zation of the body's (specifically, the hand position's) interaction with the environment. Tapping such regularities in immediate response performance provides insight about how patterns of action mesh with those based on previous experience.

It can be argued that Glenberg's central contention "that perceptual systems have evolved to facilitate our interactions with a real, three-dimensional world" (Glenberg 1997t, sect. 1.3) holds for suppression mechanisms as well. Our evolutionary ancestors spent much of their time navigating forest canopies. In such an environment, efficient branch selection required acute spatial sensibilities and qualitative judgments about color, texture, and form, in order to choose a sound branch and avoid those that were brittle or too thin, and could lead to a precipitous tumble to the ground below. The efficient selection of appropriate branches within the canopy, necessitated rapid initial parallel processing of many branches. Because momentarily unwanted branches are likely to remain so, there would also be an adaptive advantage to implicitly encode and preserve an "unwanted" tag (Neumann & DeSchepper 1992) so that such branches are more likely to be avoided in the future. These examples may be seen "natural" analogs to selective attention tasks in the laboratory. DeSchepper and Treisman (1996; Treisman & DeSchepper 1996) have documented implicit long-term negative priming effects that are clearly indicative of this type of suppressive tagging process in humans. Such studies provide exciting possibilities for fleshing out Glenberg's embodied memory framework.

Clamping and motivation

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Abstract: Arthur M. Glenberg omits discussion of motivation and this leads him to an underestimation of the part played by pleasure and pain and desire and fear in both the clamping and the updating of percepts. This commentary aims at rectifying this omission, showing that mutual correction plays an important role.

One can readily start with Glenberg's frank admission that he has left out "hedonic valence and motivation to act" (Glenberg 1997t, sect. 7.2, p. 17). Meanings are what is embodied and meanings are centrally intentional, whatever portions of the flux, internal or external to the body, are involved in the actions they embrace. As William Epstein, from whom Glenberg has drawn his key distinction of "projectable" and "nonprojectable" properties, has insisted, "an event can only assume symbolic status when it is assigned that status by an agent or process that is endowed with intentionality" (Epstein 1993, p. 705). Both kinds of properties are therefore "endowed with intentionality." This raises an apparent problem because of two of Glenberg's claims (sect. 5.1, p. 10): (1) that the clamped environment is not changed by the embodied memories, and (2) that the promptness of embodied memories in contributing to the conceptualization of the current environment is automatic. The problem is, where does intentionality come in for these two features? I address that issue here, particularly with regard to the clamping of the percepts. The same question arises in Karl F. MacDorman's criticism that Glenberg has failed to "mesh memory with affect" (*BBS*, 20:29) and in Norman H. Anderson's commentary (*BBS*, 20:19–20), which, without pursuing the link with pleasure and pain, notes the omission of goal-directedness of cognition.

With regard to the projectable properties, Glenberg rightly notes that they are habitual – that is, having been established in an evolving manner to serve a purpose, they are maintained as long as that purpose is felt to be sustained. Their "automatic" nature is only an aspect of habit, and, should a clamping register itself with the organism to be maladaptive, then it is immediately subjected to re-jigging; so, though the environment may remain unchanged, the clampings may not. This is, of course, a re-jigging of the memory that is embedded in the perceptual clampings themselves. Glenberg drew attention to the fact that it is precisely because we, like other animals, do not wish to be subjected to "freezing, burning, drowning, falling" (sect. 2.1, p. 4) that the clamping was done in the first place. He therefore wonders what part pleasure and pain have to play (sect. 7.2, p. 17).

What is it that shows a clamping to be maladaptive? The answer, implied in the remarks about freezing, burning, and so forth, is pain. Percepts evolve to their clamping under a regime of value (Edelman 1989; Wright 1985). What clamps a percept is pleasure or pain: these are the motivations that excite the gestalt process, registering in memory whatever is so unified, which may be multiple. Pain marks the percept-memory with fear. *Mutatis mutandis* for adaptive reward: Pleasure excites the gestalt-embedding system, in this case marking the percept-memory with desire.

