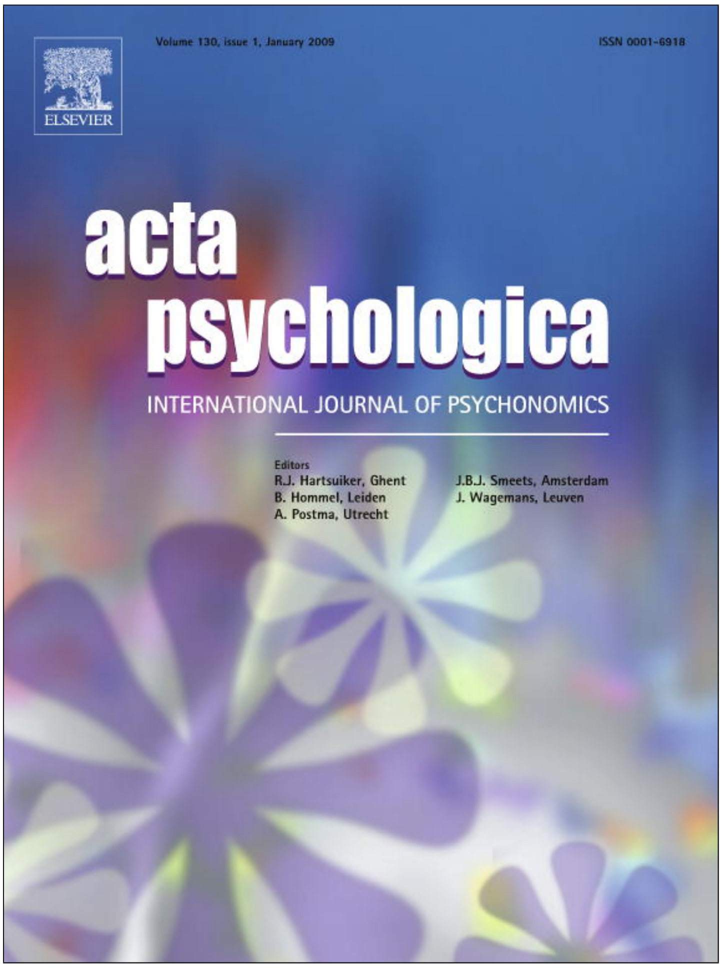
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Gender differences in global–local perception? Evidence from orientation and shape judgments

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Direct examinations of gender differences in global–local processing are sparse, and the results are inconsistent. We examined this issue with a visuospatial judgment task and with a shape judgment task. Women and men were presented with hierarchical stimuli that varied in closure (open or closed shape) or in line orientation (oblique or horizontal/vertical) at the global or local level. The task was to classify the stimuli on the basis of the variation at the global level (global classification) or at the local level (local classification). Women's classification by closure (global or local) was more accurate than men's for stimuli that varied in closure on both levels, suggesting a female advantage in discriminating shape properties. No gender differences were observed in global–local processing bias. Women and men exhibited a global advantage, and they did not differ in their speed of global or local classification, with only one exception. Women were slower than men in local classification by orientation when the to-be-classified lines were embedded in a global line with a different orientation. This finding suggests that women are more distracted than men by misleading global oriented context when performing local orientation judgments, perhaps because women and men differ in their ability to use cognitive schemes to compensate for the distracting effects of the global context. Our findings further suggest that whether or not gender differences arise depends not only on the nature of the visual task but also on the visual context.

Gender differences in spatial abilities have been reported in a number of studies over the years (see Voyer, Voyer, & Bryden, 1995, for a review). Men typically outperform women in mental rotation tasks (e.g. Collins & Kimura, 1997; Halpern, 1992; Linn & Petersen, 1985; Voyer & Bryden, 1990; Voyer & Hou, 2006), in the water-level task (e.g. Kalichman, 1988; Rilea, Roskos Ewoldsen, & Boles, 2004; Robert & Ohlmann, 1994), the rod-and-frame task (e.g. Morell, 1976; Voyer & Bryden, 1993), the judgment of line orientation (JLO) test (Basso & Lowery, 2004; Benton, Sivan, Hamsher, Varney, & Spreen, 1994), in navigation in a "virtual" maze (Moffat, Hampson, & Hatzipantelis, 1998), and in the spatial orientation dynamic test-revised (SODT-R; e.g. Peña, Contreras, Shih, & Santacreu, 2008).

One of the accounts proposed for the gender differences, mainly in the context of mental rotation, suggests that men and women differ in the strategies they employ: men employ a holistic, global approach in which the entire stimulus as a whole is rotated or compared to a target, whereas females employ a local, piecemeal approach in which individual features/parts are rotated or compared separately to a target (Blough & Slavin, 1987; Kail, Carter, & Pellegrino, 1979; Rilea, 2008). A recent study on gender differences in a dynamic spatial task also found that men used a holistic strategy more frequently, whereas there were more women than men who used a segmentary strategy (Peña et al., 2008).

