

Interference Suppression vs. Response Inhibition: Preschoolers Demonstrate a Bilingual Advantage with a New Conflict Task



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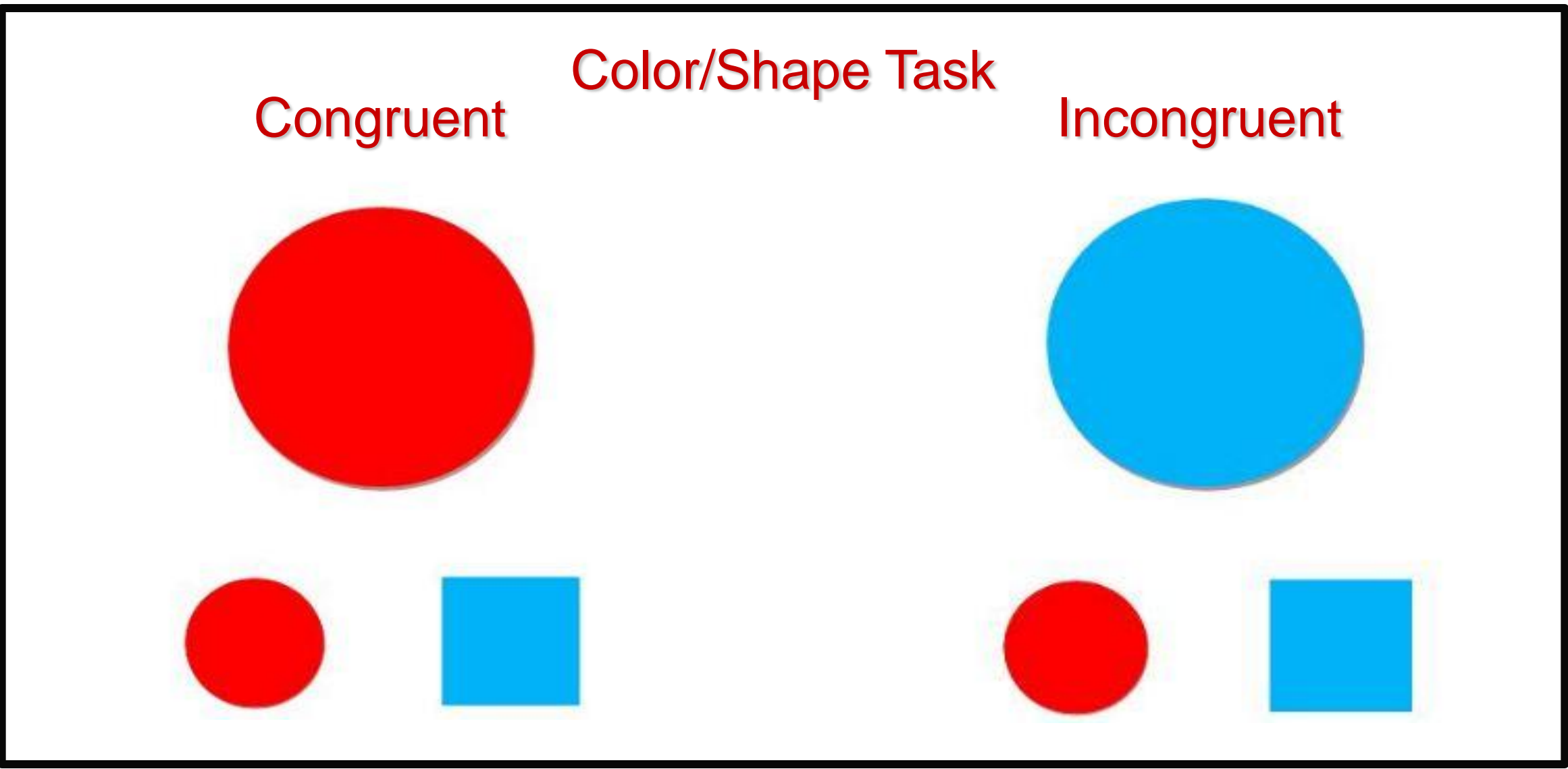


