Turkish Psychological Articles, June 2023, *26*(51), 57-59 DOI: 10.31828/tpy1301996120230522m000056

Summary
The Role of Memory as a Top-Down Influence on the Haptic Perception

Fatma Kılıç[1]
Middle East Technical University

Dicle N. Dövencioğlu
Middle East Technical University

Haptic Perception

Haptic perception is the exploration of objects in the environment with the aid of tactual sense. The stereotypical hand movements, which are used while exploring the objects are called 'Exploratory Procedures (EPs)' and they vary depending on the object and the information that is to be extracted (Lederman & Klatzky, 1987). For instance, to measure the temperature of an object, people touch it statically or to understand how elastic an object is, individuals try to pull that object. Within this framework, the importance of haptic information should be emphasized because it shapes our interaction with the environment. Even a congenitally blind individual can interact with his environment, manipulate objects, or can have depth perception thanks to tactile information that he receives (see Eşref Armağan).

When we talk about tactile perception, it is important to make a distinction between active and passive exploration since tactile perception covers both exploration types. Passive touch is related with cutaneous sense and active touch is the active exploration of objects.

In tactile perception literature, there are studies with everyday materials (Bergman Tiest & Kappers, 2006; Cavdan et al., 2019, 2021; Dövencioğlu et al., 2022; Fleming et al., 2015; Hollins et al., 1993; Picard et al., 2003) as well as artificially produced 3-D materials and surfaces (Amedi et al., 2002; Millar, 1974, 1975; Heller, 1982; Metzger & Drewing, 2019, 2020). To use different types of materials yields the opportunity to observe the variety of exploratory procedures.

To conclude, the role of the information that we obtain through the tactile experience with objects needs to be studied and comprehended under theoretical and experimental grounds.

Tactile Memory

Tactile memory allows us to encode the information attributed to objects that is obtained by touching and actively interacting with the objects. Tactile memory plays a crucial role in our daily life, such as in the darkness of our bedroom it navigates us to our bed without seeing and without hitting something.

Tactile memory benefits from mechanoreceptors, open nerve endings, and proprioceptive receptors to obtain the information it needed (Gallace & Spence, 2009). These receptors help us to explore the micro geometric properties of materials, such as their surface, and macro geometric properties, such as materials' shape. In that review, we elaborated on both micro and macro geometric properties of materials.

The tactile memory studies focusing on passive tactile sense are present in the literature. The findings of these studies were contradictory in the sense that they contended different memory models. One assumed two different mechanisms to encode the tactile information, one is rapidly decaying with a subsidiary task (decay) and the second one is more durable in the long-term (Gilson & Baddeley,1969); and the other revealed only one mechanism decaying in time without the interference from a secondary task, but with the interference from internal cognitive set of individuals. (Sullivan & Turvey, 1975). Gallace et al. (2008) demonstrated that the decay of the information is related with the number of tactile stimulation and the task difficulty is not associated with the memory performance.

The nature of the encoded information and the relationship of tactile sensitivity with memory were also the focus of the investigation (whether it is verbal, visual, spatial etc.). The studies showed that tactile information might be representational and the more sensitive a body area is, the more durable the tactile information obtained by that body area.

Address for Correspondence: [1]Fatma Kılıç, Middle East Technical University, Faculty of Arts and Sciences, Department of Psychology, Çankaya / Ankara
E-mail: fatmakilic2396@gmail.com

Memory Studies with Surfaces and 3-D Objects

The studies concentrated on 2 dimensional surfaces, or 3 dimensional objects are much more valuable, because it is expected from them to reveal more about the nature of tactile memory. The rationale behind this notion is that in daily life we interact with these objects, not with artificial objects/surfaces or passive touch.