The gender differences in navigation and way-finding also appear to suggest a global bias for men versus a local bias for women. For instance, when finding their way in the environment, men are more likely to use an orientation strategy of attending to cardinal directions and other global reference points, like the position of the sun in the sky (Lawton, 1994, 1996, 2001). Women, on the other hand, refer more to landmarks when giving directions (Lawton, 2001; Miller & Santoni, 1986; Ward, Newcombe, & Overton, 1986), show a greater accuracy in recalling landmarks (Galea & Kimura, 1993), and they are more likely to use a route-based way-finding strategy of attending to local cues indicating when to turn right or left (Lawton, 1994, 1996).

The possibility of gender differences in global–local bias is also implicated by findings suggesting that hemispheric asymmetry is one factor underlying the differential cognitive strengths of men and women, on the one hand, and by findings suggesting differential hemispheric specialization in global–local processing, on the other hand. The former includes findings indicating that women tend to perform better on verbal tasks while men show a distinct advantage in visuospatial task (e.g. Halpern, 1992), and that the visuospatial tasks in which men outperform women tend to be

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right hemisphere dependent and men's spatial processing tends to be more lateralized in the right hemisphere than women's (e.g. Gur et al., 2000; Rilea, 2008; Siegel Hinson & McKeever, 2002). The latter includes findings suggesting that the right and left hemispheres more efficiently process global and local information, respectively (e.g. Fink et al., 1997; Heinze, Hinrichs, Scholz, Burchert, & Mangun, 1998; Lamb, Robertson, & Knight, 1989; Van Kleeck, 1989).

Global–local processing is usually examined by studying the perception of hierarchical stimuli in which larger figures are constructed by a suitable arrangement of smaller figures (Navon, 1977). All else being equal, participants are faster in responding to the information at the global than at the local level (global advantage), and conflicting information between the global and the local interferes with responses to the local level but not to the global level (global-to-local interference). Several studies have demonstrated important boundary conditions of the global advantage, pointing out certain variables that can modulate the effect. These include overall visual angle (e.g. Kinchla & Wolfe, 1979), exposure duration (e.g. Paquet & Merikle, 1984), retinal position (e.g. Lamb & Robertson, 1988), density of elements (e.g. Martin, 1979), number and relative size of elements (e.g. Kimchi, 1988, 1998), and the nature of the stimuli at the global and local level (e.g. Poirel, Pineau, & Mellet, 2008). (For extensive reviews, see Kimchi, 1992; Navon, 2003).

Direct examinations of gender differences in global–local processing are sparse, and the results are equivocal. Kramer, Ellenberg, Leonard, and Share (1996) administered a similarity judgment task with hierarchical geometrical stimuli (originally devised by Kimchi & Palmer, 1982) to boys and girls aged 4–12, and found that boys were more global in their judgments than girls at all ages. Using the same task with adults, Basso and Lowery (2004) found no overall gender differences in global–local judgments, but they found that men had higher scores on the JLO task than women, and that global bias was related to a better performance in the JLO task. Roalf, Lowery, and Turetsky (2006) employed hierarchical letters and a target detection task under divided attention with adults, and found an overall local processing bias. In addition, they found that women responded significantly faster to the local than to the global targets, whereas no such difference was observed for men. Therefore, Roalf et al. suggested a local bias in women, which was concurrently supported by their physiological (ERP) data.

The inconsistencies in the results of these studies are most probably due to the differences in stimulus and task variables, which are known to affect global–local performance, as discussed earlier. Thus, for example, although Basso and Lowery (2004) and Kramer et al. (1996) used the same similarity judgment task (albeit with different populations – children vs. adults), it is not clear whether the size of their stimuli was the same. In addition, these two studies differ from the one by Roalf et al. (2006) in both task (similarity judgment vs. target detection under divided attention) and stimuli (geometrical triads vs. hierarchical letters). Furthermore, the finding of an overall local advantage (rather than the typical global advantage) in Roalf et al. study suggests, as was acknowledged also by the authors, that certain design and stimulus characteristics (e.g. overall stimulus size, relative size of the elements) facilitated local processing bias. Therefore, it is unclear to what extent their results concerning the gender difference in global–local processing are related to the overall local processing bias.

The main purpose of the present study was to systematically examine gender differences in global–local processing. To this end, we employed stimuli within the overall size range, number of elements and relative size of elements that are likely to produce the typical global advantage. In addition, we aimed at providing a more sensitive test for gender differences in global–local processing by examining it in the context of a spatial and a non-spatial task. The findings of men's superiority in spatial tasks (e.g. Voyer et al., 1995), on the one hand, and Basso and Lowery (2004) finding of a positive correlation between performance in the JLO task and a global bias, on the other hand, can be seen to suggest that gender differences in global–local perception could be confined to spatial perception. The investigation of gender differences in global–local processing in the context of a spatial and a non-spatial task will allow us to examine whether these differences, if they exist, characterize visual perception of women and men in general, or whether they are related only to visuospatial performance.

