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Pre-conscious Automaticity of Sound-Shape Mapping

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Abstract

The bouba–kiki effect depicts a non-arbitrary mapping between specific shapes and non-words: an angular shape is more often named with a sharp sound like 'kiki', while a curved shape is more often matched to a blunter sound like 'bouba'. This effect shows a natural tendency of sound-shape pairing and has been shown to take place among adults who have different mother tongues (Ramachandran & Hubbard, 2001), pre-schoolers (Maurer, Pathman, & Mondloch, 2006), and even four-month-olds (Ozturk, Krehm, & Vouloumanos, 2013). These studies therefore establish that similar sound-to-shape mappings could happen among different cultures and early in development, suggesting the mappings may be innate and possibly universal. However, it remains unclear what level of mental processing gives rise to these perceptions: the mappings could rely on introspective processes about 'goodness-of-fit,' or they could rely on automatic sensory processes which are active prior to conscious awareness. Here we designed several experiments to directly examine the automaticity of the bouba-kiki effect. Specifically, we examined whether the congruency of a sound-shape pair can be processed before access to awareness?

Keywords: automaticity, sound-shape mapping, bouba–kiki effect

1. Experiments

To directly examine whether sound-shape mapping (i.e. bouba-kiki effect) happens prior to conscious awareness, we designed a first experiment (Exp. 1) in which the congruency was defined by the relationship between a non-word and a shape (Ramachandran & Hubbard, 2001b), that is, the non-word "kiki" was congruent with the angular shape, while the non-word "bouba" was congruent with the curvy shape. We blended the non-words into the shapes and presented the pairs with a series of flashing colourful squares in a dichoptic setup to suppress the visibility of the target pairs. (see **Figure 1**). The technique is referred to as 'continuous flash suppression'; for details, see Tsuchiya & Koch (2005). The time taken to see the pairs was measured, and the results exhibited a congruency effect: congruent pairs broke suppression and reached conscious awareness faster, suggesting that prior to being consciously aware of the visual stimulus, the phonology of the non-word has been extracted and matched with the shape.

Furthermore, we tested whether the congruency effect depended on the sound-shape consistency or was simply a result of the visual similarity between the non-words and shapes. In two further experiments (Exp. 2a and 2b), we implemented unfamiliar letters from the West African *Vai* Script. They were chosen from a database of 56 ancient and unfamiliar scripts that have been previously tested for their sound symbolic properties, and show neutral symbolism for linguistic contrasts (see **Figure 2**) (Styles, 2014). The congruency of the letter-shape pairs was determined by the training received prior to the main experiment. For instance, a letter paired up with the sound "kiki" was deemed to be congruent with the angular shape. Again, the "congruency effect" was found. Crucially, results showed that the congruency effect stemmed from the relationship between the shape and the sound represented by the letter, and not from shared visual characteristics.

Taken together, the three experiments suggest that sound-shape mapping can happen automatically, and that sensory congruency facilitates the access to conscious awareness.

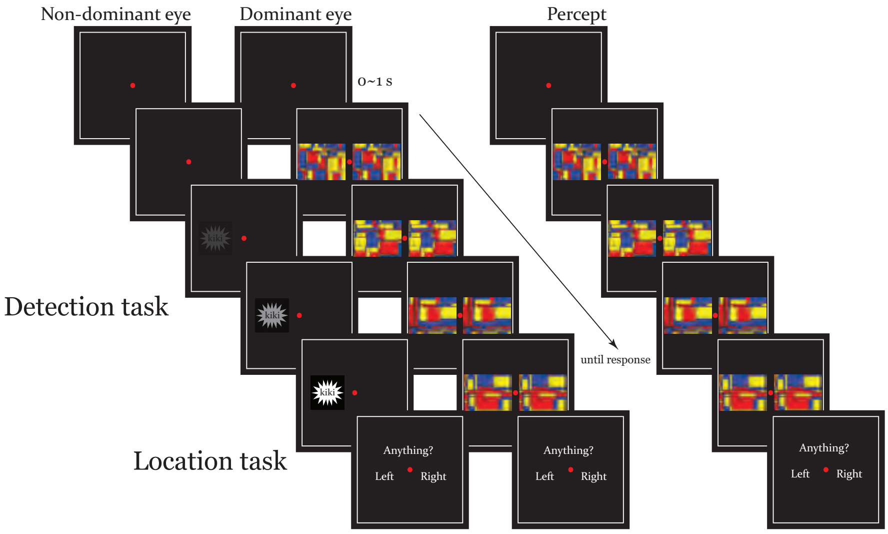

Figure 1. Illustration of the experiment procedure and stimuli in Exp. 1. After a fixation period ranging from 0 to 1 second, a series of 'colourful squares' flashing at 10 Hz was presented to the dominant eye. Meanwhile, the target stimulus was presented to the non–dominant eye either on the left or right side of the fixation point. The contrast of the target stimulus ramped up from 0 to 75% in 10 seconds. The target stimulus stayed on the screen up to 10 s or until the visibility was indicated. Participants were required to press a button immediately after any part of the target stimulus became visible (Detection task) and then report the location of it (Location task).

Figure 2. Left panels: example congruent stimuli in Exp. 1. Right panels: example stimuli in Exp. 2a (congruent) and 2b (incongruent), where the congruency of a pair depended on the training received. One word was paired up with the sound "bubu" in Exp. 2a and the sound "kiki" in Exp. 2b.

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