The Bilingual Advantage Investigated Using Visual Search

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Introduction

Research has shown that relative to monolinguals, bilinguals perform better on various tasks that require attentional guidance and conflict resolution that arises from distracting information (e.g., Bialystok, Craik, & Ryan, 2006; Hilchey & Klein, 2011). Researchers have suggested that this bilingual executive function advantage stems from the continuous selection and suppression required for the processing of two languages. Previous research has demonstrated that concepts in both languages are always active, regardless of the language the bilingual speaker is currently using for the task. Bilinguals must resolve this conflict which leads to advantages in their ability to attend to task relevant information and ignore interference from distracting information (Hilchey & Klein, 2011). Recently, Hernández, Costa, and Humphreys (2012) observed evidence indicating that bilinguals may be more efficient in visual search tasks. In their study, bilinguals were both faster at finding a target item and better at ignoring irrelevant distractors compared to monolinguals. However, it is not possible to determine which aspect of search behavior explains Hernandez et al.'s bilingual advantage. Any successful visual search requires two things: 1) putting your attention in the right place, and 2) correctly matching the online visual input with your mental representation of the target held in memory. It is possible that bilinguals were more efficient at one or both of these aspects of search.

In the current study, we sought to quantify the extent to which the bilingual search advantage arises due to superior attentional guidance or more efficient perceptual decision-making. To do this, we tracked the eye movements of our participants, and dissected search RTs into two behavioral epochs: scanning and decision-making. If bilinguals are better at guiding their attention, then their scanning behavior should be superior to monolinguals. In contrast, if bilinguals are better able to match visual information to their target template, we should find shorter decision-times, relative to monolinguals.

Method

Participants

The participants were recruited from Arizona State University undergraduate courses and received partial course credit for their participation. Colorblindness was assessed using the Ishihara Color Test. No participants reported a history of neurological impairments.

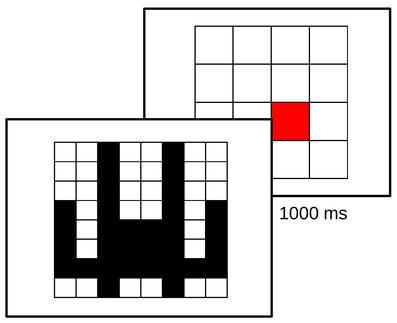
Monolingual (N=15). All reported English as their native language and spoke no other languages fluently.

Bilingual (N=15). All reported speaking English and another language fluently. Language experience was assessed using a modified version of the Language Experience and Proficiency Questionnaire (LEAP-Q) (Marian, et al., 2007).

Stimuli and Procedure

All participants were administered the following tasks: Visual Search Task, Symmetry Span Task (Unsworth et al., 2005), and Raven's Advanced Progressive Matrices (Raven, Court, & Raven, 1986).

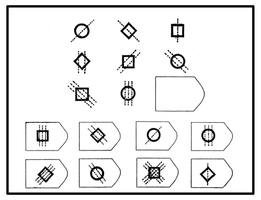
Symmetry Span Task



Symmetrical? **YES** or **NO**

Remember the location of the square

Raven's Advanced Progressive Matrices

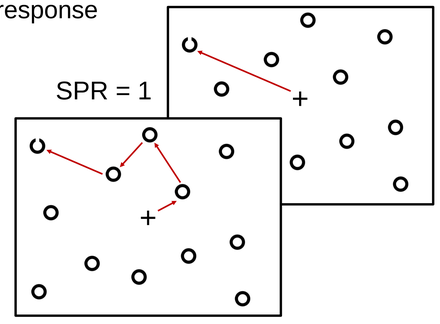


Which piece completes the pattern?