Thus, in this study, we examined gender differences in global–local processing with a visuospatial judgment task (line orientation) and a shape judgment task (open vs. closed shape). Men and women were presented with hierarchical stimuli that varied in closure (open or closed shapes) or in line orientation (oblique or horizontal/vertical) at the global or the local level (see Fig. 1). The task was to classify the stimuli either on the basis of the variation at the global level (global classification) or on the basis of the variation at the local level of the stimuli (local classification). Previous results with similar stimuli and mixed groups of participants (Han, Humphreys, & Chen, 1999; Kimchi, 1994) showed the global advantage that is typically observed with hierarchical stimuli (e.g. Kimchi, 1992; Navon, 1977), as well as faster classification by closure than by line orientation. In addition, the global advantage was more pronounced when local classification was based on line orientation than on closure (Han et al., 1999; Kimchi, 1994).

If there is an advantage for men in visuospatial tasks (e.g. Voyer et al., 1995), and if there is a global bias for men and a local bias for women in visual processing, as some of the literature and findings have suggested (e.g. Kramer et al., 1996; Roalf et al., 2006), then men's overall performance in classification by line orientation would be better than that of women, and regardless of the property relevant for classification, men would exhibit a global advantage (i.e. faster and/or more accurate global than local classification), whereas women would exhibit local advantage (i.e. faster and/or more accurate local than global classification). A somewhat weaker version of the hypothesis concerning gender differences in global–local processing suggests that both women and men would exhibit a global advantage, but that men would be faster than women in their global classification and women would be faster than men in their local classification, regardless of the property that is relevant for classification. If, on the other hand, gender differences in global–local processing are related only to visuospatial performance, as the results concerning the correlation between global bias and successful orientation judgments (Basso & Lowery, 2004) taken together with the findings of men superiority in spatial tasks (e.g. Voyer et al., 1995) may suggest, then a global bias for men and a local bias for women, or at least a relative advantage for men in global classification, would be observed only for classification by line orientation but not for classification by closure.

1. Method

1.1. Subjects

Eighty-two Universities of Haifa students, 41 women and 41 men, with ages ranging from 20–30 years (Women: $M = 23.15$, $SD = 3.03$; Men: $M = 24.87$, $SD = 2.18$), participated in this experiment. All participants were right handed (assessed by a questionnaire adapted from Oldfield, 1971), and all had normal or corrected-to-normal vision.

1.2. Stimuli

Four sets of four stimuli each (see Fig. 1) were created by combining type of property (closure – closed/open shapes or line orien-

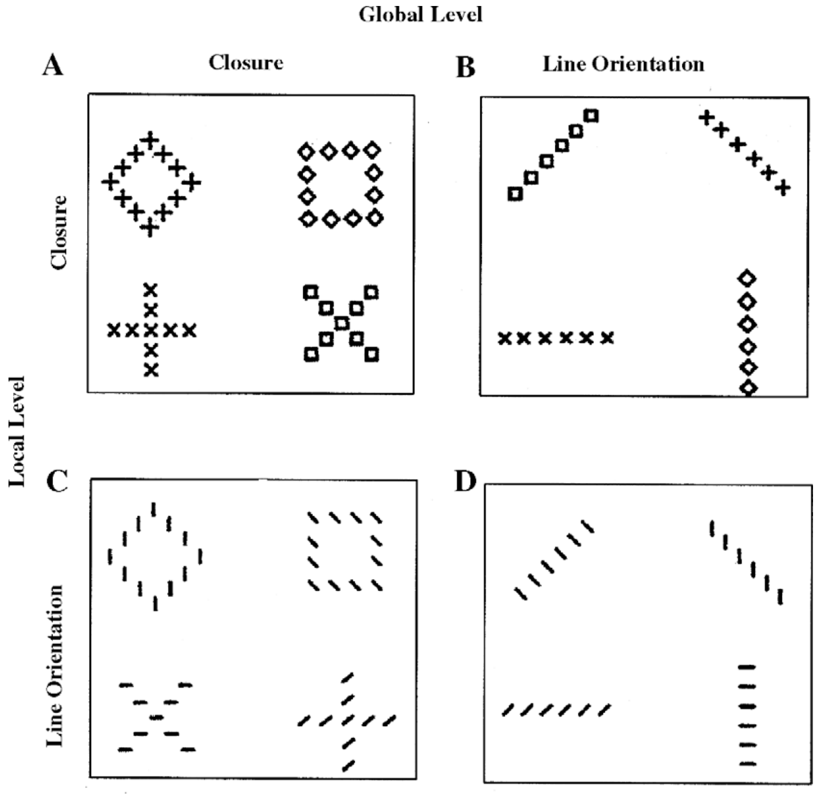

Fig. 1. The stimulus sets used in the experiment. The orthogonal combination of hierarchical level (global, local) and type of property (closure, line orientation) produces two congruent sets (A and D) in which the same type of property (closure in A and orientation in D) varied at the global and local levels, and two incongruent sets (B and C) in which different type of property varied at the global and local levels (line orientation at the global and closure at the local in B, and closure at the global and line orientation at the local in C).

tation – oblique/non-oblique lines) with level of pattern structure (global or local). The two congruent sets (Fig. 1A and D) consisted of stimuli in which the same type of property (either closure – stimulus set A, or line orientation – stimulus set D) varied at the global and the local levels. The two incongruent sets (Fig. 1B and C) consisted of stimuli in which a different type of property varied at the global and at the local level (i.e. line orientation at the global level and closure at the local level – stimulus set B, or closure on the global level and line orientation at the local level – stimulus set C).

