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The impact of gender and bilingualism on cognition: the case of spatial perspective-taking

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Introduction

Bilingual children demonstrate cognitive advantages (Bialystok, 1999) including theory of mind (Kovacs, 2009). One theory suggests that bilingualism improves inhibitory control (Bialystok, Craik, & Luk, 2008). Others suggest elements of executive function beyond inhibition are implicated. However, little is known about the impact of bilingualism on cognition in adulthood.

In the experiment described in this paper, we examine the impact of bilingualism on spatial perspective-taking because it is a challenging domain for adults (Schober, 1993) and bilingual children show perspective-taking advantages. Because adult perspective-taking is modulated by memory and inhibition (Brown-Schmidt, 2009; Lin, et al., 2010), we also used individual differences measures (inhibition, memory, etc.) to specify the cognitive mechanisms underlying the bilingual advantage in adulthood, if one exists.

Finally, gender and verbal ability are likely to influence performance. Superior spatial skills are often attributed to males (Voyer, Nolan & Voyer, 2000), while females may possess superior theory of mind (Baron-Cohen, 2003). Further, bilingual adults may be at a disadvantage when it comes to verbal tasks (Sandoval, et al. 2010).

Participants engaged in a dialogue during which they were given instructions to trace a course through a map of objects. Crucially, the experimenter holds a different spatial perspective on the map. In the easy condition, the experimenter gives directions from the perspective of the participant; in the hard condition, the experimenter gives directions according to her own (opposite) perspective of the map. While the bilingual verbal disadvantage predicts poorer performance in the easy condition, if the bilingual perspective-taking advantage extends to adulthood, bilinguals should have equivalent or better performance in the hard condition. If so, this would suggest that bilinguals more easily adjust to an opposing perspective.

2 Methods

2.1 Participants

Participants were 32 monolingual English speakers (16 female) and 33 bilinguals (21 female) who spoke English and ≥1 other language fluently.

2.2 Materials and Procedure

Participants filled out a language background questionnaire. They then performed a series of tasks to measure perceptual speed, working memory, and inhibition. Then they completed the dialog task in either the hard or easy condition.

The experimenter sat across the table from the participant. A barrier prevented non-verbal communication. In the easy condition, the experimenter's maps were oriented like the participant's, and the experimenter gave directions from the perspective of the subject while the participant drew a path (Figure 1a). In the hard condition, the experimenter's maps showed the opposite visual perspective from the participant (Figure 1b) and the experimenter gave directions from her own perspective. A practice trial was followed by 10 critical trials. An error was considered any deviation from the given directions.

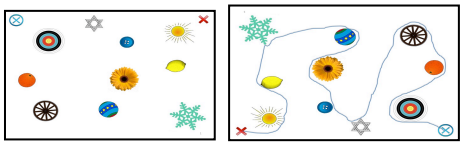

Figure 1. left: example of map seen by participant (1a), right: example experimenter map- hard condition (1b).

3. Results

There were 174 data points (opportunities for error) for each participant (Table 1).

	Monolingual		Bilingual	
	Easy	Hard	Easy	Hard
Female	8.5	26.3	19.1	25.3
Male	1.8	29.3	6.5	35

Table 1. Average errors per condition

Performance was better in the easy condition. While language experience and gender both modulated performance, perceptual speed, working memory, and inhibition scores revealed no significant differences between bilinguals and monolinguals, or males and females.

The data were analyzed in a mixed model. A significant effect of condition ($p<.0001$) was due to more errors in the hard condition. A significant effect of language ($p<.05$) was due to more errors by bilinguals compared to monolinguals. These main effects were qualified by a significant condition by gender interaction ($p< 0.01$). In the easy condition, monolinguals outperformed bilinguals, ($p<.01$) and males outperformed females ($p<.001$). These deficits were eliminated in the hard condition, where there were no significant effects of language or gender.

4. Discussion

The error data coincided with our hypothesized pattern for the language effects. In the easy condition, when subjects were not required to take an opposite spatial perspective, monolingual subjects performed significantly better than bilinguals. This is consistent with research on a bilingual disadvantage in linguistic tasks (Sandoval et al., 2010). In the hard condition, where there was the added difficulty of taking the perspective of the experimenter, monolingual and bilingual subjects did equally well. The disappearance of a bilingual disadvantage in the hard condition suggests that the perspective-taking aspect of the task proves to be a greater challenge for the monolingual participants, indicating a possible bilingual advantage in the domain of perspective-taking. Regarding gender, the female disadvantage in the easy condition may be related to previous reports of a male advantage in spatial abilities (Voyer et al., 2000). The fact that females performed as well as males in the hard condition suggests that females have less difficulty dealing with a challenging spatial perspective, consistent with research demonstrating a female advantage in theory of mind (Baron-Cohen, 2003).

These results suggest the cognitive exercise involved in learning and speaking a second language affects brain mechanisms that are also involved in other domains, such as perspective-taking. However, the source of the bilingual advantage may be due to more general cognitive differences between monolinguals and bilinguals (e.g., Bialystok et al., 2008). Thus, perhaps bilingual participant's facility at adapting to the speaker's egocentric perspective was due to their better executive function.

5. References

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