

# Gender differences in memory for objects and their locations: A study on automatic versus controlled encoding and retrieval contexts

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## Abstract

Object–location memory is the only spatial task where female subjects have been shown to outperform males. This result is not consistent across all studies, and may be due to the combination of the multi-component structure of object location memory with the conditions under which different studies were done. Possible gender differences in object location memory and its component object identity memory were assessed in the present study. In order to disentangle these two components, an object location memory task (in which objects had to be relocated in daily environments), and a separate object identity recognition task were carried out. This study also focused on the conditions under which object locations were encoded and retrieved. Only half of the participants were aware of the fact that object locations had to be retrieved later on. Moreover, by applying the ‘process dissociation procedure’ to the object location memory assessments and the ‘remember-know’ paradigm to the object identity measure, the amount of explicit (conscious) and implicit (unconscious) retrieval was estimated for each component. In general, females performed better than males on the object location memory task. However, when controlled for object identity memory, females no longer outperformed males, whereas they did not obtain a higher general object identity memory score, nor did they have more explicit or implicit recollection of the object identities. These complicated effects might stem from a difference between males and females, in the way locations or associations between objects and locations are retrieved. In general, participants had more explicit (conscious) recollection than implicit (unconscious) recollection. No effect of encoding context was found, nor any interaction effect of gender, encoding and retrieval context.

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## 1. Introduction

Everyday we use, manipulate and navigate through space. Although these abilities seem to be equally important to all individuals, on most spatial tasks (e.g. mental rotation and way-finding) males tend to outperform females (for a review see: Coluccia & Louse, 2004; Voyer, Voyer, & Bryden, 1995). One of the few spatial abilities in which females have been shown to outperform males is object location memory, i.e. remembering where things are located in space. Eals and Silverman (1994); Silverman

(1992) found that females excel when asked to retrieve locations of object drawings as well as when retrieving objects from a more natural setting. Subsequent studies also demonstrated a female advantage in object location memory (James & Kimura, 1997; Levy, Astur, & Frick, 2005; McBurney, Gaulin, Devineni, & Adams, 1997; Rahman, Abrahams, & Jussab, 2005). Explanations for gender differences in spatial abilities are typically sought in human evolutionary history. Task divisions between our male and female ancestors (Eals & Silverman, 1994) as well as sexual selection pressures (Ecuyer-Dab & Robert, 2004) are considered to be important causes. Females would have resided close to their homes in order to protect and feed their offspring. Therefore there was a greater chance of personal survival as well as that of their offspring if they

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were talented in hiding resources and remembering food spots. In contrast for males, competition for mating as well as hunting may have led to the necessity to cover greater distances which resulted in better navigation.

Not all studies however have shown a female advantage in memorizing object locations. (Dabbs, Chang, Strong, & Milun, 1998; Epting & Overman, 1998; Postma, Izendoorn, & De Haan, 1998; Postma, Jager, Kessels, Koppeschaar, & Van Honk, 2004; Iachini, Sergi, Ruggiero, & Gnisci, 2005). These controversies are likely to have arisen from different task components that were assessed, and specific conditions under which information was encoded and retrieved. Postma et al. (2004) proposed that object location memory consists of three separate processes; object identity processing, remembering the locations and finally, binding objects to their locations. As such, object location memory is a complex multi-component process, and the various components might show different gender effects. Concerning memory conditions, it has been widely acknowledged that encoding of information as well as retrieval can be based on automatic (implicit) as well as controlled (explicit) processes. Importantly, it has been suggested that differences between men and women might critically depend on how information is encoded or retrieved. Hence, the aim of the present study was a systematic comparison of men and women on components of object location memory and the conditions under which object locations are encoded and retrieved from memory. Most importantly, whilst the majority of studies focused on a single aspect, in this study, multiple components of object location memory were investigated in relation to each other, and in relation to the conditions under which they were stored and retrieved.

One of the factors that defines to what extent we are able to retrieve information later on, is the amount of attention we pay to the information during encoding. It has been suggested that men and women differ in the amount of attention that is paid to objects in the environment, irrespective of the relevance of these objects. Eals and Silverman (1994) and McGivern et al. (1998) showed that females were better than males when recalling object locations under *incidental* conditions, i.e. when they were unaware of the subsequent retrieval phase, as well as under *intentional* conditions, where the requirement of subsequent retrieval was made explicit to the subject. An advantage in object location memory would enhance survival based on greater foraging success and offspring protection. These factors would therefore have selected for greater incidental memory and better global perception in females (Eals & Silverman, 1994; McGivern et al., 1998). Notice, incidental encoding of object locations is a very important aspect of our everyday life. We repeatedly have to use and retrace objects whose locations we did not consciously and deliberately encode.

A female advantage in more unconscious aspects of memory processing might also apply to *retrieval* of information (Anooshian & Seibert, 1996). The assumption that

recognition memory consists of two types of memory, *implicit* memory and *explicit* memory, is quite extensively supported by empirical findings (see for a review: Yonelinas, 2002). Explicit memory entails conscious, controlled recollection of learned information, while implicit memory is considered as more automatic and unconscious. Anooshian and Seibert (1996) found that females outperformed males in the implicit (unconscious) recollection of route-based visual scenes, but not in explicit (conscious) retrieval. Anooshian and Seibert (1996) attributed the female advantage in implicit retrieval to a greater tendency in women to rely on their intuition in making decisions, i.e. on quick and automatic processing of holistic properties. To the authors' knowledge, no study has specifically addressed possible gender differences in the way object locations are retrieved. Moreover, it would be interesting to investigate the relationship between the type of encoding context and the way object locations are retrieved. If females indeed show an advantage under incidental (unconscious) encoding, would this also involve greater implicit retrieval?

As well as the manner of encoding and retrieving information, the exact components being processed might form an important factor in the study of gender differences in object location memory. This is especially relevant since it has been shown that in general, females perform better at object identity memory tasks (Levy et al., 2005; McGivern et al., 1998). This is possibly linked to a left-hemisphere advantage in females for processing of categorical, easy-to-verbalize inputs (Chipman & Kimura, 1998) (see however: Eals & Silverman, 1994; Silverman, 1992; Alexander, Packard, & Peterson, 2002). Therefore, the observed superior object location memory in females could simply be related to a better memory for object identities. In the present study, with this in mind, we specifically assessed object identity memory and its role in remembering object locations.

A related possibility could be that, rather than differences in object identity memory, object location memory differences between men and women involve the process of *binding* an object to its location. James and Kimura (1997) suggested that females outperform males when location (spatial context) and identity of an object have to be integrated. They showed subjects an array with different objects of which subjects had to learn the identity and location. Subjects were then presented with an array in which half of the objects were in different positions; pairs of objects either exchanged locations or locations were shifted. Women showed better location memory performance only in the location exchange task. James and Kimura (1997) argued that in the location shift task, subjects could rely mainly on the information of filled and unfilled spaces since new locations were added. This way, object identity became less important. However, using the same paradigm, Levy et al. (2005) found a female advantage in the location shift condition as well as in the location exchange condition. This might have to do with slightly different task characteristics, like the dimensions of the array.

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