It is important to note that our definition of stimulus congruency refers to the variation at the global and local levels – whether the same or different type of property varies at the global and local levels. The specific information (i.e. the specific orientation or the specific shape) at the global and local levels always varied, regardless of congruency.

In addition to the stimulus congruency, namely, whether the same or different type of property varied at the global and local levels, in stimulus sets A and D (the two congruent sets, see Fig. 1), there were also consistency relations in terms of the response required at the global and local levels – whether it was the same or different response. In stimulus set A (Fig. 1A), the two consistent stimuli are the global square made of local diamonds (i.e. closed shapes at both levels) and the global plus made of local Xs (i.e. open shapes at both levels). The two inconsistent stimuli are the global diamond made of local pluses (i.e. a closed shape at the global level and an open shape at the local level) and the global X made of local squares (a global open shape and local closed shapes). In stimulus set D (Fig. 1D), the two consistent stimuli are the global oblique line made of local oblique lines and the global vertical line made of local horizontal lines, and the two inconsistent stimuli are the global horizontal line made of local oblique lines, and the global oblique line made of local vertical line.

A global shape subtended 1.51° vertically, and a global line subtended about 2.2° in length. A local shape subtended 0.3° vertically, and a local line subtended 0.3° in length.

1.3. Design and procedure

The four factors in the experiment were gender (male or female), task (global or local classification), property (closure or line orientation), and congruency (property type at the global and local levels, congruent or incongruent). All factors were combined orthogonally, and all except for gender were manipulated within subjects. Participants performed two classification tasks with each of the stimulus sets. In each task, the stimuli were presented one at a time, and a two-choice speeded response was required. The global classification task required the classification of the four stimuli in a set on the basis of the variation at the global level of the stimuli. When the property relevant for classification was closure (stimulus sets A and C), subjects were required to give one response to global closed figures (i.e. the global square or diamond) and the other response to global open figures (i.e. the global + or *x*). When the property relevant for classification was line orientation (stimulus sets B and D), subjects were required to give one response to global oblique lines (i.e. the global left diagonal line or right diagonal line) and the other response to global non-oblique lines (i.e. the global horizontal or vertical line). The local classification task required the classification of the four stimuli in a set on the basis of the variation at the local level of the stimuli. When the property relevant for classification was closure (stimulus sets A and B), subjects were required to give one response to the local closed figures (i.e. the local squares or diamonds) and the other response to local open figures (i.e. the local + or x). When the property relevant for classification was line orientation (stimulus sets C and D), subjects were required to give one response to the local oblique lines (i.e. the local right diagonal lines or left diagonal lines) and the other response to the local non-oblique lines (i.e. the local horizontal or vertical lines).

Participants performed each task with each set of stimuli in a separate block of 64 experimental trials, preceded by 24 practice trials, with each stimulus in a set occurring on an equal number of trials. Altogether, the participants completed a total of 512 experimental trials. At the beginning of each block, subjects were instructed about the stimulus set and the stimulus-response mapping. The response assignment and the order of the blocks were counterbalanced across the subjects.

Each experimental trial started with the appearance of a fixation dot for 500 ms. After a 500 ms interval, the stimulus appeared at the center of the screen and stayed on until subject responded. 2500 ms was allowed for the response. Subjects were encouraged to respond as quickly and as accurately as possible. Responses were made by moving a small lever up or down.

2. Results

All reaction time (RT) summaries and analyses are based on participants' mean RTs for correct responses. RTs outside the range of 250–2500 ms were omitted from the analyses (0.19% of all trials). Mean correct RTs for women and men are depicted in Fig. 2 as a function of task, property type, and stimulus congruency. Mean error rates (ERs) for women and men in each condition are presented in Table 1. Error rates were low (an overall mean of 2.67%), and the positive correlation between ER and RT ($r = 0.32$, $p < 0.0001$) indicated that there was no speed-accuracy trade-off, for both women ($r = 0.40$, $p < 0.0001$) and men ($r = 0.25$, $p < 0.0001$).

The RT and ER data were submitted to four-way (Gender × Task × Property × Congruency) analyses of variance (ANOVAs) that treated gender (women, men) as a between-subjects factor, and task (global classification, local classification), property type (closure, line orientation), and congruency (property type at the global and local levels congruent or incongruent) as within-subjects factors.

