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# **E**mbodied & **S**ituated **L**anguage **P**rocessing



**2012**

Newcastle Upon Tyne, UK

28-30 August

## Programme & Talk Abstracts

**Past events**

Saarland University	2007
Erasmus University	2009
UC San Diego	2010
Bielefeld University	2011

**Keynote Speakers for 2012:**

Gerry Altmann (York)  
 Bernhard Hommel (Leiden)  
 Jesse Snedeker (Harvard)

**Chairs for 2012:**

Kenny Coventry  
 Larry Taylor  
 Paul Engelhardt

**Contents**

Cover	1
Introduction, Contents	2
Programme	3
Talk abstracts – <i>Day 1</i>	6
<i>Day 2</i>	16
<i>Day 3</i>	26
Poster sessions and titles	33
Map and sponsor acknowledgments	35

**DAY 1 – Tuesday, 28<sup>th</sup> August** (*Great Hall, Sutherland Building*)

From 8am *Registration open – in the lobby*

9.15am Welcome

9.30am **Keynote address:** Gerry Altmann (University of York, UK): *Event comprehension in the brain: Objects 'before' compete with themselves 'after'.*

10.30am Dermot Lynott (University of Manchester) and Louise Connell (University of Manchester): *Cognitive triage? Using the linguistic shortcut in both shallow and deep conceptual processing.*

11am Diego Frassinelli (University of Edinburgh, UK) and Alessandro Lenci (University of Pisa, Italy): *Linguistic and simulation systems: contextual effects in a property generation task.*

11.30am Coffee

12pm Anuenue Kukona (University of Dundee, UK), Gerry Altmann (University of York, UK) and Yuki Kamide (University of Dundee, UK): *Competition dynamics in the representation of location in a situated language context.*

12.30pm Kenny Coventry (University of East Anglia and Northumbria University, UK), Debra Griffiths (Northumbria University, UK) and Colin Hamilton (Northumbria University, UK): *Language and the perceptual parameters affecting the representation of space.*

1pm Lunch (*Domain, Students' Union*)

2.30pm Francesca Citron, Michael Kucharski (Freie Universität Berlin, Germany) and Adele Goldberg (Princeton University, USA): *An Effect of language on embodied metaphor: Sour vs. sauer.*

3pm Sophie De Grauwe (Radboud University Nijmegen, The Netherlands), Shirley-Ann Rueschemeyer (University of York, UK), Kristin Lemhöfer (Radboud University Nijmegen, The Netherlands) and Herbert Schriefers (Radboud University Nijmegen, The Netherlands): *Is there a 'stand' in 'understand'? Embodied representations of simple and complex verbs in L1 and L2 speakers.*

3.30pm Marlene Johansson Falck (Umeå University, Sweden): *Metaphorization of TIME in SPACE: Cross-linguistic analysis of English and Swedish prepositions.*

4pm Gabriele Paschek (University of Bielefeld, Germany) and Jan de Ruiter (University of Bielefeld, Germany): *Abstract concepts of right- and left-handers – Is our entire thinking built on the experiences of our body?*

4.30pm Coffee

5pm **Keynote address:** Bernhard Hommel (University of Leiden, the Netherlands): *Integrating perception and action: The Theory of Event Coding.*

6.30pm Poster session 1 (*Domain, Students' Union*) & Reception

**DAY 2 – Wednesday 29<sup>th</sup> August** (*Great Hall, Sutherland Building*)

9.30am **Keynote address:** Jesse Snedeker (Harvard University, USA): *Embodied cognition(s), development and language: An outsider's perspective.*

10.30am Maria Staudte (Saarland University, Germany), Matthew Crocker (Saarland University, Germany), Alexander Koller (University of Potsdam, Germany) and Konstantina Garoufi (University of Potsdam, Germany): *Grounding spoken instructions using listener gaze in dynamic virtual environments.*