Millar (1975b) presented visually impaired children with a recall task consisting of Braille alphabet with sets of 2, 3, 4, 5, and 6 letters. The recall performance of the children was impaired for the letters that were phonologically similar rather than for the words that were similar in form. The recall span was impaired for tactually similar letters only when the recall span of the children in already limited before the experiment, which is an indicator of a tactile and short-term memory according to the author. Another study by Millar (1974) investigated tactile recognition of sighted and visually impaired children with attention demanding and modality-specific distractor task. She argued that the model suggested by Sullivan and Turvey was not supported by these results. Thus, she concluded that there should be a decay in the tactile information in a short period of time and attention-distractor tasks should have a long-term interference effect on this memory.

The effects of delay period between study and test phases, and interference on memory performance drew attention in the literature. Kiphart et al. (1988) showed that the tactile system is an expert system because no matter the delay period or distractor task the memory performances of the participants were high. The high performance might be due to the incomplexity of the chosen objects and their resemblance to the object that are used in daily life. Yet, authors stated that the objects that they created were abstract enough to use in this study. Thus, they contended another possible hypothesis which suggests that the expertise of the tactile memory could be due to its associations with more than one complex sensory systems.

The studies done with familiar objects focuses on people's ability to recognize and comprehend the material properties as well as the comparison between haptic and visual memories. The results were in line with the view that proposes a durable and detailed tactile memory (Hutmacher & Kuhbandner, 2018). What is more, the durability of tactile memory has resemblance with the visual memory in the case of recall span of elderly (Ferreira et al., 2019). However, another study carried out by Pensky et al. (2008) showed that the performance in the visual test and output was higher than the haptic test and output. Hence, although the decay in the haptic and visual memory depicted a similar pattern, visual memory is more durable than tactile memory.

Nevertheless, tactile memory, based on the abovementioned studies, can be seen as an expert system that can store tactile information for a long period of time and show similarities with visual memory in terms of storage capacities.

The Relationship of Experience with Tactile Memory

Top-down and bottom-up processing are two processes running in the brain. While the second one enables us to form a representation of the explored objects by combining and breaking down the received information, the first process allows us to apprehend the objects and their properties by aiding the previous experiences and stored information. Working together of these two systems helps brain to efficiently process information without spending too much energy and reaching more accurate conclusions (Friston, 2005, 2010; Friston et al., 2006; Kersten et al., 2004; Kersten & Yuille, 2003; Kveraga et al., 2007; Summerfield & de Lange, 2014; Urgen & Boyacı, 2019). Besides, the effect of stable and transient states (cognitive and affective states, individual differences, learning and conditioning, and voluntary and attentional control) affect the way we perceive the world and objects within (Scocchia et al., 2013).

The influence of top-down information on the perceived material properties has attracted the interest of researchers in the last few decades. Metzger and Drewing (2019) specifically focused on its influence on perceived softness and concluded that top-down information affects the received (bottom-up) information and shapes the information of material properties. Yet, it was suggested to be cautious because this effect could be limited. This influence also was studied with sighted and visually impaired individuals, and it was stated that the load on the memory resulted in less decrease in the memory performance of visually impaired participants because their experience with the world depends on tactile sense, therefore the interference of the prior knowledge they had about that object can be little.

Abdel Rahman and Sommer (2008) argued that the expertise on object recognition might be due to our comprehensive perceptual experiences and deep semantic knowledge. Subsequent studies on the effect of expectation on the exploration processes revealed that the information we had about object properties might be interfering with the bottom-up visual processing (Zoeller et al., 2019). These studies concluded that expectation (in other words, prior knowledge) has an impact on the perceived information by matching and shaping it with the existing knowledge. When there is a contradiction with the expectation the visual system updates its generative model to lower down the error.

Conclusion

When we interact with the environment and the objects in it, the information related to the objects and the environment is encoded in our memory. The brain strives to form a whole representation of the world by gathering all the sensory information coming from visual, auditory, and/or tactile channels. By using diverse methods to study tactile perception and memory, researchers try to understand the nature of this type of memory. Considering the studies gathered from the literature, it can be concluded that tactile memory has been receiving more attention recently. Even though some hypothesis seems to be explaining certain phenomena, there are lots of points that needs to be shed light. Especially regarding the nature of tactile memory, there are plenty of questions to be investigated.