Visuospatial Attention and Redundancy Gain

Jeff Miller[1] & Daniela Beutinger[2]

[1]University of Otago, New Zealand [2]Universität Tübingen, Germany

Contact: miller@psy.otago.ac.nz

Background

Processes underlying visuospatial attention can be studied with simple reaction time (RT) tasks in which people must respond as rapidly as possible to the onset of any visual stimulus. Two robust phenomena have been reported:

Spatial precuing effect: People respond more rapidly when a visual stimulus appears in a cued location rather than an uncued location (e.g., Posner, Nissen, & Ogden, 1978). Psychophysiological measures indicate that spatial precuing affects neural responses in early sensory/perceptual processes within the visual system (e.g., Mangun & Hillyard, 1991).

Redundancy gain: People respond more rapidly to the onset of two separate visual stimuli than to a single stimulus (e.g., Miller, Kühlwein, & Ulrich, 2004). Redundancy gain suggests that visual stimuli in different locations somehow combine to activate responses. It is not yet clear, however, at what level the combination of information/activation occurs.

Research Question

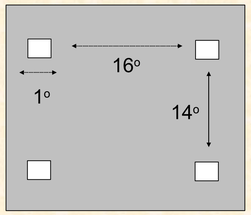
Does the size of redundancy gain depend on whether stimuli appear in attended or unattended locations?

If so: Redundancy gain probably arises during sensory/perceptual processes influenced by spatial attention. For example, if redundancy gain speeds these processes due to neural interactions, and if these processes are 10% faster for attended locations than for unattended ones, then redundancy gain should be smaller for attended locations than for unattended ones.

If not: Redundancy gain probably arises after the sensory/perceptual processes influenced by spatial attention, presumably at the level of decision-making or responding.

Method

Figure 1: Stimulus Display. Imperative stimuli were bright squares at any of the four corners of an imaginary square on a CRT. Stimulus intensity was ~70 cd/m^2 against a dark background.



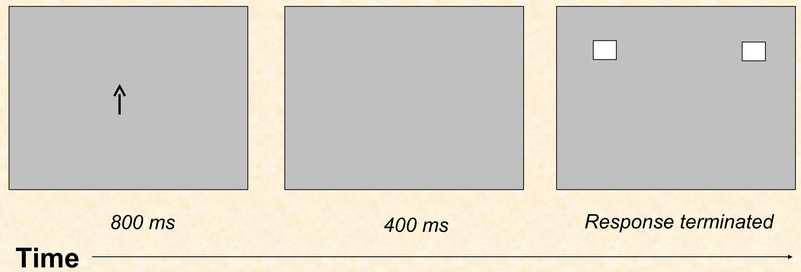
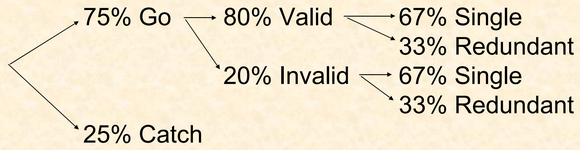


Figure 2: Trial Time Line. Each trial began with an arrow cue indicating two squares that were especially likely to appear—in this example, the two squares in the top row. Soon after the cue disappeared, 1 (single) or 2 (redundant) squares appeared until the participant responded. This example trial has a *valid* cue and *redundant* stimuli.

Simple RT Task Instructions: Respond as quickly as possible if 1 or 2 squares appear ("go" trials). Do nothing if no square appears ("catch" trials).

Experimental Factors Manipulated on Go Trials:
Single versus ***Redundant:*** 1 versus 2 squares appear.
Valid versus ***Invalid:*** Square(s) appear in cued versus uncued locations.

Proportions of Trials:



Experiment 1 (row cues): Cues indicated the top or bottom row; redundant stimuli were both in the same row (one on the left & one on the right).

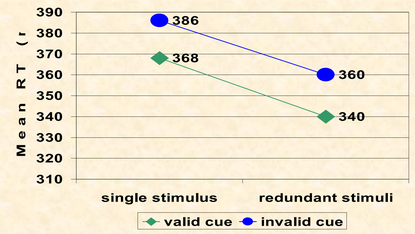
Experiment 2 (side cues): Cues indicated the left or right side; redundant stimuli were both on the same side (one on the top & one on the bottom).

Data: N=40 participants per experiment; 640 trials per participant.

Results

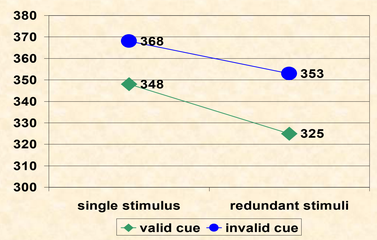
Redundancy has the same effect on mean RT regardless of whether the locations are cued or uncued:

Experiment 1: Row Cues



Interaction: $F(1,39)=0.03$, $p > .85$

Experiment 2: Side Cues



$F(1,39)=1.74$, $p > .15$

Additional analyses with RT distributions: The race model inequality was satisfied with both valid and invalid cues (Ulrich, Miller, & Schröter, 2006).

Conclusions

- Redundancy gain is the same size whether stimuli appear in attended or unattended locations.
- Redundancy gain probably arises after the sensory/perceptual visual processes that are sensitive to spatial cues.

References

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