11am Louise Connell (University of Manchester) and Dermot Lynott (University of Manchester): *I see/hear what you mean: Modality-specific attention implicitly engaged during reading affects how quickly and accurately a word is processed.*

11.30am Coffee

12pm Bo Yao (University of Glasgow), Pascal Belin (University of Glasgow) and Christoph Scheepers (University of Glasgow): *Brain "talks" over direct speech quotes: Mental simulation of voice in language processing or direct versus indirect speech.*

12.30pm Eiling Yee (Basque Centre on Cognition, Brain and Language, Spain), Lisa Musz (University of Pennsylvania, USA) and Sharon Thompson-Schill (University of Pennsylvania, USA): *Mapping the similarity space of concepts in sensorimotor cortex.*

1pm Lunch (*at your leisure*)

2.30pm Lu Zhang (University of Bielefeld, Germany) and Pia Knoeferle (University of Bielefeld, Germany): *The role of recent versus future events in children's comprehension of referentially ambiguous sentences: Evidence from eye tracking.*

3pm Kerstin Fischer (University of Southern Denmark, Denmark), Davide Marocco (University of Plymouth, UK), Anthony Morse (University of Plymouth, UK) and Angelo Cangelosi (University of Plymouth, UK): *Embodied language learning and tacit distributional analyses: A comprehensive framework for learning new words.*

3.30pm Michele Wellsby (University of Calgary, Canada) and Penny Pexman (University of Calgary, Canada): *Effects of bodily experience in children's word reading.*

4pm Robin Thompson (University College London, UK), David Vinson (University College London, UK), Bencie Woll (University College London, UK) and Gabriella Vigliocco (University College London, UK): *The road to language learning is iconic: Evidence from British Sign Language.*

4.30pm Coffee

5pm Poster session 2 (*Domain, Students' Union*)

7pm Conference Dinner (Blackfriars Restaurant)

**DAY 3 – Thursday 30<sup>th</sup> August** (*Great Hall, Sutherland Building*)

9.30am Nikola Vuković (University of Cambridge, UK): *Sensorimotor processing of action verbs in second language speakers.*

10am Yuki Kamide (University of Dundee, UK), Shane Lindsay (University of Dundee, UK), Christoph Scheepers (University of Glasgow, UK) and Ronald Gordon Brown (University of Dundee, UK): *Linking language and space: Verb trajectory effects in motion event processing.*

10.30am Madeleine Beveridge (University of Edinburgh, UK), Daniel Casasanto (New School of Social Research New York, USA), Roberto Bottini (New School of Social Research New York, USA) and Martin Pickering (University of Edinburgh, UK): *Body specificity in action sentences.*

11am Coffee

11.30am Lu Zhang (University of Bielefeld, Germany) and Pia Knoeferle (University of Bielefeld, Germany): *Visual context effects on thematic role assignment in children versus adults: evidence from eye tracking in German.*

12pm Laura Speed (University College London, UK) and Gabriella Vigliocco (University College London, UK): *The multimodal meaning of speed in language.*

12.30pm Lunch (*Domain, Students' Union*)

1.30pm Conference close

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9:30am, Tuesday, 28<sup>th</sup> August

***Event comprehension in the brain: objects 'before' compete with themselves 'after'.***



**Gerry Altmann**

To understand that an object has changed state during an event, we must represent the 'before' and 'after' states of that object. Because a physical object cannot be in multiple states at any one moment in time, these 'before' and 'after' object states are mutually exclusive. In the same way that alternative states of a physical object are mutually exclusive, are cognitive and linguistic representations of alternative object states also incompatible? If so, comprehending an object state-change should involve interference between the constituent object states. Through a series of functional magnetic resonance imaging experiments, we test the hypothesis that comprehension of object state-change, during language understanding, requires the cognitive system to resolve conflict between representationally distinct brain states. We discover that (1) comprehension of an object state-change evokes a neural response in prefrontal cortex that is the same as that found for known forms of conflict, (2) the degree to which an object is described as changing in state predicts the strength of the prefrontal cortex conflict response, (3) the dissimilarity of object states predicts the pattern dissimilarity of visual cortex brain states, and (4) visual cortex pattern dissimilarity predicts the strength of prefrontal cortex conflict response. Results from these experiments suggest that distinct and incompatible representations of an object compete when representing object state-change. The greater the dissimilarity between the described object states, the greater the dissimilarity between rival brain states, and the greater the conflict.