2.1. Reaction times

The analysis of the RT data showed no overall difference in the speed of classification between women and men ($F < 1$). Global classification was faster than local classification [$F(1,80) = 173.28$, $p < 0.0001$, $\eta_p^2 = 0.68$], indicating a global advantage, and classification by closure was faster than classification by line orientation [$F(1,80) = 161.61$, $p < 0.0001$, $\eta_p^2 = 0.68$], indicating a closure advantage. The global advantage was more pronounced for classification by line orientation than for classification by closure, as indicated by the interaction between task and property [$F(1,80) = 21.16$, $p < 0.0001$, $\eta_p^2 = 0.21$]. There was also a significant effect of congruency [$F(1,80) = 4.40$, $p < 0.04$, $\eta_p^2 = 0.05$], which interacted significantly with property [$F(1,80) = 4.68$, $p < 0.04$, $\eta_p^2 = 0.06$]. The three-way interaction among gender, property, and congruency was also significant [$F(1,80) = 8.51$, $p < 0.005$, $\eta_p^2 = 0.10$], as was the four-way interaction among gender, property, task, and congruency [$F(1,80) = 4.00$, $p < 0.05$, $\eta_p^2 = 0.05$].

Following the four-way interaction, separate three-way (Task × Property × Congruency) repeated measures ANOVAs were carried out for men and women in order to examine the pattern of performance for each gender group. For men, there was a significant global advantage [$F(1,40) = 81.73$, $p < 0.0001$, $\eta_p^2 = 0.67$], a significant closure advantage [$F(1,40) = 84.11$, $p < 0.0001$, $\eta_p^2 = 0.68$], and global advantage was more pronounced for classification by line orientation than by closure [$F(1,40) = 16.49$, $p < 0.0002$, $\eta_p^2 = 0.29$]. Stimulus congruency had no significant effect [$F(1,40) = 2.44$, $p > 0.12$], and no interaction involving this factor was significant ($F_s < 1$). For women, as for men, there was a significant global advantage [$F(1,40) = 91.60$, $p < 0.0001$, $\eta_p^2 = 0.70$], a significant closure advantage [$F(1,40) = 78.54$, $p < 0.0001$, $\eta_p^2 = 0.66$], and global advantage was more pronounced for classification by line orientation than by closure [$F(1,40) = 6.64$, $p < 0.02$, $\eta_p^2 = 0.14$]. However, unlike for men, there were significant interactions between congruency and property [$F(1,40) = 10.84$, $p < 0.0025$, $\eta_p^2 = 0.21$], between congruency and task [$F(1,40) = 4.23$, $p < 0.05$, $\eta_p^2 = 0.10$], and between congruency, task, and property [$F(1,40) = 6.41$, $p < 0.02$, $\eta_p^2 = 0.13$]. Thus, congruency had a differential effect on women's speed of performance, depending on the task (global or local classification) and the property relevant for classification (line orientation or closure). Congruency had no effect on women's classification by closure [$F(1,40) = 1.02$, $p > 0.31$], either global or local ($F < 1$). However, a significant effect of congruency [$F(1,40) = 11.99$, $p < 0.0015$, $\eta_p^2 = 0.23$], which interacted significantly with task [$F(1,40) = 11.75$, $p < 0.015$, $\eta_p^2 = 0.23$], was observed for women's classification by line orientation. Whereas global classification by line orientation was equally fast for congruent and incongruent stimuli ($F < 1$), local classification by line orientation was significantly slower for congruent stimuli (stimulus set D) than for incongruent stimuli (stimulus set C) [$F(1,40) = 17.99$, $p < 0.0001$, $\eta_p^2 = 0.31$].

As can be seen in Fig. 2, local classification by line orientation with congruent stimuli was the only condition in which women were slower than men. Three-way (Gender × Property × Congruency) ANOVAs, performed separately for global and local classifications, confirmed this observation. The analysis for global classification showed no effects of gender and congruency ($F_s < 1$). The effect of property was significant [$F(1,80) = 101.30$, $p < 0.0001$, $\eta_p^2 = 0.55$], but it did not interact with gender [$F(1,80) = 2.59$, $p > 0.11$]. No other interaction effect was significant ($F_s < 1$). Thus, women and men were equally fast in their global classification; both exhibited a faster classification by closure than by line orientation, and stimulus congruency had no effect on their performance. For local classification, the effects of property and consistency were significant [$F(1,80) = 88.08$, $p < 0.0001$, $\eta_p^2 = 0.52$, $F(1,80) = 4.95$, $p < 0.03$, $\eta_p^2 = 0.05$, respectively], as was their interaction [$F(1,80) = 5.04$, $p < 0.03$, $\eta_p^2 = 0.06$]. Most importantly, the interaction between congruency, property, and gender was significant [$F(1,80) = 7.40$, $p < 0.008$, $\eta_p^2 = 0.08$]. Women and men were equally fast in their local classification by closure ($F < 1$), with no effect of congruency ($F < 1$), and no interaction be-

