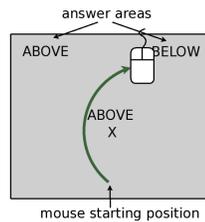


Abstract

- We used a variant of the Stroop task in which subjects reported whether a **spatial preposition** word (ABOVE, BELOW) was above or below a cross. The word's position either conflicted or agreed with its meaning (which subjects were instructed to ignore).
- We measured the **trajectory of the mouse** as the subject moved the cursor from the bottom of the screen to the appropriate answer location to register the response. Trajectories are a continuous measure of stimulus processing; when the word's position and its meaning conflicted, the response path could deviate toward the wrong corner before finally reaching the correct corner.
- This deviation was reflected in the **direction of movement** at each point in time, and it revealed when the subject made his or her choice between the two responses; a moment in time we propose to call the **decision time**. This decision time was 356ms after onset of the word in the congruent condition, compared to 529ms in the incongruent condition. In contrast, the final response times did not show a significant conflict effect, suggesting that response trajectories are a **more sensitive measure**.
- We conclude that spatial prepositions give rise to **conflict** like colour words do in a classic Stroop task, and that this conflict happens roughly between 350ms and 550ms after word onset.

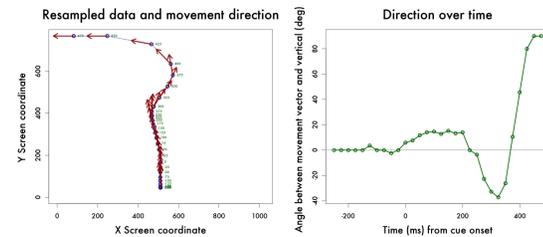
Response measurement

WE measure not only *what* response the subject made and *when*, but also *how*. In every trial, the subject clicked in the bottom of the screen and responded by moving the cursor to one of the two answers that were presented in the corners of the screen.

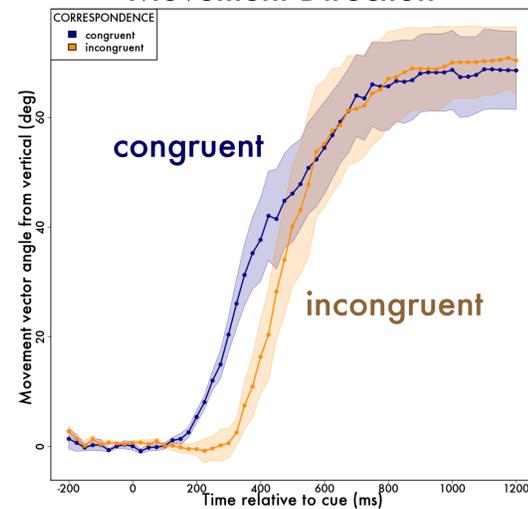


Movement direction

FOR every moment in time we calculate the movement direction, defined as the tangent to the path at that point with 0° being the vertical tangent and positive values assigned to the direction toward the correct corner. The average direction traces for 4 subjects with the standard error of the subject mean indicated by the shaded area are shown below. These curves reveal exactly when the (task-irrelevant) word meaning conflicts with the position information.

