Spatial cueing

Background

According to the "spotlight" theory, visual attention is like a beam which can be focused on one area of a scene to highlight objects and events in that area. A classic experiment which shows this "spotlight" effect is the spatial cueing experiment. In this experiment, subjects asked to maintain fixation in the center of a screen and detect (as quickly as possible) targets which can appear either to the left or right of fixation. At the start of each trial, the subject sees a cue (such as an arrow) which points to the likely location of the target. After the cue vanishes, a target (such as a red dot) appears in either the left or right location and the subject must press a key as soon as he detects the target. Although the subject cannot move his eyes, he can shift his attention to the side indicated by the cue. Most of the cues are valid (ie, the arrow points to where the target will appear). But every so often, there is an invalid cue (the arrow points in one direction, but the target appears on the other side). The typical finding in this experiment is that subjects are faster to detect the targets after valid cues, and slower to detect the target after invalid cues (relative to a control condition with a neutral cue, which signals that the target is equally likely to appear in either location). The speed difference for valid and invalid cues suggests that subjects are shifting their attentional "spotlight" according to the cue, becoming more sensitive to events in the "spotlighted" area (but less sensitive to events occurring outside the field of attention).

Abnormal patterns of attention are a hallmark of many cognitive disorders, including autism, schizophrenia, and Alzheimer's. Two undergraduate cognitive science students, Cassandra and Dawn, are asked to do a study of attention in a patient population for a clinical psychology class. They decide to investigate attention in austistic spectrum disorders by running a spatial cueing experiment on young adults with Asperger's Syndrome.

Experiment

Cassandra and Dawn recruited 15 participants (12 male, 3 female) with the help of an autism/ADHD research group associated with their university. The only requirements for the study were that participants had to be between the ages of 18 and 26 and have a diagnosis of Asperger's Syndrome.

Participants were seated at a computer screen in a dark, quiet room. The experimenter (either Dawn or Cassandra, selected at random) read instructions from a script. Participants were told that they would need to maintain fixation on a cross on the center of the screen, while targets (red dots) appeared on one side of the screen or the other. The participant's job was to press the spacebar as quickly as possible when they saw the target. Before each target appeared, there would be a cue, which was either a left arrow (signifying the target was most likely to appear on the left), a right arrow (signifying a target on the right), or a double-headed arrow (a neutral cue which meant that the target was equally likely to appear on either side). Participants were told that they would need to start each trial by pressing the return key, and that they could take breaks whenever they needed throughout the experiment. Participants were given an opportunity to ask questions to ensure that they understood the instructions.

The experiment consisted of 200 trials, half experimental trials (with left/right arrow cues) and half control trials (with neutral, double-headed arrow cues). Of the arrow cues, half were valid cues (the arrow pointed in the direction in which the target would appear) and the other half were invalid cues (the arrow pointed in one direction, but then the target appeared on the other side). The arrow appeared 400 ms after the start of the trial, remained on screen for 1000 ms, and then vanished; at which point, simultaneously, the target appeared on the screen. The various types of trial (valid cue, invalid cue, and neutral cue) were mixed together and shown in a random order. Within each trial type, there were exactly as many right-hand targets as left-hand targets, and the valid and invalid cue trials were also balanced so that there were equal numbers of right arrows and left arrows within each type of trial.

Results

The typical pattern of results for a spatial cueing experiment is that people are, on average, fastest to detect the target on valid cue trials, slowest on invalid cue trials, and in between on the neutral cue trials. However, this was not what Cassandra and Dawn found with the Asperger's Syndrome adults. These subjects did not perform differently on the different types of trials: they responded to targets at the same speed no matter whether they saw a valid cue, invalid cue, or a neutral cue. Dawn thinks these results are exciting and show that there is something very unusual about visual attention in individuals with Asperger's Syndrome. However, Cassandra disagrees. She thinks the results could have been caused by methodological issues and might have nothing to do with Asperger's Syndrome. What do you think?

Answer key

1. The number one problem is that they didn't include a non-patient control group. Without this, they have no way of knowing that their findings have anything to do with Asperger's Syndrome. In fact, given the other serious flaws with this experiment, it's likely that a non-patient group would give exactly the same results (no spatial cueing effect).

2. Another huge problem is that the cues did not actually tell people anything about where the target would appear, so participants might have just ignored them. Since half of the cues were valid and half invalid, the odds of a target appearing on the right after a right-arrow cue was only 50/50 (same as the odds after a neutral cue). Participants may have picked up on this, consciously or unconsciously, and just treated the arrow cues as neutral cues, since they were really no more informative. (Normally this problem is avoided by having far more valid than invalid cues, ie 80% valid cue trials and 20% invalid cue trials.)

3. Making the target appear at exactly the same time the arrow disappeared was probably a bad idea – the sudden disappearance of the arrow probably would tend to draw participants' attention back to the center of the screen when they should have been keeping their attention focused on one side of the screen or the other.

4. It's possible that participants cheated by anticipating the target and just pressing the button when they thought a target was about to appear. It would be a good idea to look at the individual RTs and see if many of them are abnormally fast (it takes some time for a signal to travel from the eyes to the fingers – subjects who respond much too quickly cannot be detecting the target; they are guessing or anticipating the target).

5. Similarly, it's possible that participants were cheating by moving their eyes (however, eye movements would probably not explain these results). An eyetracker could have been used to make sure that participants maintained fixation throughout each trial.

6. The intermixed design might have caused additional problems in a patient population which has problems with task switching; patients might find it difficult to switch between using the cue in experimental trials and ignoring it in control trials, and perhaps they wound up ignoring the cue in all trials. I'm not sure whether this is a likely problem with Asperger's Syndrome individuals, but might have been worthwhile to try a blocked design in addition to the intermixed.

7. It's possible that participants did not understand the instructions and did not feel comfortable asking the experimenter for an explanation. (The way the instructions were presented in this experiment might have been particularly bad for autistic spectrum individuals, who are likely to have problems with social interaction and language.)

8. The students probably should have screened their participants for other disorders, so they could either exclude certain subjects or use the extra data in their analysis. Since participants were recruited from an autism/ADHD research group, it's likely that some participants had both ADHD and Asperger's. The ADHD individuals might have been driving any results that showed an unusual pattern of attention.

9. You could argue that the participant pool is biased towards males and they should have tried to include more women in the study (but on the other hand, about 80% of the people with Asperger's Syndrome are male, so their sample is actually very representative of the population).

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