First Sources - Relationship between Aphantasia and Embodied Cognition

PRIMARY SOURCES

1. **Dawes, A.J., Keogh, R., Andrillon, T. *et al.* A cognitive profile of multi-sensory imagery, memory and dreaming in aphantasia. *Sci Rep* 10, 10022 (2020).**

    1. Here we found that individuals with aphantasia report signifcant reductions in sensory simulation across a range of volitional and non-volitional mental processes, and overall appear to demonstrate a markedly distinct pattern of cognition compared to individuals with visual imagery. Notably, aphantasic individuals reported signifcantly reduced imagery across all sensory modalities (and not just visual). However, only 26.22% of aphantasic participants reported a total absence of multi-sensory imagery altogether, raising important questions about the primary aetiology of aphantasia and suggesting possible sub-categories of aphantasia within a heterogeneous group (8).
    2. Despite these demographic discrepancies, the results of our replication analysis with control group 2 revealed a remarkably similar pattern of between-group effects to our main analysis (see Tables S2–6 in Supplementary Information). Additionally, a majority of the signifcant changes to our results that did occur are congruent with established efects of age and gender on cognitive outcomes. For example, our fnding that undergraduate participants reported signifcantly more frequent memory intrusions and avoidance behaviours than aphantasic participants in response to stressful life events may be explained by the typically higher prevalence of PTSD diagnosis and symptomatology amongst females (and younger females in particular) (8-9).

2. **Ganczarek, Joanna & Żurawska-Żyła, Renata & Rolek, Aleksandra. (2020). "I remember things, but I can't picture them." What can a case of aphantasia tell us about imagery and memory?. Psychiatria i Psychologia Kliniczna. 20. 134-141.**

    1. The relationship between aphantasia and memory is mentioned in Zeman's account of the M.X. patient. In fact, it seems that aphantasia may provide an interesting opportunity to study the relationship between memory and imagery. Usually, in order to separate memory from imagery, researchers have to employ complex experimental procedures and consider the vividness of mental imagery as a correlate of performance in memory tasks (e.g. Baddeley and Andrade, 2000; Gur and Hilgard, 1975; Keogh and Pearson, 2011, 2014). Instead, in aphantasic individuals we can observe how memory works in the absence of mental imagery. To the best of our knowledge, among the different types of memory, aphantasia

has been studied in the context of visual working memory and autobiographical memory (135).

2. Moreover, she scored very low in object imagery, but had a higher score in spatial and verbal subscales of OSIVQ. This suggests that A.B. experiences no vivid images and has a preference for spatial and verbal reasoning. Her good performance in spatial tasks is further supported by a higher than usual score in the mental rotation test. Also, despite a clear lack of visual imagery, she performed normally in both the forward and backward span of the Corsi Block-Tapping Task, suggesting good capacity and performance of her working memory, including visuospatial working memory (138-139).

3. Wilson, M. (2002). Six views of embodied cognition. Psychonomic Bulletin & Review, 9(4), 625–636.

1. Rather than continue to treat embodied cognition as a single viewpoint, we need to treat the specific claims that have been advanced, each according to its own merits. One benefit of greater specificity is the ability to distinguish on-line aspects of embodied cognition from off-line aspects. The former include the arenas of cognitive activity that are embedded in a task-relevant external situation, including cases that may involve time pressure and may involve off-loading information or cognitive work onto the environment. In these cases, the mind can be seen as operating to serve the needs of a body interacting with a real-world situation (635).
2. Simply put, situated cognition is cognition that takes place in the context of task-relevant inputs and outputs. That is, while a cognitive process is being carried out, perceptual information continues to come in that affects processing, and motor activity is executed that affects the environment in task-relevant ways. Driving, holding a conversation, and moving around a room while trying to imagine where the furniture should go are all cognitive activities that are situated in this sense (626).

4. Gibbs, R. W., Jr., & Berg, E. A. (2002). Mental imagery and embodied activity. Journal of Mental Imagery, 26(1–2), 1–30.

1. Most generally, both blind and sighted individuals' haptic abilities are constrained by a complex coordination between tactile senses, proprioception, and the involvement of the motor cortex. The large range of imagery evidence for the blind clearly rejects the idea that mental images are amodally visual or amodally spatial (Intons-Peterson & Roskos-Ewoldsen, 1989). These findings suggest that there is no reason to believe a visual representation is necessary for mental imagery (7).
2. Our claim that there are fundamental links between embodied activity and mental imagery rests on the idea that perception itself is fundamentally based on kinesthetic action. As Gibson (1979) famously argued, movement is essential to

perception. When people merely touch an object, they understand little of what is perceived unless they move their hands and explore its contours and texture. Although our hands contain sensory transducers, the musculature with which we control movement allows us to explore objects in ways that make it easy to identify what is being felt. When we lift an object, this reveals something about its weight, rubbing our fingers across it tells us about its texture, and its overall shape, and squeezing it says something about its compressibility (2).