## **Cognitive triage? Using the linguistic shortcut in both shallow and deep conceptual processing.**

Dermot Lynott and Louise Connell

Previous research has shown that people use both embodied perceptual simulations and linguistic distributional statistics during conceptual processing (Louwerse & Connell, 2011), with linguistic information especially useful for shallow tasks and rapid responding (Barsalou, Santos, Simmons & Wilson, 2008; Louwerse & Jeuniaux, 2008). Using two conceptual combination tasks with noun-noun compounds (e.g., *octopus apartment*), we measured the time taken to accept or reject a compound as sensible (shallow judgement) or interpretable (deep judgement, requiring participants to provide a meaning for the compound), and the rate of acceptance/rejection in both tasks. Results showed that linguistic distributional frequency predicts both the likelihood and timecourse of rejecting a novel word compound as nonsensical or uninterpretable. Furthermore, it predicts the timecourse of successful processing only in shallow sensibility judgement, and not in deeper interpretation generation, where the timecourse of generating an interpretation reflects conceptual processing in the simulation system.

These findings suggest that, in both shallow sensibility judgement and deep interpretation generation tasks, people use the linguistic shortcut as a “quick and dirty” guide to whether the concepts are likely to combine in a coherent situated simulation. First, linguistic distributional frequency can predict not only the timecourse of successful conceptual processing (i.e., accept responses in sensibility judgement), but also the timecourse and likelihood of failure (i.e., reject responses). Second, use of this linguistic shortcut extends beyond simple retrieval into the processing of novel stimuli in conceptual combination. The more often two words have appeared in close proximity to one another, the faster people are to accept the compound as sensible and the slower they are to reject it as uninterpretable nonsense. Third, we show that the influence of such linguistic shortcuts is not restricted to shallow conceptual tasks, but is also useful in deeper conceptual processing as a form of cognitive triage. The less often two words have appeared in close proximity, the faster people reject their compound as uninterpretable rather than risk costly failure in the simulation system. These findings support theories that argue for complementary roles of the linguistic and simulation systems in conceptual combination (Lynott & Connell, 2010) and conceptual processing more generally (Barsalou et al., 2008; Louwerse & Jeuniaux, 2008).

## **Language and the perceptual parameters affecting the representation of space.**

Kenny Coventry, Debra Griffiths and Colin Hamilton

How we represent space has been the subject of much research. For example, the dichotomy between near (peripersonal) and far (extrapersonal) space has been demonstrated in both patient studies and normal populations (Vuilleumier, Valenza, Mayer, Reverdin & Landis, 1998; Halligan & Marshall, 1991; Bowers & Heilman, 1980). Coventry and colleagues (2008) have shown that demonstrative usage in English ('this' and 'that') and Spanish maps well to near and far space respectively. They also show an extension of the use of 'this' into far space when participants use tools, similar to the shift in near space representation shown with neglect patients and pseudoneglect (Longo & Lourence, 2006; Gamberini, Seraglia, & Priftis, 2008).

This paper presents a series of experiments that examine how common perceptual parameters, such as ownership, visibility, and familiarity affect both language usage and contribute to our representation of space. A memory game paradigm (see Coventry, Valdés, Castillo, & Guijarro-Fuentes, 2008 for details) was used to elicit the use of the demonstratives 'this' and 'that', without participants realising the purpose of the experiment. Participants were more likely to use 'this' when the object referred to was their own, visible or was more familiar.