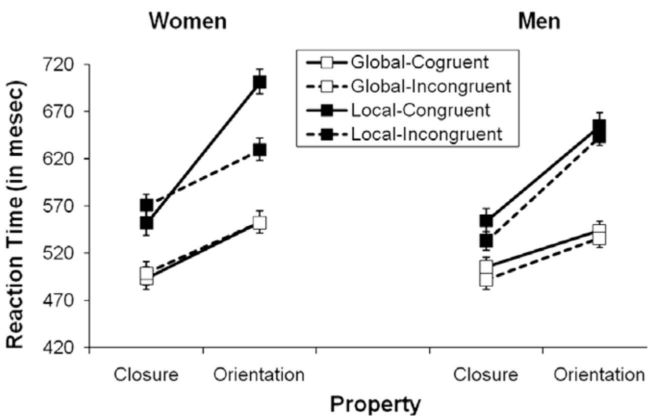

Fig. 2. Mean correct RTs for global and local classifications by closure and by line orientation in each congruency condition, for women and men. Error bars indicate standard errors of the means.

Table 1
Mean error rate (ER, in %) for global and local classifications by closure and by line orientation in each congruency condition, for women and men.

Global classification				Local classification			
Closure		Line orientation		Closure		Line orientation	
Congruent	Incongruent	Congruent	Incongruent	Congruent	Incongruent	Congruent	Incongruent
Women							
1.28	0.86	2.93	1.91	1.73	1.99	3.80	2.88
Men							
3.36	1.86	3.19	3.50	3.67	2.18	3.79	3.81

tween congruency and gender [$F(1,80) = 1.78$, $p > 0.18$]. In contrast, a significant effect of congruency [$F(1,80) = 13.33$, $p < 0.0005$, $\eta_p^2 = 0.14$], which interacted significantly with gender [$F(1,80) = 7.08$, $p < 0.01$, $\eta_p^2 = 0.08$], was observed for local classification by line orientation. No gender difference was found for local classification by line orientation with incongruent stimuli, in which the global level varied in closure ($F < 1$). However, women were significantly slower than men in local classification by line orientation with congruent stimuli, in which the global level varied in orientation (averaged 702 ms and 655 ms, for women and men, respectively) [$F(1,80) = 4.04$, $p < 0.05$, $\eta_p^2 = 0.05$].

2.2. Errors

The analysis of the ER data showed that global classification was more accurate than local classification [$F(1,80) = 6.20$, $p < 0.015$, $\eta_p^2 = 0.07$], classification by closure was more accurate than classification by line orientation [$F(1,80) = 13.26$, $p < 0.0005$, $\eta_p^2 = 0.14$], and responses to incongruent stimuli were more accurate than responses to congruent stimuli [$F(1,80) = 4.09$, $p < 0.05$, $\eta_p^2 = 0.05$]. As can be seen in Table 1, women (mean ER = 2.18%) tended to be more accurate than men (mean ER = 3.17%) in nearly all conditions, but the effect of gender did not reach statistical significance [$F(1,80) = 3.67$, $p > 0.05$, $\eta_p^2 = 0.04$]. The only significant interaction was between gender, property, and congruency [$F(1,80) = 6.67$, $p < 0.02$, $\eta_p^2 = 0.08$].

Two-way (Gender × Congruency) ANOVAs were performed separately for classification by closure and for classification by line orientation. The analysis for classification by closure showed a significant effect of gender [$F(1,80) = 7.30$, $p < 0.01$, $\eta_p^2 = 0.08$], a significant effect of congruency [$F(1,80) = 4.77$, $p < 0.05$, $\eta_p^2 = 0.06$], and a significant interaction between gender and congruency [$F(1,80) = 3.86$, $p < 0.05$, $\eta_p^2 = 0.05$]. The analysis of simple effects revealed that women were significantly more accurate than men in the congruent condition [$F(1,80) = 7.34$, $p < 0.01$, $\eta_p^2 = 0.08$] (mean ER = 1.51% and 3.51%, for women and men, respectively), but not in the incongruent condition [$F(1,80) = 1.07$, $p > 0.30$]. The analysis for classification by line orientation did not yield any significant effect.

Thus, women were significantly more accurate than men in their classification by closure with congruent stimuli (i.e. with stimulus set A). This finding may suggest that women are more accurate than men in the judgment of shape properties, but this advantage is less likely to surface when the stimuli vary on different properties at the global and local levels (i.e. closure on one level and line orientation on the other level).

2.3. Effect of response consistency

Mean correct RTs for stimulus set A (classification by closure) and stimulus set D (classification by line orientation) for women and men as a function of task and response consistency are depicted in Fig. 3. Mean ERs are presented in Table 2.