5. **Takahashi, J., Saito, G., Omura, K., Yasunaga, D., Sugimura, S., Sakamoto, S., … Gyoba, J. (2022, May 25). Diversity of aphantasia revealed by multiple assessments of the capability for multi-sensory imagery.**

    1. There is a large discrepancy between the criteria for VVIQ and self-identification of the absence of visual imagery. Although the criteria for identifying aphantasia have not yet been determined, many studies have used the VVIQ criteria to identify aphantasia and have conducted perceptual and cognitive experiments to reveal the characteristics of people with aphantasia, focusing on tasks associated with visual imagery (4).
    2. Our data showed a ratio of 3.67% under the VVIQ criteria (VVIQ ≤ 32) and 12.24% under the self-identification criterion. We found a large discrepancy between these proportions, in which participants reported self-identification of the absence of visual imagery even with higher VVIQ scores (33 ≤ VVIQ) (21).

6. **Jacobs, C., Schwarzkopf, D. S., & Silvanto, J. (2018). Visual working memory performance in aphantasia. *Cortex*, 105, 61–73.**

    1. In order to investigate the functional role of mental imagery in visual working memory, we compared performance of a congenitally aphantasic individual to that of a group of age-matched controls on a number of different (visual) working memory aspects. The first surprising result was that her performance in the mental imagery task did not differ from controls. However, her metacognitive performance on this task was lower than that of controls; specifically, she overestimated her own performance on inaccurate trials. Thus, although she was able to perform a task that was designed to require mental imagery, she lacked insight into her performance (9).
    2. Visual working memory and mental imagery are two processes that both depend on the representation and manipulation of visual mental content not driven by current visual input. Even though they share this important feature, within the field of cognitive psychology the two processes have been mostly researched independently (e.g., Tong, 2013), although some investigations on the link between visual working memory and visual imagery have been published (2).

7. **McNorgan, C.(2012). A meta-analytic review of multisensory imagery identifies the neural correlates of modality-specific and modality-general imagery. *Frontiers in human neuroscience*, *6*, 285.**

1. Activations were seen bilaterally in the general imagery analysis, and in some modalities (auditory, motor, gustatory, visual form and visual motion), but were primarily left-lateralized. It was noted earlier that perceptually-based representational theoriesassume that multisensory imagery underlies semantic retrieval (10).
2. One challenge for this interpretation concerns the failure to show recruitment of primary sensorimotor perceptual cortices for the auditory and motor modalities. The ALE analyses showed imagery in these modalities does reliably recruit posterior superior temporal gyrus (STG) and premotor cortex, respectively. These results are consistent with Kosslyn et al. (2001) review finding that auditory imagery does not activate primary auditory cortex (A1), but does activate auditory associative areas (10).

SECONDARY SOURCES

1. **Iachini, T. (2011). Mental imagery and embodied cognition: A multimodal approach. *Journal of Mental Imagery, 35*(3-4), 1–66.**

    1. It was argued that data about the neural bases of mental imagery would overcome the indeterminacy problem and resolve the imagery debate (Kosslyn, 1994). Indeed, neural data, unlike behavioral data, are not ambiguous because they locate the basis of imagery in the same areas underlying visual perception. The neural theory distinguishes between low level visual perception (a bottom-up process that is driven by on-line external stimulation) and high level visual perception (a top-down process that is driven by information stored in long-term memory). Mental imagery belongs to the latter category. Stored perceptual information can be used both to assist in recognition of stimuli being perceived (e.g., when stimuli are degraded) and to generate mental images in the absence of external stimulation (9).
    2. Cognition is grounded in the body in two ways: it emerges from the brain; and, it emerges from the dynamic body/environment interaction. A transversal argument in embodied cognition theories is that cognition is grounded in thebrain. This assumes that cognition emerges from neural activation and is constrained by the cerebral anatomy and physiology; it implies that cognitive models should be constrained by neural data, according to the principle of neural plausibility. However, it is important to regard the relationship as reciprocal. Not only does neural data put constraints on cognitive models, but cognitive methods are fundamental for the advancement of neuroscience (Barsalou 2010) (11-12).

