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Towards an artificial model of 'languaging': reviewing the distributed language hypothesis

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ABSTRACT

In this review of Stephen Cowley's special issue of *Pragmatics & Cognition* [Cowley, S.J., 2009. Distributed language and dynamics. Pragmatics & Cognition 17 (3), 495–508] we present an overview of the extensive overlap between the distributed language approach and the development of artificial dialogue systems. After presenting a brief summary of each of the articles in the Distributed Language special issue of Pragmatics & Cognition we will discuss how this new approach could contribute to existing artificial models of language and the production of effective human–computer conversational interactions. In doing so we will briefly highlight the mutual advantages of an interdisciplinary program of research, one that could unify the varied strands of distributed language and contribute to current Artificial Intelligence research programs.

1. Outline

Linguistics, phonetics, Artificial Intelligence and the cognitive sciences have been conducting a long and fruitful collaboration for a number of decades. It is in this tradition that this paper will review the recent *Pragmatics & Cognition* special issue on Distributed Language and consider how the distributed language hypothesis could influence engineering and research directions within the field of Artificial Intelligence. This consideration will encompass both existing models of communication and current challenges in the development of human–computer conversational systems.

From the standpoint of distributed language there are strong parallels between the scientific histories of cognitive science and Artificial Intelligence. Cowley's account of the cognitive sciences could apply equally well to both fields:

> Classic views of cognition used serial computational models to link Shannon's (1948) information-processing with eighteenth-century views of mental representation. Cognition is attributed to a mind that mediates input and output (p. 496).

In Artificial Intelligence, behaviour based robotics (Brooks, 1990) arose in response to this conception. But even in this 'new wave' Artificial Intelligence (Sharkey, 1997) the progress that has been made by discarding eighteenth-century symbolism and stating that the "world is its best own model" (Brooks, 1990, p. 5) remains limited by the fact that the world is treated as a constraint on a 'lazy' artificial system. Artificial cognition remains in-the-head; in comparison the distributed language hypothesis presents the possibility of a richer environment–system interaction:

> As we act in an environment, we grasp what is possible. The task is restructured *in the act*. Out view of distributed cognition thus conforms to Järvilehto's (1998) biological model. As organism-environment systems, we draw on biological, physical, and cultural events. Life history allows us to shift continuously between thinking and the world beyond the skin.

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> Movements connect perception with events that prompt impasse, solutions or strategic change. While we may anticipate opportunistic solutions, movement is sufficient to connect simple heuristics with the anticipatory dynamics of body-world interaction" (Fioratou and Cowley, 2009, p. 564).

After a summary of the special issue in Section 2 the potential of this approach will be explored in Section 3. Moving beyond environment-system interactions we will consider artificial models of system-system interactions in Section 3.1 and briefly consider the challenges of embedding artificial systems in complex social environments in Section 4. As stated by Hutchins:

> [t]he environments of human thinking are not 'natural' environments. They are artificial through and through. Humans create their cognitive powers by creating the environments in which they exercise those powers. At present so few of us have taken the time to study these environments seriously as organizers of cognitive activity that we have little sense of their role in the construction of thought" (Hutchins, 1995, p. 169, quoted from Tribble (2009)).

We will conclude in Section 5 that the constructive artificial systems approach has a clear role to play in the development of the distributed language hypothesis. In turn the hypothesis itself has the potential to make significant contributions to the development of socially embedded artificial systems – ones that are able to form useful cognitive artifacts in their own right.

2. Summary

Summarised by Cowley (2009), this collection proposes two key points. First, it rejects the central role of symbolic cognition and denies that minds represent verbal patterns. Second, it proposes an alternative, one in which cognition is primarily distributed coordination across multiple scales. This theory is supported by evidence from reading comprehension, task completion and rapport and is applied to the areas of semiotic cognition, value realisation and human dynamics. This is a compelling body of work, one with a number of implications for current approaches to Artificial Intelligence. However, it also is clear that this approach will require further work to better unify the various strands of empirical evidence and theory building. Accordingly, this review will consider this work's implications for existing modelling approaches in the hope of making further progress in both areas. We will now consider each paper in turn.

After Cowley's summary of the special issue, we open with Järvilehto et al.'s work investigating the role of contextual anticipation in reading. By measuring fixation-speech intervals (FSI) evidence is provided for the influence of verbal patterns, experience and textual features on reading times. The implications of these results then tie reading to a wider human sensory-motor anticipatory behaviour, challenging the classic conception where text is transcribed into symbolic 'mentalese'. The measured interval times seem to leave no room or purpose for classic symbol forming approaches. This leads Järvilehto et al. (2009) to conclude that "Action is thus almost simultaneous in any task that makes critical use of environmental features." (p. 518) and to propose an alternative that hints at the wider theory presented in the collection as a whole, as it can be argued that writer and reader are engaged in a dialogue distributed across time through the use of material artifacts. Cognition is then distributed across writer, reader and meaningful interactions with the environment.

In a contribution that relates to this point Kravchenko (2009) then considers the further question of meaning and comprehension in reading. Considering the challenge of functional illiteracy he insists that as part of a dynamic system writing and reading form a crucial cognitive artifact, one that shapes human cognition. In making this point he illustrates a secondary goal of this special issue: the need to differentiate between distributed cognition and extended cognition. In an extended cognition framework human cognition would remain unaffected and would simply choose to exploit literacy when it was available. Rather, in distributed cognition "they rely on their intrinsic organization which results from ontogenetic structural coupling that determines the significance of the parts of the environment (including the dynamics of the other) acting as 'stimuli'" (Kravchenko, 2009, p. 543). Literacy shapes distributed cognition as each exploitable material artifact forms an influential component of a complex dynamic interactive process.

Fioratou and Cowley's (2009) paper perhaps best addresses the challenge of gathering evidence for this interactive process. By investigating the difference between abstract and real chain links when completing a cheap necklace test it was proposed that the material artifacts themselves trigger solutions. The key is not the representation of material artifacts or the constraints that they provide but rather a 'dialogue' between individual and environment where action effects are observed and rapid user-environment feedback is established. "By investigating how objects are used, we show that they do more than supplement neural events. Rather, participants monitor and anticipate the effects of action (and thinking) within an organism-environment system" (Fioratou and Cowley, 2009, p. 549).

Greater consideration is given to the environmental aspects of this system by Tylén et al. (2009) who consider the role of environmental cues in triggering a social response. This then highlights the importance of anticipation and projection in our attempts to assign meaning to material artifacts. By annotating spoken responses (Neuendorf, 2002) to various pictures, some of which contain 'signs', some of which don't, it was clear that individuals consider the intentionality of others when interpreting their environment. By considering why someone would choose to adjust their environment, intentional reconfigurations were quickly spotted and meaning was assigned to these intentions. The theory defined by Tylén et al. (2009) is appealing as it suggests that various algorithms and symbolic world models can be unified under a system of 'languaging' with apparently complex 'in the head' cognitive behaviour accounted for by complex environmental variation and interaction.