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Robust spatial ventriloquism effect and trial-by-trial aftereffect under memory interference

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Our brain adapts to discrepancies in the sensory inputs. One example is provided by the ventriloquism effect, experienced when the sight and sound of an object are displaced. Here the discrepant multisensory stimuli not only result in a biased localization of the sound, but also recalibrate the perception of subsequent unisensory acoustic information in the so-called ventriloquism aftereffect. This aftereffect has been linked to memory-related processes based on its parallels to general sequential effects in perceptual decision making experiments and insights obtained in neuroimaging studies. For example, we have recently implied memory-related medial parietal regions in the trial-by-trial ventriloquism aftereffect. Here, we tested the hypothesis that the trial-by-trial (or immediate) ventriloquism aftereffect is indeed susceptible to manipulations interfering with working memory. Across three experiments we systematically manipulated the temporal delays between stimuli and response for either the ventriloquism or the aftereffect trials, or added a sensory-motor masking trial in between. Our data reveal no significant impact of either of these manipulations on the aftereffect, suggesting that the recalibration reflected by the trial-by-trial ventriloquism aftereffect is surprisingly resilient to manipulations interfering with memory-related processes.

Sensory recalibration is a mechanism by which the brain continuously adapts to apparent discrepancies in our sensory environment, such as the displaced figure and voice of an actor in a movie watched over headphones[1,2]. One example of adaptive recalibration is the ventriloquism aftereffect (VAE), a frequently studied paradigm for multisensory perception in the laboratory. To reveal this aftereffect, participants are first (in an audio-visual trial) presented with spatially discrepant audio-visual stimuli, which give rise to a biased localization of the sound. This bias reflects the partial fusion of the discrepant audio-visual information—the so called ventriloquism effect (VE)[3]. In a subsequent trial, participants are then asked to localize a unisensory sound, which they often misjudge in the direction established by the previous multisensory discrepancy[4–7]. For example, when the light is to the left of the sound in the audio-visual trial, the subsequent sound is misjudged to the left. This aftereffect, or recalibration bias, is observed following prolonged exposure to consistent multisensory discrepancies[8,9], but also following single trial exposure, the so called immediate or trial-by-trial recalibration effect[4,7]. In either case, the resulting aftereffect bias reflects the persistent influence of previously received multisensory evidence on subsequent behavior.

Using neuroimaging we have recently investigated the neurophysiological mechanisms underlying the trial-wise ventriloquism aftereffect[7]. We found that medial parietal cortices reflect the persistent encoding of previous multisensory stimuli and are predictive of the trial-wise aftereffect[7]. This led us to speculate that brain regions traditionally implied in spatial and working memory[10–13] contribute to the aftereffect, for example by maintaining a representation of the previous sensory evidence between trials and mediating its influence on the perception of subsequent stimuli. Such a role of parietal regions in the ventriloquism aftereffect has also been suggested by other studies, and possibly the same parietal processes contribute to both the immediate and long term effects[14,15].

That brain regions involved in short-term memory may contribute to the ventriloquism aftereffect is similarly predicted by studies on other types of serial dependencies in perceptual decision making. Statistical dependencies between judgements made in consecutive trials are seen ubiquitously in sensory and cognitive tasks[16–18]. While in many paradigms such dependencies could in principle arise from changes in early sensory representations, the emerging consensus seems to be that these arise from memory-related processes[17,19]. In support of this, recent studies showed that experimental manipulations known to affect memory processes[20,21], such as changing the delay between stimulus and response, alter serial dependencies during judgements of visual

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