This marking in both cases is certainly automatic, in that one cannot prevent such a memory-embedding from taking place: One cannot stop immediately beginning to desire a repetition of pleasure, or to fear the repetition of pain – that is indeed automatic. The clamping itself, however, once established, frequently becomes so habitual by repeated confirmations that it can be said to be automatic, as Glenberg says, but only in the sense of being *prompt*. As Glenberg centrally argues, updatings are continually necessary wherever a problematic situation occurs; a new meshing (to use his own term) becomes imperative. And what is it that renders the problem imperative? In the case of aversion it is pain, whether the threat is present or to come. The clamping often emerges as a result of the discovery of a new significance in a context not previously thought to be relevant. The changing of a clamped gestalt thus comes about as in a narrative with the emergence of a contextual clue that effects a realignment of a key conceptualizaton (as in a comedy, a tragedy, a joke, a pun – any transformation, indeed, that partakes of an ironic analysis; Wright 1993). Here is a pointer to the answer to Arthur C. Graesser's question "Where in the body is the mental model for a story?" (*BBS*, 20:25). The mesh is with action precisely because of the binding of drive to percept; it is this that secures the embodiment, but the ironies, the tropes, the narrative transformations, occur because of the inescapable – and evolutionarily valuable – fact of perceptual relativity. It creates the opportunity for a mutual correction (or a lie).

A further philosophical point arises out of that very embodiment Glenberg speaks of: the clamping to particulars (sect. 3.2, pp. 6–7). If Glenberg accepts the full implications of individual embodiment he should accept that what we have is a mutual coordination of differing gestalt selections that have to be repeatedly readjusted in a cooperative act. The method we adopt is that we have to speak, out of linguistic convenience, as if there is a *numerically singular* logical particular before us, just in order to effect the needful fuzzy superimposition of our *numerically multiple* selections (Gregory 1993, p. 259; Wright 1992, pp. 42–50; 1993, pp. 192–93). To use Harnad's terms, there is a never-to-be-achieved perfect "convergence" of each agent's "approximations" to the putatively common categorization (Harnad 1987, p. 538). This being so, there is strictly no common "referent," no single Gibsonian "invariant" to provide given "affordances," only a multiplicity of individually chosen referent selections from the flux which may or may not produce a coinciding of purposeful action. The Gibsonian Richard A. Carlson asks Glenberg to mesh Piaget with his theory (*BBS*, 20:21), but Piaget regarded knowing as an assimilation of reality into "systems of transformations" (Piaget 1970, p. 15) and saw the roots of logic in the "coordination of actions" viably maintained together (ibid., p. 17). Glenberg (1997r), in his answer to those who accused him of neglecting affect, still places his analysis at the ordinary-language level in referring to given overlapping selections, about which we have to talk contin-

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ually to improve the degree and success of that superimposition of our differing clampings, to update the concepts of each other in a narrative manner – all of which negotiation is fraught throughout with motivation.

Authors' Response

Embodied meaning and negative priming

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Abstract: Standard models of cognition are built from abstract, amodal, arbitrary symbols, and the meanings of those symbols are given solely by their interrelations. The target article (Glenberg 1997t) argues that these models must be inadequate because meaning cannot arise from relations among abstract symbols. For cognitive representations to be meaningful they must, at the least, be grounded; but abstract symbols are difficult, if not impossible, to ground. As an alternative, the target article developed a framework in which representations are grounded in perception and action, and hence are embodied. Recent work (Glenberg & Robertson 1999; 2000; Glenberg & Kaschak 2002; Kaschak & Glenberg 2000) extends this framework to language.