Do these results merely show differences in language usage or is there a shift in the perception of the location of the object referred to? To answer this question a further series of experiments was carried out. Participants were asked to view an object on a table for a few seconds. The object was then removed and the participants asked to estimate where the object had been. The experiments manipulated whether the object belonged to the participant, was visible, or was a familiar item to them. Participants made migration errors depending on the objects used. For example, the objects owned by the participant were consistently judged as having been located closer to them than objects they did not own. The results from these experiments showed striking similarities between the effects on language and the migration errors in memory for distance, suggesting that factors affecting language use also contribute to underlying representations of space.

## **Linguistic and simulation systems: contextual effects in a property generation task.**

Diego Frassinelli and Alessandro Lenci

The role of linguistic and sensory-motor information in conceptual representations is a widely debated question in cognitive science. Some proposals have suggested that during conceptual processing different cognitive mechanisms are interactively activated (Paivio (1986), Glaser (1992), Barsalou et al. (2007)). It is possible to identify at least (but not only) two different systems that constantly interact to produce a complete and grounded conceptual representation: one of them processes linguistic information and the other one processes modal information. All these theories recognize the importance of contextual information that surrounds the actual object; however they do not explicitly include contextual variability in their analysis. In this work, we target the effects that the activation of the linguistic and the modal systems exert on the processing of concepts. Moreover, we analyse the effects that different contexts have on our data.

A widely recognized way to access the conceptual representation is the use of a property generation task. We collected 6922 semantic properties for 8 concrete concepts in 3 different context conditions (visual context, linguistic context, and non-context). After a normalization process, we classified them according to the coding scheme proposed by Wu and Barsalou (2009). Here we focus our analysis on the property order of production.

A clear difference in the order of production of different property types emerges from our analysis: there is a strong distinction between taxonomic properties and those that are more entity and situation related. Those belonging to the first group are frequently produced as first properties but after that they show a deep and continuous decrease in the frequency of production. On the other hand, the properties describing entities and situations are produced more frequently from the second slot and on average they do not manifest a strong variability. However it is possible to identify in the second group some local peaks that allow us to identify at least a trend in the production of these properties: the properties describing the entity manifest an early peak followed by those properties describing the situations where the entity appears and finally the properties describing emotional states. These results suggest an order of processing that goes from the more language-related knowledge (taxonomic properties) to situated properties (situation and introspective properties); entity properties appear in between.

Moreover, we analysed the effects exerted by contextual information presented as visual or linguistic stimuli. The major effect affects the first property produced and in particular taxonomic properties: a linguistic context elicits a more strong production of these properties than the visual and the non-context conditions.

## Competition dynamics in the representation of location in a situated language context.

Anuenue Kukona, Gerry Altmann and Yuki Kamide

Listeners rapidly retrieve location-based information about objects that are described in a linguistic discourse as moving between different locations. Altmann and Kamide (2009) presented listeners with a scene with a table (with nothing on it), a glass (on the floor), and a bookshelf (distractor), followed by a blank screen and spoken sentences like “The woman will put the glass onto the table. Then, she will pour the wine into the glass.” At the discourse-final “glass,” listeners fixated (the prior location of) the table more than the glass, suggesting that they were retrieving relevant new location information. However, there was no evidence for competition from the initial location information: glass and bookshelf fixations did not differ.

These results are surprising in two respects. First, research on lexical-semantic competition reveals that listeners transiently fixate objects that are semantically tied to a target (e.g., lock-key, Yee & Sedivy, 2006; piano-trumpet, Huettig & Altmann, 2005). Second, research on memory recall (Hoover & Richardson, 2008) reveals that listeners re-fixate prior locations of entities that are associated with to-be-recalled information. When listeners, who had heard two facts from a cartoon creature in two different display locations, were asked to recall just one of the facts, they nevertheless re-fixated both locations. These results predict similar competition effects in the representation of an object’s location over time, based on transient activation of semantically-tied, but irrelevant location information, and/or on retrieval of associated spatiotemporal cues. In the current study, we tested for location-based competition effects in less predictable discourse contexts than Altmann and Kamide (2009).