2. **Palmiero, M., Piccardi, L., Giancola, M., Nori, R., D’Amico, S., & Olivetti Belardinelli, M. (2019). The format of mental imagery: from a critical review to an integrated embodied representation approach. *Cognitive Processing*.**

1. Since mental images generally rely on representations of things that are not actually present to senses, their activation vary widely according to two characteristics: the individual ability to evoke subjective perceptual and motor experiences manifested in terms of diferences in the vividness of images, and the strategy preferentially used in the individual processing of the related sensory information. This does not mean that imagery ability and imagery strategy are involved into organizing principles and mechanisms of imagery, but that they are fundamental characteristics of imagery that can be also added on the top of the integrated embodied representation approach (6).
2. In general, it rejects the idea that cognition works by processing abstract symbols. It focuses on the role of the body, action, environment and sensorimotor experience. The basic assumption is that perception is direct and serves to guide actions in cooperation with the environment, ofering afordances of interactions in relation to the sensorimotor capacities of the organism, either for good or ill (Garbadini and Adenzato 2004; Gibson 1966, 1979). For example, a set of stairs represents an afordance that they be used for going up or down to a human adult, but not for a crawling infant that is not yet able to walk. Thus, cognition is grounded in the body because it emerges from both the brain and the dynamic interaction between the body and its environment (2).

3. Adams, F. (2010). Embodied cognition. *Phenomenology and the Cognitive Sciences*, *9*(4), 619-628.

1. Influenced by Barsalou (1999) and Gibson (1979) and being among those who are helping to develop the view that cognition is embodied, Glenberg and colleagues (for example, Glenberg and Kaschak 2002) accept the view meaning is embodied and "consists in a set of affordances…a set of actions available to the animal."(558) On this view, words and phrases are indexed or mapped to perceptual symbols— calling this the Indexical Hypothesis (IH) about meaning. And they see perceptual symbols as modal and non-arbitrary. That is, the affordances are derived from perceptual symbols and the meanings of these symbols are grounded in the sensorimotor system (620).
2. In a second experiment (Borghi et al. 2004), subjects took the perspectives inside (driving the car) or outside (filling the tank). Then subjects were asked to identify car parts that would be near or far from those perspectives. From inside the license plate would be far. From outside the steering wheel would be far, and license plate near. From the inside perspective, subjects were faster (50 ms) to identify near inside car parts than far inside car parts. From the outside perspective, subjects were faster (100 ms) to identify near outside car parts than far outside car parts (622)

4. Gallagher, S. (2011). Interpretations of embodied cognition.

1. In contrast to G&D, who rule out anatomy and bodily movement as important, non-trivial factors for cognition, other theorists suggest that anatomy and movement are important contributors to the shaping of cognition prior to brain processing (pre-processing) and subsequent to brain processing (post-processing) of information in the cognitive system (e.g., Chiel and Beer 1997; Shapiro 2004; Straus 1966; see Gallagher 2005a). Embodiment in this case means that extra-neural structural features of the body shape our cognitive experience (5).
2. Many of these insights are still cast in terms of information processing, and as such may be consistent with the general principles of classical cognitivism. As Shapiro notes: "steps in a cognitive process that a traditionalist would attribute to symbol manipulation might, from the perspective of EC, emerge from the physical attributes of the body" (2007, p. 340). In addition, even if the body is doing some of the work, cognitivists could easily claim that pre‐processing is in fact feeding the more central processing that is certainly more constitutive of cognition, just as post‐processing is to some degree determined by instructions from the brain as central processor (5).

5. Anderson, M. L. (2003). Embodied cognition: A field guide. *Artificial intelligence*, *149*(1), 91-130.

1. Simply put, cognitivism is the hypothesis that the central functions of mind—of thinking—can be accounted for in terms of the manipulation of symbols according to explicit rules. Cognitivism has, in turn, three elements of note: representation, formalism, and rule-based transformation. First and foremost is the idea that cognition centrally involves *representation*; cognitivism is committed to the existence of "distinct, identifiable, inner states or processes"—that is, the symbols—"whose systemic or functional role is to stand in for specific features or states of affairs" [20, p. 43]. However, just as is the case in modern logic, it is the *form* of the symbol (or the proposition of which the symbol is a part) and not its meaning that is the basis of its rule-based transformation (93).
2. As an illustration of how a given example of higher-order cognition can be traced back to its bodily bases, consider the metaphorical mapping "Purposes are Destinations", and the sort of reasoning about purposes which this mapping is said to encourage. We imagine a goal as being at some place ahead of us, and employ strategies for attaining it analogous to those we might use on a journey to a place. We plan a route, imagine obstacles, and set landmarks to track our progress. In this way, our thinking about purposes (and about time, and states, and change, and many other things besides) is rooted in our thinking about space. It should come as no surprise to anyone that our concepts of space—up, down, forward, back, on, in—are deeply tied to our bodily orientation to, and our physical movement in, the world (105).