Inhibition and the Bilingual Advantage

- The regular use of two or more languages benefits controlled attention (Adesope et al., 2010). This **bilingual advantage** arises in part from the management of two (or more) linguistic representations, which results in extensive practice in selective attention and cognition flexibility. Bilingual relative to monolingual participants demonstrate superior performance in a variety of tasks requiring attentional control.
- However, it is unclear if a bilingual advantage exists in Stroop tasks among preschool children (Martin-Rhee & Bialystok, 2008; Siegal, Iozzi, & Surian, 2009), in contrast to adults (Bialystok, Craik, & Luk, 2008; Hernández et al., 2010).
- A possible explanation for the discrepancy is the distinction between **interference suppression** and **response inhibition**.
 - Tasks in which the bilingual advantage is found contain conflicting perceptual stimuli, and such tasks require **interference suppression** (Bunge et al., 2008), defined as choosing between two viable alternatives. The Classic Color Word Stroop task (Stroop, 1935) in which color words are printed in an ink color that is incongruent to the word (the word "blue" printed in red ink) requires interference suppression.
 - In contrast, **response inhibition** is the inhibition of a dominant or prepotent response. An example of this would be the Day/Night task (Gerstadt et al., 1994) in which children respond to a picture of the sun with the word "night" and the moon with the word "day".
 - Interference suppression more closely resembles the everyday experience of being bilingual than response inhibition (Martin-Rhee & Bialystok, 2008).
- Bilingual advantages have been found in Stroop tasks with conflicting perceptual stimuli, but not in tasks such as the Day/Night task used with preschoolers. **We propose that the discrepancy in whether there is a Stroop task advantage is due to task demands relating to interference suppression vs. response inhibition.**

The Need for a New Conflict Task

- To test whether the discrepant results were the result of task demands, we needed a conflict task that measured interference suppression, matched critical elements of the original Color/Word Stroop, and was suitable for use with bilingual and monolingual preschoolers.
- The task must include both congruent and incongruent test items with perceptually distracting stimuli in a mixed block and must not require reading or number knowledge. Also, because acquiring two languages at once may limit vocabulary in each (e. g., Bialystok, Luk, Peets, & Yang.), the task must not be dependent on word knowledge.



- Our task runs on Psychology Experiment Building Language (PEBL; Mueller, 2011, 2010). **The Color/Shape task is a manual response bivalent (meaning it has distracting perceptual information as well as perceptual features relevant to the required response) mixed block conflict task designed for use across the lifespan regardless of vocabulary or literacy level.**
- Two active buttons, a red circle and a blue square, remain at the bottom of the screen. Test items (circles and squares in either red or blue) appear above the buttons in the center of the screen. The test items vary in both shape and color so that each shape is presented in each color, creating four possible test items. The test items are bivalent in that participants are required to ignore the very salient color and only respond to the shape.
- Congruent test items are those that match in both color and shape to one of the available buttons and incongruent test items match in shape to one button but in color to the other. Participants are directed to match the shape. No verbal response or vocabulary is required
- Test items are presented in a fixed but mixed block order. Self-correction is not permitted and only the first response is recorded.

Hypotheses

- We expected to replicate previous findings of a greater number of errors in the incongruent condition compared to the congruent condition (Stroop effect), but did not expect this relationship to be moderated by bilingual status.
- Again, we expected to replicate findings of no difference between language groups in the number of congruent or incongruent errors (accuracy) in the Day/Night task.
- In contrast, we expected that the Color/Shape task would produce a larger Stroop effect for monolingual preschoolers (in the form of more incongruent compared to congruent errors), but that this relationship would be attenuated for bilingual preschoolers.
- We also expected that on incongruent trials, the bilingual groups would have significantly fewer errors (accuracy) than the monolingual group, but that the groups would not differ in errors on congruent trials.

- Parental consent was obtained as well as child assent. Children participated within a quiet classroom in their childcare center.
- Children were tested in their preferred language and codeswitching was permitted throughout the session.
- Children completed the Day/Night task and the Color/Shape task in counter balanced order with a vocabulary fluency assessment and a block game interspersed between these tasks.

Participants

- Participants were healthy, typically developing children, aged 37-63 months with either monolingual (English) or bilingual (Spanish and English) functional ability.
- Children were recruited from 4 local child care centers. In order to maximize the number of Spanish/English bilingual children, 3 centers offering Spanish immersion as an option were included as well as one traditional English center.
- Language group was determined by parent and teacher report as well as language exposure and experience. Children who did not clearly fall into either category were not included in analysis (23). This left a sample of 26 children bilingual children (16 females; mean age = 49.8 months, $SD = 7.5$ months) and 25 monolingual children (12 females; mean age = 50.1 months, $SD = 8.6$ months).