Participants (N = 36) heard forty-eight sentence pairs like 1 and 2 while viewing arrays with containers like a bowl, jar, pan, and jug. Sentence 1 described two (non-pictured) objects moving in the array either from one location into another (1a), or into one location from another (1b). Thus, order-of-mention was not a cue to the sequencing of the described events. Sentence 2 referred back to one of the objects (“sweet corn”/“gravy”), and either its start (“But first”) or end (“And then”) location. Inconsistent with Altmann and Kamide (2009), we found clear competition effects at the discourse-final noun. For example, listeners hearing “And then, he will taste the sweet corn” fixated the competitor bowl reliably less than the target jar, but reliably more than the unrelated jug and pan. We discuss these findings of situated, location-based competition effects in relation to models of semantic memory and cue-based memory retrieval.

### Examples

1a. The boy will pour the sweet corn *from the bowl into the jar*, and he will pour the gravy *from the pan into the jug*.

1b. The boy will pour the sweet corn *into the jar from the bowl*, and he will pour the gravy *into the jug from the pan*.

2. And then/But first, he will taste the sweet corn/gravy.

## **An effect of language on embodied metaphor: sour vs. sauer.**

Francesca Citron, Michael Kucharski, and Adele Goldberg

Conceptual metaphor theory posits that there exist systematic mappings between target and source domain, e.g., POSITIVE as UP, that are used in language but are actually part of our conceptual knowledge (Lakoff and Johnson 1980). Previous research on embodiment has shown that physical experience with the source domain implicitly activates the target domain, e.g., moving marbles upwards causes positive memories to be retrieved (Casasanto & Dijkstra, 2010). Nevertheless, multiple target domains can be associated with the same source domain depending on the language and possible cultural factors. A *sauer* person in German refers to an ANGRY person, whereas a *sour* person in English refers to a NEGATIVELY PREDISPOSED person. The present study explored whether exposure to sour taste would activate different conceptual metaphors in German and American participants.

42 German and 38 American participants (mostly students) were tested in Berlin and Princeton, respectively. After eating 3 sour or sweet candies for later evaluation, participants were asked to categorize 33 faces: 5 ambiguous angry-disgusted, 5 happy-surprised and 5 sad-fearful faces (50-50% morphed) along with 3 unambiguous faces expressing each of the 6 emotions. No time limit was given, but participants were encouraged to choose the first emotion that came to their minds, without thinking too much. The order of faces was randomized across participants. Faces were selected from several published databases including different ethnicities and both genders. Ambiguous faces were obtained by morphing original ones (using Abrosoft Fantamorph) and a pilot study allowed us to select only faces that were categorized half of the times as one emotion or the other. A candy evaluation questionnaire was given at the end, to make sure participants actually perceived the candies as sour or sweet.

If people rely on their language for the choice of metaphor, we expect Germans primed with sour taste to choose anger more often and Americans disgust; if people rely on more fundamental associations that do not vary with context or language, we expect all sour-primed participants to choose disgust more often. No taste-related differences were expected for the other ambiguous faces.

Results showed that the choice of emotion of sour-primed participants from both populations significantly differed from their sweet-primed counterparts. Crucially, the direction of the choice (anger vs. disgust) was opposite for Germans and Americans. No taste-related difference in the choice of emotion for the other ambiguous faces was found. The results suggest that language-related (or cultural) factors affect our choice of metaphor, which adds to previous findings (Fuhrman et al., 2011) by exploring a new perceptual domain.

