirindelli, & Castiello, 2011; Tubaldi, Ansuini, Tirindelli, & Castiello, 2008). Specifically, facilitation effects were evident on hand kinematics when 'size' congruent odours or flavours preceded the presentation of the visual object to be grasped. Conversely, interference effects emerged on hand choreography when 'size' incongruent odours or flavours preceded the presentation of the visual to-be-grasped object. It is worth noting that both the facilitation and the interference effects reported in the above mentioned experiments were not voluntarily produced by the participants, who were not aware of the differences in their hand movements between conditions.

Given that the reach-to-grasp movement cannot be explicitly controlled in its parameterisation, it can be considered a movement implicitly reflecting appetitive intentions. To our knowledge, no previous studies have investigated whether the reach-to-grasp movement could serve as an implicit index of food selection. If this is the case, kinematic parameters would be correlated to the implicit flavour memory index and, possibly, to liking ratings. This would provide a new and reliable implicit index aimed at ascertaining consumer's attitudes towards food selection, while avoiding the risk of consumers' consciously-induced bias.

In summary, the aims of the present study concern the analysis of an example of food appetitive behaviour, considering both the sensory–cognitive relationships and the motor-mediated food selection process. Specifically the main questions become the following. What are the similarities and the differences between flavour memory and visual memory in the specific context of the features taken into consideration here? Is novelty a key concept in differentiating food recognition and visual recognition? Does food liking modulate flavour memory recognition? Does flavour memory recognition influence the motor control of the hand? Does food liking affect the motor control of the hand? Can kinematics serve as an implicit index in the food selection process? In the effort of answering these questions, we exposed participants to a