Response latencies to chromatic and achromatic visual stimuli

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Abstract

There has been considerable debate about how visual information is processed for the perception of stimuli and the generation of motor responses to the same stimuli. While there are well-documented differences in conduction latencies of the luminance and chromatic pathways, it is unclear if information that is integrated from these pathways is used in a similar way across motor and perceptual tasks. Key aspects of human behaviour have different requirements in terms of the spatial and temporal resolution required to complete the task. Certain tasks may therefore rely on processing of information that has spatial or temporal characteristics that are most informative for that specific task. Three studies examined tasks with different task demands; a simple reaction time task, three perceptual asynchrony tasks and a reaching task. Differences in processing for perceptual and motor responses were investigated by measuring differences in the relative response latencies to chromatic and luminance stimuli in these tasks.

In the first study, I investigated ways to equate the contrast of different chromatic and luminance stimuli. I then measured RTs to these stimuli as a function of contrast. RTs to luminance stimuli were approximately 45 and 60 ms shorter than RTs to L-M and S-cone stimuli respectively. RTs decreased as a function of contrast more rapidly to luminance stimuli than to chromatic stimuli.

In the second study, I used three tasks to investigate relative latencies with which chromatic and luminance stimuli were perceived to appear. I demonstrated that two of the existing tasks typically used to investigate

perceptual asynchrony were unsuited for this comparison. I then developed a task that determined the minimum backmask onset delays that allowed participants to accurately locate stimuli. The differences in the delays between the pathways indicated the differences in the latencies in when the stimuli appeared to participants. The temporal advantage for the luminance pathway was only approximately 9 and 14 ms over the L-M and S-cone pathways respectively.

In the final study, I examined the delays in correcting rapid reaches to luminance and chromatic stimuli. The temporal advantage for the luminance pathway was approximately 15 and 20 ms over the L-M and S-cone pathways respectively.

The temporal advantage found for the luminance pathway in the RT task may be larger than the advantage that would be predicted on the basis of differences in conduction latencies alone. Thus, the relatively rapid decrease in RT with contrast for the luminance pathway, and the large dissociation in the response latencies measured in the RT and perceptual tasks, is consistent with there being separate decision making processes for RT and perception, with the RT response being relatively more reliant on luminance information. The reaching correction response however appears to rely on a similar contribution from the pathways to the perception of the stimuli. It is discussed how these stimuli and results could be readily utilised to extend these comparisons to further develop understanding of commonality and differences in processing visual information for different visual tasks.

Contents

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Abbreviations

(in order of appearance)

L-M	L-M opponent or parvocellular retino-geniculate pathway
S-cone	S-cone opponent or koniocellular retino-geniculate pathway
RT	Simple reaction time
VEP	visually evoked potential
TOJ	temporal order judgement
SJ	simultaneity judgement
AFC	alternative forced choice
MOA	mask-onset asynchrony
L	long wavelength photoreceptive cone
M	medium wavelength photoreceptive cone
S	short wavelength photoreceptive cone
LGN	lateral geniculate nucleus
MT	middle temporal
PPC	posterior parietal cortex
MB-DKL	MacLeod, Boynton, Derrington, Krauskopf & Lennie colour space
CRT	cathode ray tube
RMS	Root mean square
MDT	Multiples of detection threshold
PA	perceptual asynchrony
SOA	stimulus onset asynchrony
ART	anticipatory reaction time