



Sex differences in the Kimchi-Palmer task revisited: Global reaction times, but not number of global choices differ between adult men and women

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HIGHLIGHTS

- Number of global choices did not differ between adult men and women.
- In women, global choices were slower than local choices.
- Responses to global choices were slightly faster in men, compared to women.
- Testosterone was positively related to the number of global choices.
- Positive and negative affect were both positively related to the number of global choices.

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ABSTRACT

Research, directly assessing sex-dependent differences in global versus local processing is sparse, but predominantly suggesting that men show a stronger global processing bias than women. Utilizing the Kimchi-Palmer task however, sex differences in the number of global choices can only be found in children, but not in adults. In the current study 52 men and 46 women completed a computerized version of the Kimchi Palmer task, in order to investigate whether sex-differences in global-local processing in the Kimchi-Palmer task are reflected in choice reaction times rather than choices per se. While no sex differences were found in the number of global choices, we found that especially women are faster in making local choices than men, while men are faster in making global choices than women. We did not find support for the assumption that this sex difference was modulated by menstrual cycle phase of women, since the difference between reaction times to global and local choices was consistent across the menstrual cycle of women. Accordingly there was no relationship between progesterone and global-local processing in the Kimchi-Palmer task. However, like in studies utilizing the Navon task, testosterone was positively related to the number of global choices in both men and women. To our knowledge, this is the first study including reaction times as outcome measure in a Kimchi Palmer paradigm and also the first study demonstrating sex differences in the Kimchi Palmer task in adults.

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1. Introduction

Most stimuli in everyday life are of a hierarchical nature, i.e. a global or higher order figure is composed of several local and more detailed features. People can either process scenes and stimuli in a global way, by attending to the figure as a whole or in a local way, by processing the details of a scene or the single parts of a figure.

Global and local visual processing has traditionally been assessed with a *Navon task* [1], in which participants are presented hierarchical stimuli. Large letters or shapes (global level) are composed of smaller letters or shapes (local level), which are evenly distributed in the larger letter or shape. Participants are asked to respond if they detect a target stimulus at the global or local level, respectively. Navon [1] demonstrated overall faster responses to the global, compared to the local level.

There are many factors influencing global-local processing in the Navon task, like the stimulus category (shapes or letters), stimulus properties or visual angle of presentation [2–6]. Research also indicates that mood and sex relate to global-local processing in a Navon task. Regarding mood, positive affect has been linked to a global processing bias, i.e. faster global responses, while negative affect has been linked to a

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local processing bias, i.e. faster local responses [7–11]. Regarding sex differences, increased global processing bias, i.e. faster responses to global targets were observed in men compared to women ([12–15], but see also [16]). Most recent results suggest that these sex differences are driven by opposite relationships of testosterone and progesterone to the global processing bias (i.e. faster responses to global stimuli) and may thus be restricted to the luteal cycle phase in women, when progesterone levels peak [14]. Interactive effects of sex and mood on global-local processing have however not been previously investigated, even though sex and menstrual cycle effects on mood have repeatedly been demonstrated [17–19].

Similar in stimulus architecture to the *Navon task* is the *Kimchi Palmer task* [20]. Like Navon stimuli, Kimchi Palmer stimuli consist of a global shape (square or triangle) made up of local shapes (squares or triangles). Participants are presented with two figures, which should be compared against a target or standard stimulus on the basis of subjective perceptual similarity. One of the figures matches the target stimulus at the global level (global match), the other one at the local level (local match). For an example stimulus, see Fig. 1.

Research with children, using the Kimchi Palmer task revealed large and reliable sex differences in the number of choices for global versus local matches [21–22]. They observed an increased number of global choices in boys compared to girls. Age of children in these studies ranged between 4 and 12 years [21] and 6 to 7 years [22]. On the contrary, Basso and Lowery [23] were not able to detect sex differences regarding the number of global and local choices in adults. Thus, sex difference research with the Navon task revealed significant sex differences in adults, whereas significant sex differences in the Kimchi Palmer task were only found in children.

Both tasks have been introduced as measures of global-local processing [1; 20]. However, while they are similar in stimulus architecture, there are several characteristics that distinguish between the Navon task and the Kimchi Palmer task.

First, the Navon task is usually implemented as a target detection paradigm, while the Kimchi Palmer task is implemented as a similarity judgment paradigm. Instead of searching for a predefined target, participants are asked to decide which match is more similar to the target stimulus. Note however that some studies also implement the Navon task as a similarity judgment paradigm and confirm faster responses for global matches than for local matches [24].

