Why use bodies at all?

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1 Abstract

A lot of research is being conducted on cognition; on human cognition as well as on robotic cognition. From the classical or Cartesian perspective, cognition and the body on which the cognition operates are two separate entities. In this paper we point out that not only the body is needed for cognition, but moreover that cognition should be seen as an integrated part of the body.

2 Introduction: the Cartesian split

Traditional Good Old Fashioned Artificial Intelligence (GOFAI) approaches are based on what is commonly called the Cartesian split: the distinction between body and mind[i]. Although this distinction goes back at least to Plato, several arguments against it arise. In this paper we describe three arguments why the distinction between body and mind should not be made.

3 Arguments for integrating body and mind

3.1 Argument 1: interaction with environment

The first argument is that behavior, as the interaction between an agent and its environment, and as the product of cognition, shows that cognition may be seen as a part of the body and not as a independent entity [ii].

3.1.1 Cognition is about interaction with environment

An agent receives input from its environment and processes it using its cognition to some output. This input-output loop, which is the behavior of the agent, is realized by sensors and actuators. These sensors and actuators are part of the body. Therefore the body is necessary to allow cognition to interact with the environment. Given that cognition exist by the grace of its interaction with the environment, or its behavior, the body must be seen as a fundamental part of cognition. Even more, cognition may be seen as a part of the body.

3.1.2 Body provides cognition from continious feedback

The body provides cognition from feedback. This feedback is used to optimize actions and moves. Without this feedback, it would for most organisms be impossible to survive. From the fist days of our lives, feedback enables us to optimize movements as grabbing or following objects. For infants, feedback already plays a vital role in development of their moves by adjusting for the dynamics.

In adults, proprioceptive feedback plays a role in generation of fluent, controlled moves. This feedback is needed to execute tasks efficiently. Without this feedback, all moves would be done ballistically, which means that they are not controlled. Agents experienced with some task often produce such moves. However, in order to learn such ballistic moves, novices agents use controlled moves and feedback provided on these moves.

3.2 Argument 2: parts of cognition may be build into the body

3.2.1 Preprocessing of input signals

In organisms, signals received from the environment are selected and preprocessed by the body. By suppressing irrelevant signals, selection of signals dramatically reduces the amount of computational power necessary. This is not an active process, but is inherent to the physical properties of the body. However, these physical properties are evolved in such a way that selection of signals is optimized for relevance.

Preprocessing of signals relieve central processing from certain tasks. For example, for most mammals their ears are displaced from each other in such a way that for that mammal the displacement is optimal for 3D-localization of a sound.

3.2.2 Postprocessing output signals

In mammal brains, separate signals may flow towards the same actuator. Different, even contradictory signals may arrive at the same actuator in rapid alteration or even at the same time. The target actuator may postprocess these signals by not taking all incoming signal into account separately, but using them to ‘estimate’ an average signal from which the actuator determines its action.

Like preprocessing signals, postprocessing is not an active process, but is inherent to the physical properties of the actuator. These physical properties might be evolved in such a way that the action is executed as fluently as evolutionary demanded.

3.3 Argument 3: The mind must fit the body

Earlier in this paper we found that a body is necessary for interaction with the environment and that parts of cognition may be build in the body. Whether cognition on

the one side and the sensors and actuators in the body on the other side are largely seperated or largely integrated, they will in both cases form an entity together.

3.3.1 Communication between cognition and sensors and actuators

Within this entity, the cognition should communicate with the sensors and actuators. To make this possible, the cognition must be adapted to communicate with the sensors and actuators in order to communicate through the sensors and actuators.

3.3.2 Cognition must fit the properties of the cognition-body-part

In intelligent systems, part of the body is reserved for cognition. With humans for example the brain handles most of the cognition. Such a body-part has certain properties. The cognition has to fit this properties. Consider for example the possibility of parallel processing in a single-core or a multi-core personal computer. Or consider the amount of memory available in a snail. Cognition must fit the properties of the cognition-body-part.

4 Conclusion

We decribed three arguments for integrating body and mind. These arguments immediately describe why to use bodies at all:

- interaction with environment
- parts of cognition may be build into the body
- the mind must fit the body

We do not argue that research for cognition without considering the body is useless. We argue only that integrating body and mind has certain advantages. The body must not be forgotten when researching cognition and in some cases will be necessary to take in consideration.

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[i] Robotics: Philosophy of Mind using a Screwdriver, Harvey, I. (1999), School of Cognitive and Computing Sciences, University of Sussex, Brighton

[ii] The brain has a body: adaptive behavior emerges from interaction of nervous system, body and environment, Chiel, H.J. | Beer, R.D. (1997), Trends Neurosci. (1997) 20, pp 553-557