As can be seen in Fig. 3, the effect of response consistency on the classification RT depended on the property relevant for classification. When the relevant property was closure (Fig. 3A), the responses to consistent stimuli were faster than the responses to inconsistent stimuli, both for global and local classification, indicating a mutual interference between the global and local levels, for both women and men. A three-way ANOVA (Consistency × Task × Gender) confirmed these observations: There was a significant effect of response consistency [$F(1,80) = 31.76$, $p < 0.0001$, $\eta_p^2 = 0.28$], which did not interact with task nor with gender ($F_s < 1$), and no significant interaction between gender, consistency and task [$F(1,8) = 1.24$, $p > 0.26$]. In a clear contrast, no effect of response consistency ($F < 1$), nor any interaction involving this factor ($F_s < 1$), was observed when the relevant property for classification was line orientation (Fig. 3B).

Analyses of the ER data did not yield any significant effect, either for classification by closure or for classification by line orientation.

The differential effect of response consistency on the two classification tasks suggests a processing difference between them.

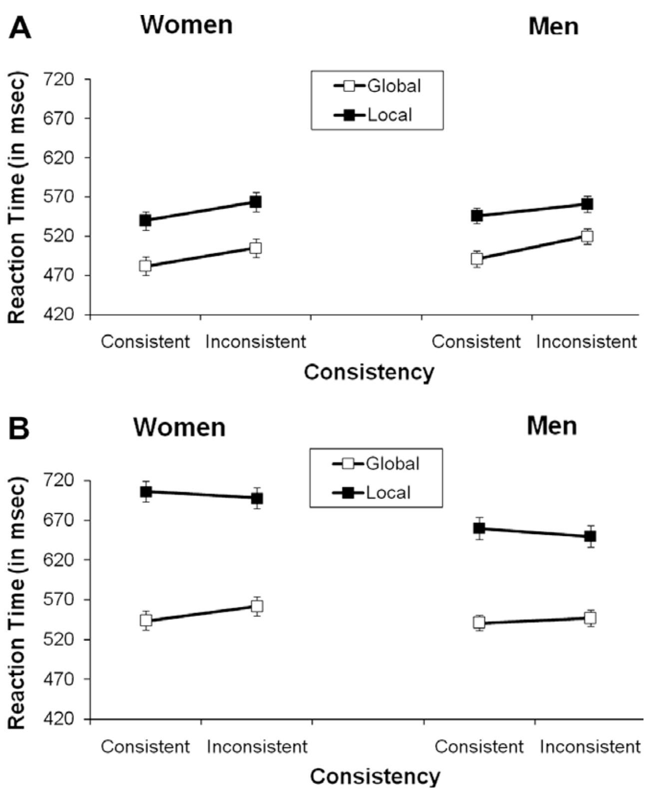

Fig. 3. Mean correct RTs for global and local classifications as a function of response consistency for (A) classification by closure (stimulus set A) and (B) classification by line orientation (stimulus set D), for women and men. Error bars indicate standard errors of the means.

Table 2
Mean error rate (ER, in %) for global and local classifications as a function of response consistency for classification by closure (stimulus set A) and classification by line orientation (stimulus set D), for women and men.

Closure				Line orientation			
Global		Local		Global		Local	
Consistent	Inconsistent	Consistent	Inconsistent	Consistent	Inconsistent	Consistent	Inconsistent
Women							
0.87	1.66	1.90	1.54	2.86	2.92	3.60	3.85
Men							
3.30	3.37	3.62	3.66	2.59	3.70	4.08	3.43

Presumably, classification by closure was based on discriminating open vs. closed shape, regardless of the specific shapes, whereas classification by line orientation was based on discriminating the specific orientations of the lines, regardless of whether they called for the same or different response. Most importantly, this processing difference between the two tasks applied to women and men alike.

3. Discussion

The main objective of this study was to examine possible gender differences in global–local visual processing, in the context of shape and orientation judgments. The results show that women and men were quite similar in their processing the global and the elemental aspects of visual stimuli. Both women and men were faster in global than in local classification, exhibiting the global advantage that is typically observed with hierarchical stimuli (e.g. Kimchi, 1992; Navon, 1977), and men's global classification was not faster than women's and women's local classification was not faster than men's. Also, both women and men were faster in classification by closure than by line orientation, and the global advantage was larger for the latter, replicating previous results with the same and similar stimuli (Han et al., 1999; Kimchi, 1994). In addition, for both women and men, classification by closure differed from classification by line orientation in a similar way. Whereas classification by closure was based on discriminating closed vs. open shapes, regardless of the specific shapes, classification by line orientation was based on the specific orientations of the lines.

Two differences between women and men, however, were observed in this study. One concerns the accuracy of classification by closure. Women's discrimination between closed and open shapes was more accurate than men's in the condition in which the stimuli varied in closure at both the global and local levels (i.e. stimulus set A). This finding suggests that women tend to be more accurate than men in discriminating shape properties. This gender difference surfaced under conditions in which the relevant and irrelevant variation was on closure. Our finding of an advantage for women in discrimination of shape properties appears to be consistent with previous findings demonstrating that women recognized significantly more abstract shapes and nameable objects than men (McGivern et al., 1998).