## Is there a 'stand' in 'understand'? Embodied representations of simple and complex verbs in L1 and L2 speakers.

Sophie De Grauwe, Shirley-Ann Rueschemeyer, Kristin Lemhöfer and Herbert Schriefers

We investigated two issues in native (L1) vs. non-native (L2) speakers: first, embodied representation of simple motor verbs; second, morphological decomposition of opaque complex verbs with motor stems. Regarding the first issue, the representation of action-related language such as motor verbs is called 'embodied' if these verbs elicit activation in the same brain areas as action itself. L1 fMRI studies (1, 2, 3) have shown inferior parietal (IPC) and/or (pre)motor activation upon presentation of motor verbs ('*werpen*' – 'throw'), suggesting embodied representation of these verbs. L2 motor verb representations have not been investigated yet, but behavioral studies suggest that L2 semantic representations may be less 'rich' than L1 representations (4, 5). Thus, the processing of motor verbs may be less 'embodied' in L2 compared to L1 speakers. Regarding the second issue, behavioral studies have shown L1 speakers to differentially process transparent (*afwerpen* – throw off) and opaque (*ontwerpen* – design) complex verbs: the former, verbs semantically related to their stems, are often decomposed; the latter, verbs with semantically unrelated stems, seem to be processed holistically (6, 7). However, little is known about L2 processing of these verb types. Also, an L1 fMRI study has shown no IPC or (pre)motor activation upon presentation of German opaque verbs with a motor stem (1). However, it is possible that L2 speakers decompose such verbs, potentially leading to more activation of sensorimotor areas by the motor stem than in native speakers. In an fMRI experiment, German-Dutch bilinguals and Dutch native speakers made lexical decisions about visually presented simple motor verbs and opaque complex verbs with a motor stem. L2 speakers, as opposed to L1 speakers, showed no IPC activation for the interaction between complexity and motor meaning. However, both groups showed IPC activation for simple motor verbs. Results are discussed in the light of embodiment theory. Also, further analyses are being conducted to elucidate the role of (pre)motor regions.

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2. Hauk, O., Johnsrude, I., & Pulvermüller, F. (2004). Somatotopic representation of action words in human motor and premotor cortex, *Neuron*, 41, 301-307.
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4. Finkbeiner, M., Forster, K., Nicol, J., & Nakamura, K. (2004). The role of polysemy in masked semantic and translation priming. *Journal of Memory and Language*, 51, 1-22.
5. Wang, X., & Forster, K. (2010). Masked translation priming with semantic categorization: Testing the Sense Model. *Bilingualism: Language and Cognition*, 13, 327-340.
6. Marslen-Wilson, W., Tyler, L.K., Waksler, R., & Older, L. (1994). Morphology and meaning in the English mental lexicon. *Psychological Review*, 101(1), 3-33.
7. Zwitserlood, P., Bolwiender, A, & Drews, E. (2005). Priming morphologically complex verbs by sentence contexts: Effects of semantic transparency and ambiguity. *Language and Cognitive Processes*, 20(1-2), 395-415.

## Metaphorization of TIME in SPACE: Cross-linguistic analysis of English and Swedish prepositions.

Marlene Johansson Falck

One of the most difficult areas when learning a second language is that of prepositions (see e.g. Morimoto & Loewen 2007). Not only are prepositions short and less salient to the language learner than content words (Field 2008), there are considerable differences between languages with respect to their usage patterns. English phrases such as *in an hour* and *on that occasion* and Swedish phrases such as *på en timme* (lit. *on an hour*) and *vid det tillfället* (lit. *at that occasion*) suggest that even closely related languages such as English and Swedish display important differences with respect to how these are used.

In this paper, I compare the usage patterns of the English prepositions *in* and *on*, and their Swedish equivalents *i* and *på* in talk about temporal concepts such as those in the phrases above. The study is based on corpus linguistic data from the *British National Corpus* and from the Swedish Language Bank corpus *Parole*.

