

LANGUAGE SHAPES MENTAL REPRESENTATIONS OF MUSICAL PITCH: IMPLICATIONS FOR METAPHORICAL LANGUAGE PROCESSING

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Speakers often use spatial metaphors to talk about musical pitch (e.g., a low note, a high soprano). Previous experiments suggest that English speakers also think about pitches as high or low in space, even when they're not using language or musical notation (Casasanto, 2010). Do metaphors in language merely reflect pre-existing associations between space and pitch, or might language also shape these non-linguistic metaphorical mappings?

To investigate the role of language in pitch representation, we conducted a pair of non-linguistic space-pitch interference experiments in speakers of two languages that use different spatial metaphors. Dutch speakers usually describe pitches as high (hoog) and low (laag). Farsi speakers, however, often describe high-frequency pitches as thin (naazok) and low-frequency pitches as thick (koloft).

Do Dutch and Farsi speakers mentally represent pitch differently? To find out, we asked participants to reproduce musical pitches that they heard in the presence of irrelevant spatial information (i.e., lines that varied either in height or in thickness). For the Height Interference experiment, horizontal lines bisected a vertical reference line at one of nine different locations. For the Thickness Interference experiment, a vertical line appeared in the middle of the screen in one of nine thicknesses. In each experiment, the nine different lines were crossed with nine different pitches ranging from C4 to G#4 in semitone increments, to produce 81 distinct trials.

If Dutch and Farsi speakers mentally represent pitch the way they talk about it, using different kinds of spatial representations, they should show contrasting patterns of cross-dimensional interference: Dutch speakers' pitch estimates should be more strongly affected by irrelevant height information, and Farsi speakers' by irrelevant thickness information.

As predicted, Dutch speakers' pitch estimates were significantly modulated by spatial height but not by thickness. Conversely, Farsi speakers' pitch estimates were modulated by spatial thickness but not by height (2x2 ANOVA on normalized slopes of the effect of space on pitch: $F(1,71)=17,15$ $p<.001$).

To determine whether language plays a causal role in shaping pitch representations, we conducted a training experiment. Native Dutch speakers learned to use Farsi-like metaphors, describing pitch relationships in terms of thickness (e.g., a cello sounds thicker than a flute). After training, Dutch speakers showed a significant effect of Thickness Interference in the non-linguistic pitch reproduction task, similar to native Farsi speakers: on average, pitches accompanied by thicker lines were reproduced as lower in pitch (effect of thickness on pitch: $r=-.22$, $p=.002$).

By conducting psychophysical tasks, we tested the Whorfian question without using words. Yet, results also inform theories of metaphorical language processing. According to psycholinguistic theories (e.g., Bowdle & Gentner, 2005), highly conventional metaphors are processed without any active mapping from the source to the target domain (e.g., from space to pitch). Our data, however, suggest that when people use verbal metaphors they activate a corresponding non-linguistic mapping from either height or thickness to pitch, strengthening this association at the expense of competing associations.

As a result, people who use different metaphors in their native languages form correspondingly different representations of musical pitch.

Casasanto, D. (2010). Space for Thinking. In *Language, Cognition and Space: State of the art and new directions*. V. Evans & P. Chilton (Eds.), 453-478, London: Equinox Publishing.
Bowdle, B. & Gentner, D. (2005). The career of metaphor. *Psychological Review*, 112, 193-216.