Second, in the Navon task participants are explained what the global and the local level are and are asked to detect targets or rate similarity for a predefined level (global or local). Thus, in the Navon task there is an objectively correct answer to each item. In the Kimchi-Palmer task however, participants are unaware of the distinction between global and local level and are specifically instructed to base their choices on subjective similarity.

Third, the Navon paradigm is computerized and participant's response times are restricted, requiring quick and spontaneous responses.

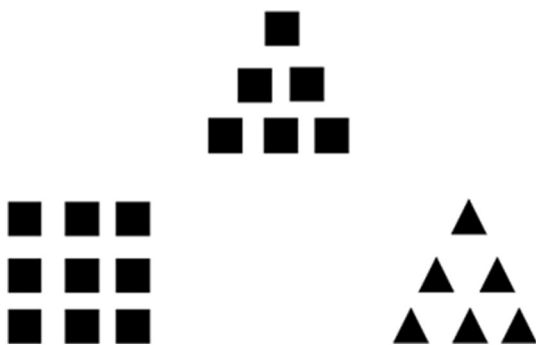


Fig. 1. An example stimulus of the *Kimchi Palmer task*. The figure on the top is the target figure. Participants were asked to decide, which of the two figures, presented at the bottom, is subjectively more similar to the target figure.

Thus, the primary outcome measure in the Navon task is the reaction time. On the contrary, the primary outcome measure in the Kimchi-Palmer task is participant's choice. The Kimchi Palmer task is traditionally presented in a paper-and pencil format without a predefined time limit. While participants are instructed to respond as quickly as possible, they can choose on their own how long they work on each item. Thus responses in the Kimchi-Palmer task may be less spontaneous than in the Navon task, which may present an issue in studies on adults.

Therefore, the present study aims to address whether response times also represent a useful outcome measure in the Kimchi-Palmer task. Therefore, in the present study, we present the traditional Kimchi-Palmer stimuli on a computer screen, where participants had the possibility to choose between global and local matches and record the response times for participant's choices. All other aspects of the task are kept as in the traditional format, i.e. there was no time limit for participant's choices and they were not instructed about the global and local level.

We aim to investigate, whether sex differences in global-local processing during the Kimchi-Palmer task in adults, may not be reflected so much in their choices, but in the time they take to make these choices, i.e. their response times. We hypothesize that decisions for global matches are faster than decisions for local matches in men, while decisions for local matches are faster than decisions for global matches in women. Based on recent results from the Navon paradigm [14], we furthermore examine if fluctuations in sex hormones and female cycle phase relate to participant's performance in the Kimchi-Palmer task. More specifically, we assume that women show an increased global processing bias (i.e. faster responses to global matches than local matches) in the follicular cycle phase, compared to their luteal phase. We further hypothesize that global choices are more frequent and faster, the higher the testosterone levels, whereas local choices are more frequent and faster, the higher the progesterone levels. Furthermore we address, whether fluctuations in mood are associated with potential changes in global-local processing across the menstrual cycle.

2. Method

2.1. Participants

104 (53 men, 51 women) German-speaking participants completed the present study. Five women had to be excluded from analyses because of inconsistencies between the self-reported cycle phases and the analyzed hormone values (see below). Two men were excluded because testosterone levels varied highly between the two test sessions, indicating external factors influencing testosterone levels, like stress. Thus a total of 7 participants were excluded prior to analyses because of inconsistencies in hormone values and all analyses were performed on data of 51 men ($M_{\text{age}} = 23.59$, $SD = 4.07$) and 46 women ($M_{\text{age}} = 22.80$; $SD = 3.47$).

Age of all participants ranged between 18 and 36 and did not differ significantly between men and women ($t_{(98)} = -1.02$, $p = 0.31$). The majority of participants were students of the University of Salzburg, who received course credits for participation. All participants gave their informed written consent to participate in the study and all methods conform to the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Only participants who reported to be right-handers and had no neurological, psychological or endocrinological disorders were included in the study. Women were only included in the study, if they reported no use of hormonal contraceptives and a regular menstrual cycle of a duration between 21 and 36 days [25]. The mean cycle length of women in the present study was 29.17 days ($SD = 2.56$). All participants were tested twice. While men participated within an interval of about 2 weeks, women participated in the study in two different cycle phases, i.e. the early follicular phase (days 1–6 of their menstrual cycle) and the mid-luteal phase (3–10 days after ovulation). Ovulation

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