Introduction to Cognitive Science - Term Paper 2

Examining evidence against the Action vs Perception Hypothesis proposed by Goodale & Milner (1992), with experiments on visual illusions

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Abstract

Ungerleide (1982) proposed based on lesion studies on monkeys that in primate brains, visual information was processed in two streams – dorsal and ventral. Goodale & Milner (1992) reinterpreted this theory, making a species jump to humans and suggesting that the dorsal stream had the purpose of guiding the manipulation of objects (action) and the ventral stream did the computations necessary for object recognition (perception). I have picked two papers that disagree with this, one via experimentation (Franz et al., 2000), and the other by an analysis of existing work at the time (Franz, 2001). In this term paper, I will be explaining the phenomenon being considered in the first place, the cognitive processes involved, a quick summary of the experiments and arguments, noted gaps in the treatment, potential extensions to the study, and my own suggestions on future experimentation.

What are we looking at?

- Studies with visual illusions have been used to propose evidence for the separate visual processing pathways theory. We're looking at counter-arguments: studies that look at the same illusions with different experimental setups and justify why the original proposal is not so.

The original hypothesis, and responses

- In brief: the theory is that primate visual system is organised into two parallel pathways. Goodale & Milner (1992) suggested extending it to humans too, using an experimental setup around the Ebbinghaus illusion. Hereon this will be referred to as 'the hypothesis'
- Initially received positively, more critical pieces tackling gaps and flaws in the original experiments came up. I'm looking at one such response (Franz et al., 2000) that sets up an experiment contradicting Goodale's (1992) results, and also adds a few more to refute assumptions taken to be true in earlier work. I will also be looking at Franz (2001), that looks at publications on the topic at the time and highlights methodological concerns with all the work agreeing with Goodale's (1992) original work.

The Cognitive Processes involved

- Vision:
  - Perception
  - The hypothesis suggests that this is a complex task involving computations for object recognition and conscious perception, taking up the ventral stream of processing.
- Motor:
  - Estimation

  - The hypothesis suggests that this is taken care of by the dorsal stream, where the focus is on quick computation and short-term memory that can locate objects (that might be moving) and start acting towards performing operations on them.

What has been shown: The Experiments and Arguments

- Background: all the experiments generally look for perception vs action, and all of them use the Ebbinghaus illusion.
- Perception is represented most often by trying to adjust an external circle to the size of the internal one, or if both are given simultaneously the task sometimes is to adjust both so they end up the same size (if they aren't physical circles).
- For action, the common task is to ask the subject to grasp the central circle (which is a physical object), with various adjustments against possible biases (such as only showing the circle for a second or so before asking the subject to grasp it). External tracking systems are used to achieve this.
- The most prominent results – Aglioti et al. (1995) – found that there was less effect of the illusion on grasping versus perception.

Franz et al. (2000)

- Observations on prior experiments:
  - it is setup such that both are shown side by side. They hypothesise that this increases the time taken for visual distinction, whereas with grasping the subject is only looking and acting on a single stimulus.
  - More specifically, the problem is the assumption that "the perceptual effects of the two Ebbinghaus figures simply add up to yield the effect obtained by the direct comparison."
- Experimental setup 1:
  - They setup experiment 1 with an alternate experiment construction, where only one of the stimuli is available to the subject at a time. So instead of seeing both side by side, the subject was shown only one at a time, and had to make adjustments accordingly.
  - More details
  - What they saw: similar effect of both visual and action tasks.
- Experimental setups 2 and 3:
  - These experiments are setup to verify that the "additive effect" that earlier studies assumed would hold, does not hold for the case of Ebbinghaus figures – essentially, that the direct comparison led to a larger perceptual effect than when one took the sum of the effects in separate comparisons.
  - For experiment 2, the perceptual setup was repeated, only this time with three variations: first with the experimental setup used in Experiment 1, then with the setup by Aglioti et al. (1995), and then with a third setup they had proposed to simulate the grasping task of the original studies.
  - As expected, results demonstrated exactly the goal of the experiment – that the perceptual effect of direct comparison was more than the sum of the effects taken individually, and so the assumption of the additive effect was a failure of the original study.
  - Experiment 3 was setup to counter a possible argument: that the original setup had subjects compare the two disks immediately before grasping. This setup was replicated by requiring participants to first compare the central circles directly before the comparison to an isolated circle. In theory, this simulates the original experiment, so if additivity is a property of such then it should be demonstrated here too. Results, again, indicated otherwise – direct comparison was greater than the sum of separate comparisons.

Franz (2001)

- In recent (for 2001) work, a number of studies agree on "significant effects of visual illusions on grasping," others show effects that are "close to being significant," and one shows a reversed effect. Franz argues that if grasping did resist visual illusions (aka if Action and Perception did indeed have separate visual pathways), then there would be more reversed, or non-significant effects.
- The studies can be grouped by:
  - Standard perceptual measures:
    - Aglioti and others: Perceptual effects more than motor effects
    - Task-normalised: Good match between perceptual and motor effects
  - Non-standard perceptual measures: Is too inconsistent for good measure.
- Responding to general arguments:
  - The correlation may be due to *partial* involvement of the perceptual stream.
    Methodological problems. It's now assuming the motor system is less affected by visual illusions than perception.
  - There is an independent motor illusion generated.
    But studies on this line either showed very small significant/non-significant effects, or were using nonstandard measures.

Gaps and Future work

Major Gaps

- In the grasping tasks, the object is 3D and the screen image is 2D. This reduces the perceptual effect. They try to counter it, but it is acknowedged as a concern, maybe an all-physical setup would be better.
- Experiment 3 is handwavy - claims that this is a reasonable explanation, but does not elaborate on why
- Carey (2001) suggested that the results meant that motor system only takes into account a close area around the target, and perceptual system has to attend to the whole thing.

How to extend the studies

- Use an all-physical setup.
- To "match the task demands" they could try something TODO

References

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