Kurthen et al. and **Wright** argue that grounding is not sufficient to make symbols (embodied or not) be about something – that is, to make them intentional or meaningful. We will address both commentaries by discussing the power of embodied representations and how they become intentional representations. **Neumann** comments on a different point. He suggests that the account of embodied cognition developed in the target article is deficient in that it does not provide a role for what we will call *internal suppression.* Part of Neumann's commentary seems to reflect a misconstrual of what was intended in the target article. Nonetheless, he is correct to point out that the target article did not consider negative priming data that are consistent with internal suppression. Here, we will sketch an account of negative priming based on the mesh of embodied representations.

According to the framework developed in the target article (Glenberg 1997t), an individual's conceptualization of a situation consists of the set of actions that a person can take in that situation. Those actions arise from the mesh of affordances (Gibson 1979), action-based goals, and experiences. Affordances are interactive properties that arise from projectable (roughly, directly perceptible) features of the environment (Epstein 1993). In brief, affordances are how an organism with a particular type of body can interact with a particular object. A chair, for example, affords for an adult the options of sitting on, standing on, or even hoisting as a defense against snarling dogs. For a small child, the chair may afford sitting, but not hoisting for defense. In the Glenberg (1997t) framework, affordances differ from Gibson's formulation in that affordances are not necessarily directly perceived, and they may become internal representations (as will be discussed shortly). In addition to affordances, some knowledge (such as that indicating ownership) must come from memory because the knowledge is not projectable. Nonetheless, the meaning of nonprojectable properties is action-based. For example, we know that a person owns an object from the way that person interacts with it, and the fact of ownership constrains our own interactions with the object.

Mesh is the process by which affordances, goals, and experiences are combined into a coherent conceptualization. The most important property of mesh that distinguishes it from association formation, concatenation, convolution, and many other forms of combination is that mesh respects intrinsic constraints on action. That is, given constraints of biology and physics, some actions can be smoothly combined and coordinated (they mesh), whereas other actions cannot be combined. Consider the situation in which you have the goal of changing a bulb in your kitchen ceiling fixture. In this case, the action-based goal (lifting the body), the projectable affordance (the chair affords standing on), and the nonprojectable knowledge (you own the chair) can be meshed into a coherent (that is doable) set of actions and thus a coherent conceptualization of the situation: Stand on the chair to change the bulb. However, if the chair is so rickety that it does not afford standing on, one cannot mesh the goal and the affordances. We offer this as an embodied account of the meaning of situations.

If one were reading about a situation, then understanding must arise from words. The Indexical Hypothesis (Glenberg & Robertson 1999; 2000) specifies how language about a situation becomes meaningfully embodied. Words and phrases are indexed or mapped onto objects or perceptual, analogical symbols (Barsalou 1999); affordances are derived from the objects or perceptual symbols, not the words themselves; the affordances are meshed under the guidance of intrinsic constraints, context, and syntax (Kaschak & Glenberg 2000). Consonant with this hypothesis, Glenberg and Kaschak (2002) have demonstrated that literal action in one direction will interfere with the comprehension of a sentence implying action in an incompatible direction. Thus, language understanding makes use of the same neural systems that plan and guide action.

Kurthen et al. suggest that embodied representations need to be grounded much like abstract symbols. We agree, although the problem is simpler for embodied representations such as perceptual symbols than for abstract, amodal, arbitrary symbols. Consider first the problem of grounding abstract symbols. Until they are grounded, content can only be represented by relations to other abstract symbols. This must be so because the symbols themselves (being abstract, amodal, and arbitrary) are stripped of any perceptual or motor qualities. In contrast, Searle's (1980) Chinese Room argument demonstrates that content cannot arise solely from relations among such symbols. Furthermore, Putnam (as discussed in Lakoff 1987) demonstrated the impossibility of finding the correct mapping from a set of abstract symbols to the correct objects of the world. That is, the set of relations among the symbols does not provide enough constraints to get the mapping right. Therefore, by Searle's argument, abstract symbols need to be grounded, but by Putnam's argument there are insufficient constraints to do so.

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