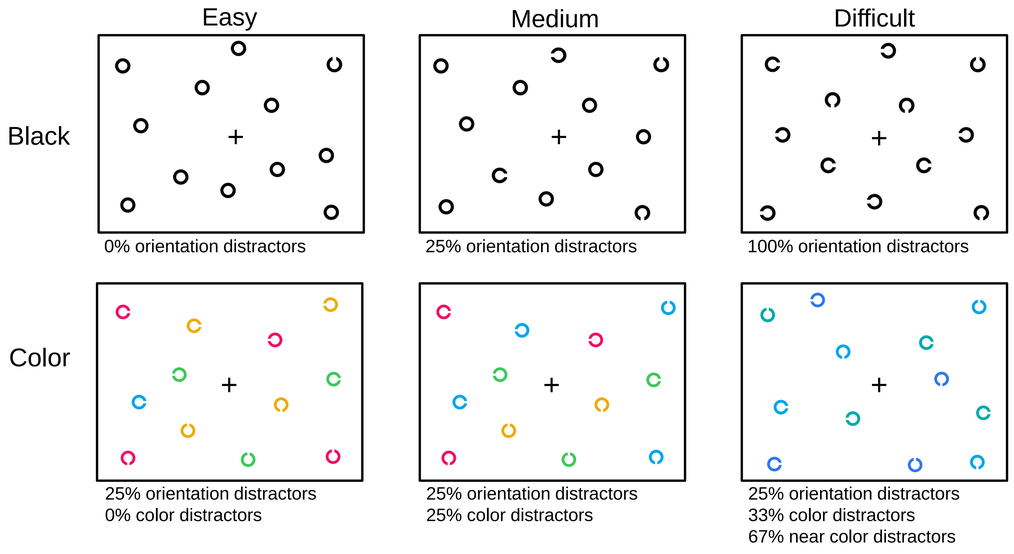
Search RTs separated into two time periods:

Scan Path Ratio – summed length of saccades, divided by shortest distance directly to target

Decision-Time – first fixation to manual response



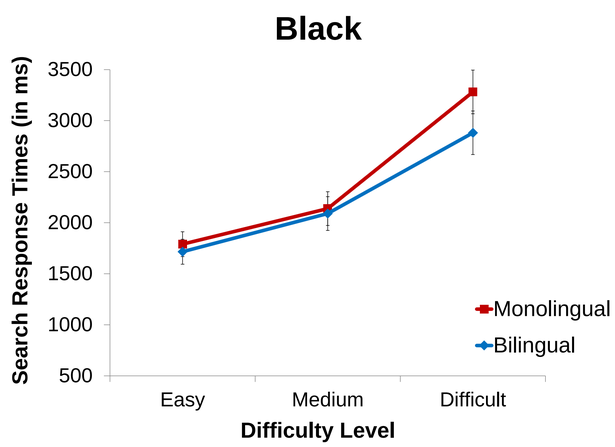
Visual Search Task



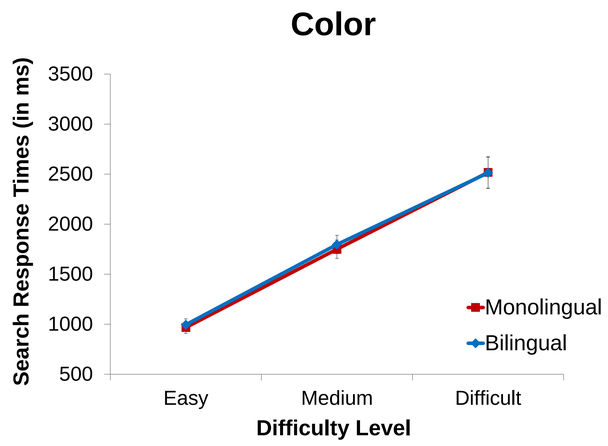
Results

All data were analyzed in a 2 (Language Group) X 3 (Difficulty) mixed Analysis of Variance (ANOVA) (significance at $p < .05$).

Overall Search Time

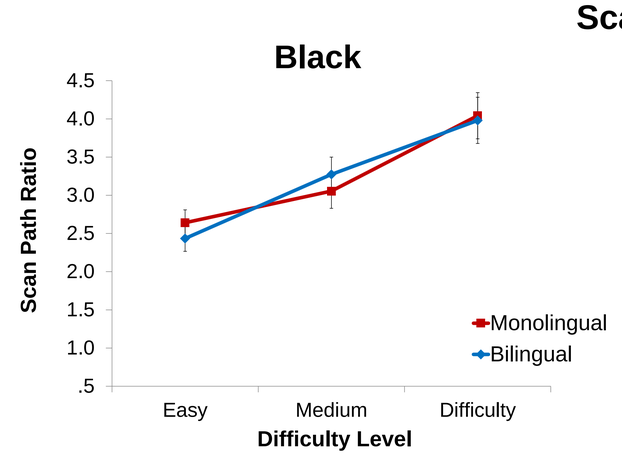


Significant effect of Difficulty [$F(2,56)=143.62$, $p<.001$, $\eta_p^2=.837$]