The other difference between women and men concerns the effect of irrelevant global variation on the speed of local classification by line orientation. Men's classification performance was not affected by the irrelevant variation – whether it involved the same or different property – regardless of the level at which the classification was performed (global or local) and the property relevant for classification (closure or line orientation). Women's classification by closure, both global and local, and their global classification by line orientation were also unaffected by irrelevant variation in property. Local classification by line orientation, however, was significantly slower when the to-be-classified lines were embedded in global lines that varied in a different orientation (i.e. congruent stimuli – stimulus set D) than when they were embedded in global figures that varied in closure (i.e. incongruent stimuli – stimulus set C).

Indeed, local classification by line orientation in the congruent condition was the only condition in which women were slower than men. Women and men were equally fast in their global and local classification by closure, in their global classification by line orientation, and in their local classification by line orientation when the to-be-classified local lines were embedded in a (task-irrelevant) global context that did not vary in orientation (i.e. global closed or open shapes). It is only when the to-be-classified local lines were embedded in a (task-irrelevant) global context that varied in a different orientation (i.e. global oriented lines) that women were slower than men, indicating that women were more distracted by the misleading orientation of the global lines than men.

A possible interpretation of these findings is that women are generally more sensitive to immediate global visual context than men are. Presumably, this gender difference is most likely to surface when the global context is misleading, as was the case with local classification of stimuli that varied on different orientations at the global and local levels. The finding that the advantage for women in accuracy of closure judgments was most pronounced for congruent stimuli (i.e. for stimuli that varied on closure on both levels) may also support the notion of a greater sensitivity of women to immediate context. However, the finding of no gender difference whatsoever in the speed of performance in global and local classification as a function of irrelevant variation, except when local orientation judgment was called for, is not easily reconciled with a gender difference in general sensitivity to global context. Rather, the gender difference with regard to the effect of global context appears to be confined to the orientation judgments.

The latter suggestion is supported by the compatibility of the present finding with the gender differences observed in the rod-and-frame and the water-level tasks. Females' performance in the rod-and-frame task (Witkin & Asch, 1948), which requires adjusting a rod to the vertical, despite the distracting information provided by the tilted square frame in which the rod is embedded, is inferior to that of males (e.g. Voyer & Bryden, 1993). Likewise females' performance in the water-level task (Piaget & Inhelder, 1956), which requires indicating the orientation of the liquid in a tilted container, is inferior to that of males (e.g. Rilea et al., 2004; Robert & Ohlmann, 1994). Interestingly, the robust gender difference was eliminated when subjects performed a haptic version of the rod-and frame (e.g. Walker, 1972) and the water-level tasks (e.g. Robert, Pelletier, St Onge, & Berthiaume, 1994). The cross-gender uniformity in the haptic version of the water-level task was due to the improvement in the performance of women and deterioration in the performance of men relative to their performance in the standard visual water-level task, suggesting that in the latter, both men and women rely mostly on visual references, but apparently men used correct ones whereas women used incorrect ones (see Robert et al., 1994).

Thus, the present results and those reported in the literature demonstrate that a gender difference in orientation judgment is observed when the immediate global visual context (the tilted square frame in the rod-and-frame task, the tilted container in the water-level task, or the global oriented line in the present study) is misleading, such that the global distracting information is more detrimental for women than for men.

What may underlie this gender difference? We can only speculate. Presumably, successful orientation judgment of an embedded line is likely to be achieved by disembedding the line from its immediate oriented context and relating it to Euclidean environment coordinates. Indeed, previous research on performance in the water-level task has demonstrated that high scorers are more likely than low scorers to spontaneously use Euclidean schemes in performing the task, and that specific instructions to use Euclidean schemes can improve the performance of low scorer to the level of high scorers (e.g. Sholl & Liben, 1995). It is possible, then, that our finding of a relative disadvantage for women in local orientation judgment when the global level varied in a different orientation, is due to women's greater difficulty (relative to men) in disembedding the local orientated lines from the global oriented line in which they are embedded and applying Euclidean schemes. Further research is needed to support this conjecture and to analyze whether it can explain the observed gender differences.

In summary, our results show that women and men do not differ in global–local processing. Both women and men exhibited a global advantage; men do not seem to surpass women in the processing of the global level of stimulus structure, and women do not seem to surpass men in the processing of the elemental level. Also, women and men alike, appear to process visuospatial information (line orientation) differently than shape information (open vs. closed shape). Nonetheless, the gender differences were observed in this study, under specific contexts. These gender differences suggest that (a) women tend to be more accurate in discrimination of shape properties than men, at least under conditions in which both the global and local levels vary on shape-related properties, such as open vs. closed shape; (b) women appear to be more distracted than men by misleading immediate global oriented context when performing local orientation judgments, perhaps because women and men differ in their ability to use cognitive schemes (e.g. Euclidean schemes) to compensate for the distracting effects of the global context. Our findings further suggest that whether or not gender differences arise depends not only on the nature of the visual task but also on the visual context.

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