Procedure

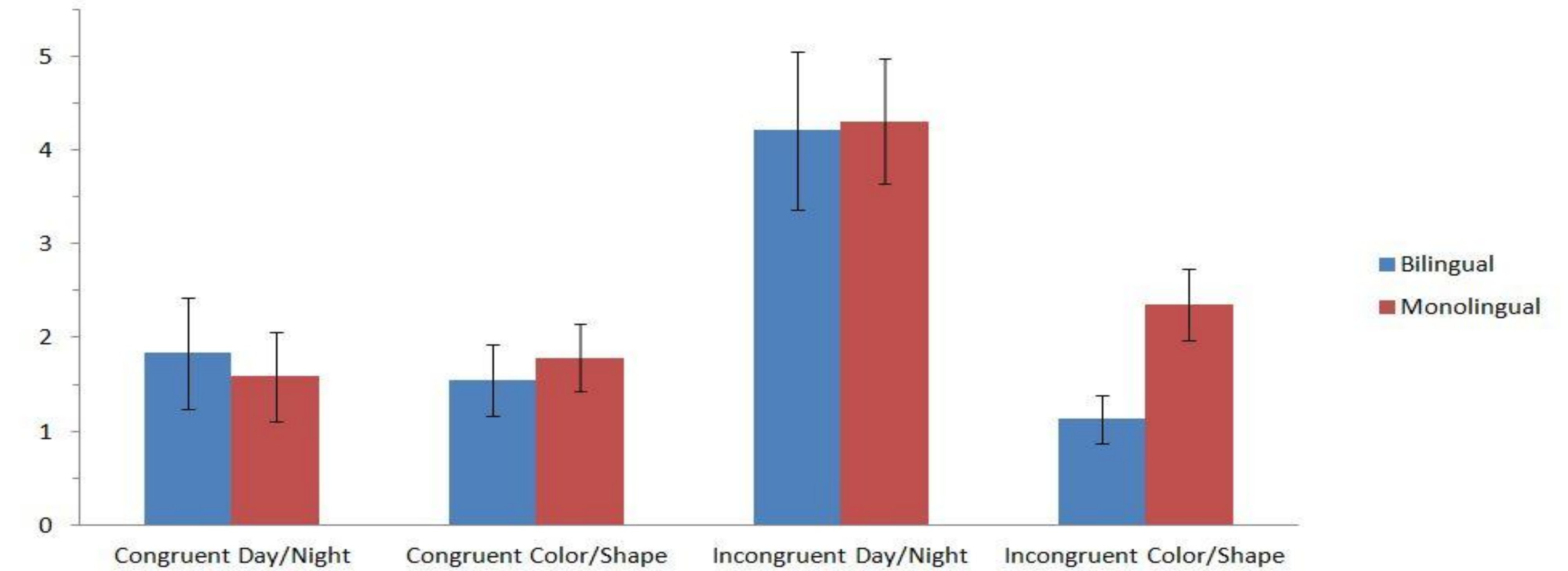
- The Day/Night task procedures followed the description of Gerstadt et al. (1994) with the exception of adding a congruent condition, following the example of Martin-Rhee and Bialystok (2008).
- The Color/Shape task began with a match the picture game to orient the children to the computer and touch screen. Then children were told to "match the shape" and given a 10 item practice. If 80% accuracy was reached, they proceeded to the task which contained 20 stimuli in a set random order ($n = 4$).

Results

Preliminary: There were no effects of task order or gender. The groups did not differ in vocabulary. Vocabulary was not a significant predictor of outcome variables, and hence was not included in further models. There were no group differences in age, but because age predicted performance it was included as a covariate in subsequent analyses. Reaction time measures were not predicted by language group, trial type, or age.

Day/Night task: As predicted, there were no language group differences in either Stroop effect or accuracy.

Color/Shape task: Monolingual preschoolers had significantly better performance on congruent compared to incongruent trials (Stroop effect). However, bilingual preschoolers did not show a Stroop effect. In addition, there were no accuracy differences between bilingual and monolingual preschoolers on congruent trials, but bilingual preschoolers were significantly more accurate on incongruent trials compared to monolingual preschoolers.



Discussion and Conclusions

- The results support a bilingual advantage in interference suppression but not response inhibition and replicate the findings of Martin-Rhee and Bialystok (2008) in a task with distracting perceptual information inherent in the stimuli rather than based on physical location.
- The results support a Stroop advantage in accuracy in bilingual preschool children.
- The task is similar to the Dimensional Change Card Sort (Zelazo, 2006) which has also shown a preschool advantage in previous studies (e.g., Bialystok & Martin, 2004). Both tasks require the children to sort bivalent stimuli, but the Color/Shape task found a bilingual advantage in the absence of the switching component. This pattern of results underscores the importance of stimulus bivalence in invoking the bilingual advantage in conflict tasks.
- Bilingual preschoolers showed no difference in accuracy between congruent and incongruent trials and the mean for incongruent was actually slightly lower than the mean for congruent trials. Although we hesitate to interpret non-significant results, this is an area for future research.
- The Color/Shape task may offer an alternative to the Stroop tasks that are currently available for use with preschool children. The Day/Night task, although a measure of inhibition, does not appear to be measuring the same construct as the Classic Color/Word Stroop. There are few bivalent tasks offering both congruent and incongruent trials for comparison and those that do exist require rapid picture naming, putting bilingual children at a possible disadvantage.
- The Color/Shape task also has the possible advantage of use across the lifespan. In ongoing research with college students, reaction times differ between congruent and incongruent trials (the Stroop effect), and reaction times on the Color/Shape task and on the Classic Color/Word Stroop are correlated.

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