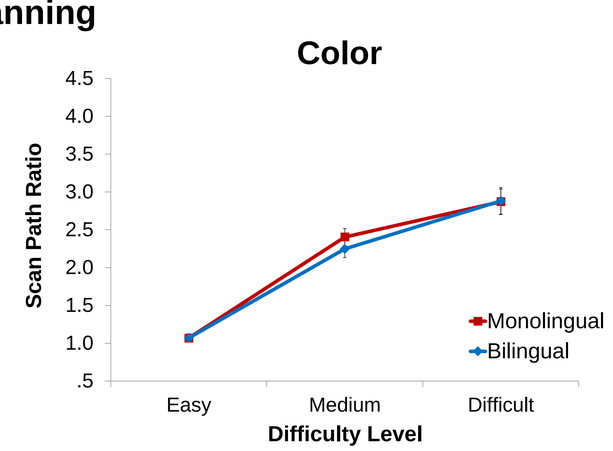


Significant effect of Difficulty [$F(2,56)=278.40$, $p<.001$, $\eta_p^2=.909$]

Scanning

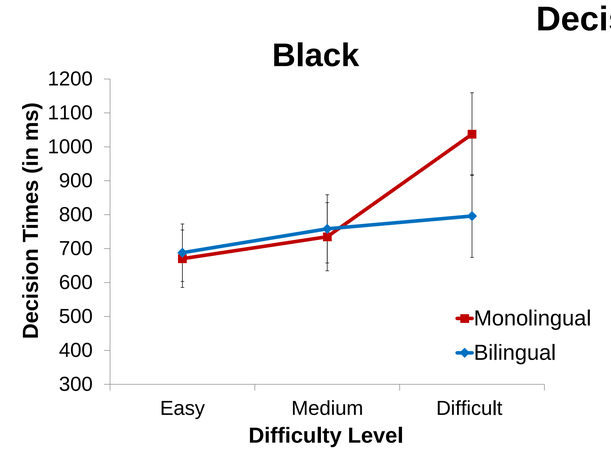


Significant effect of Difficulty [$F(2,56)=25.65$, $p<.001$, $\eta_p^2=.478$]

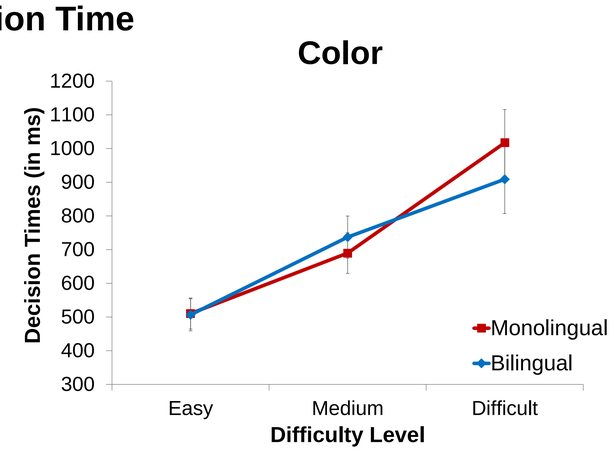


Significant effect of Difficulty [$F(2,56)=131.69$, $p<.001$, $\eta_p^2=.830$]

Decision Time



Significant effect of Difficulty [$F(2,56)=8.01$, $p=.001$, $\eta_p^2=.222$]
Marginal Speaker Group X Difficulty Interaction [$F(2,56)=3.06$, $p=.055$, $\eta_p^2=.098$]



Significant effect of Difficulty [$F(2,56)=47.18$, $p<.001$, $\eta_p^2=.636$]

Discussion

This study investigated whether the bilingual search advantage is explained by more efficient attentional guidance or enhanced perceptual decision-making during search. Our results showed that bilinguals and monolinguals were equally efficient at finding the target item across all difficulty conditions. However, in the decision-time analysis, bilinguals were marginally faster than monolinguals in the difficult search condition with black stimuli. The fact that this interaction was not found in the Color condition may be due to complexity of decision making in the Color condition, relative to the Black condition. In the Color condition, perceptual discriminations must be made on the basis of color and orientation, whereas in the Black condition, the only necessary information is orientation. These results suggest that bilinguals may have an advantage in matching the target item to a template held in memory.

References

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