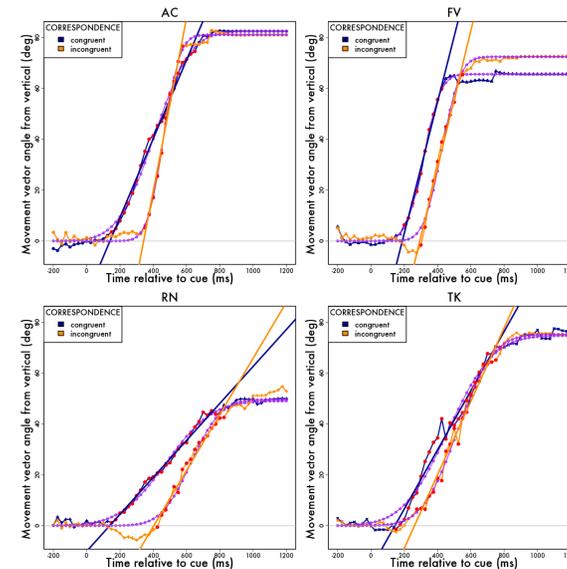


Movement Direction

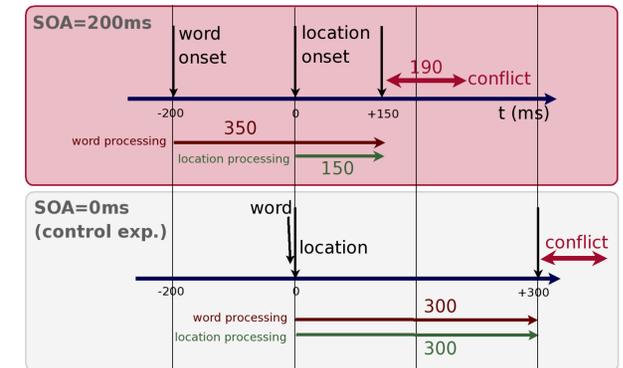


Intra-subject analysis

THESE path tangents showed a stereotypical smooth trend away from the baseline vertical toward a final direct approach to the target corner. We took the intersection of this trend with the baseline as the **decision moment** where the subject has sufficient information to begin the response toward the appropriate corner.



Time window of conflict

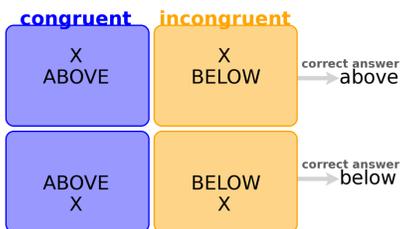


Conclusion

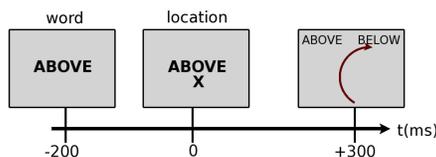
- Spatial prepositions (ABOVE, BELOW) give rise to Stroop conflict like colour words do.
- This conflict shows up in response trajectories using a regular computer mouse.
- Movement direction reveals most precisely the time window of this conflict.

Spatial Stroop

SUBJECTS were presented the word ABOVE or BELOW, which they were told to ignore. The task was to report whether an X that appeared 200ms later was *above* or *below* the word.

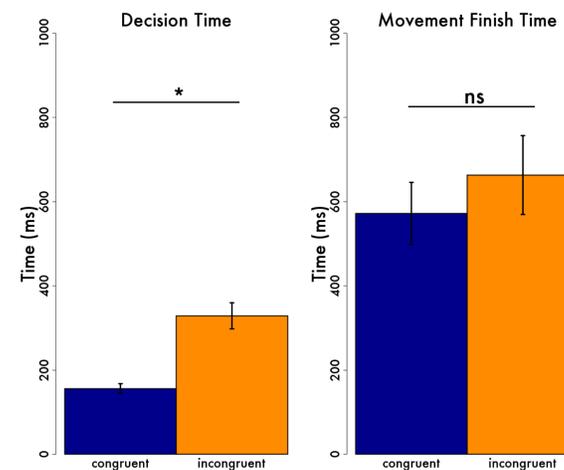


To ensure that the subject keeps reading the word (which is task-irrelevant) we interleaved these *location* trials with a second, *name* task. Here, instead of the X an O appeared and the subject is asked to report the word, ignoring the position of the O. However, we omit further analysis of these *name* trials. Furthermore, the word is given a processing advantage by appearing 200ms before the location information.



Decision time is precise

WHEN we compare these decision times for each subject with the movement finish time, we find that they show a much greater effect with a smaller standard error and they identify the early moment in time at which this conflict occurs.



Acknowledgements

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