The cross-linguistic analysis highlights systematic differences between the two languages that appear to be grounded in different ways of construing TIME through SPACE. Variation in the direction in which time moves (e.g. horizontally: *have coffee after dinner* or vertically: *dricka kaffe på maten* [lit. *have coffee on the food*]) explains some of the differences between the languages. Differences between the languages with respect to when TIME is construed as an object on which events are located, and when time is seen as a container that people, events or things can be located in are also important.

The study suggests that the metaphorization of TIME through SPACE is much more nuanced than has previously been suggested (see e.g. Lakoff & Johnson 1999). In addition to being structured by conventional conceptual metaphors (e.g. TIME IS SPACE OR TIME IS MOTION) it is intimately connected with the role of the conceptualizer and with people's experiences of doing things with objects. Knowledge about systematic differences between languages such as those observed in this study are potentially useful for the learner of a second language.

## **Abstract concepts of right- and left-handers – Is our entire thinking built on the experiences of our body?**

Gabriele Paschek and Jan de Ruiter

Casasanto (2009) has argued that the body has an impact on a person's thinking by presenting the body specificity hypothesis. This hypothesis claims that people with different bodies create different mental representations of reality, and that this influences the way a person makes decisions in his everyday life. Casasanto supported his hypothesis with a series of experiments. These experiments can be categorized into two different types – perceptual judgment experiments and active placement experiments. The results of both types showed significant results for handedness, but in the case of the perceptual judgment experiments the effect was only just significant at the .05 level, and the effect was caused solely by the small group of left handers in the study.

To obtain a more robust estimate of the statistical reliability, we performed a replication of one of Casasanto's central experiments for perceptual judgment, the 'shopping tour'. This experiment concentrated on the impact of handedness on decision making processes. The participants were confronted with several product categories and had to decide for one of two products on the basis of short descriptions, which were placed in columns on the right and left of these categories. Our replication, which involved more left-handers and a more equal distribution of left vs. right handers than in the original experiment, not reveal any significant effect of handedness. This made us suspect that the body specificity effect only occurs in 'active placement' tasks, and not in perceptual judgment tasks. In order to test this new hypothesis we also performed an 'active placement' version of the shopping tour. The participants were asked to imagine that they are the manager of a supermarket, who had the task to choose the side at in which the two objects of the same category had to be placed. In contrast with the replication experiment with the perceptual judgment task, this version showed a strong effect of left versus right handedness.

We therefore propose our 'Manipulation Specificity Hypothesis' which states that the impact of handedness is only relevant in active placement tasks and not in perception situations. Thus, body specificity is only a determining factor when people have to use their hands actively, so that the better accessibility of objects serves as a positive criterion. This Manipulation Specificity Hypothesis is weaker than the Body Specificity Hypothesis, but is strongly supported both by the combination of Casasanto's (2009) experiments and our two replication attempts.

5:00pm, Tuesday, 28<sup>th</sup> August

***Integrating perception and action: The Theory of Event Coding.***



## Bernhard Hommel

This talk gives an introduction into the Theory of Event Coding (TEC), which claims that perception and action are not only based on shared (i.e., sensorimotor) representations but are in some sense one and the same thing. Behavioral and neurocognitive studies will be discussed to show how knowledge about possible action goals and action affordances is acquired in infants, children, and adults, how this knowledge is used to select and control intentional action and to anticipate action outcomes, and how it is neurally represented. It will also be discussed how perceived action effects form the basis of our self-concept and the degree to which we experience ourselves as separated from, or part of another person.

9:30am, Wednesday 29<sup>th</sup> August

***Embodied cognition(s), development and language: An outsider's perspective.***



**Jesse Snedeker**

Over the past 30 years, cognitive science has quietly converged on a model of the mind, driven in large part by the theoretical challenges raised in Fodor (1983). I will discuss the degree to which embodied cognition can be seen as an application of this 21<sup>st</sup> century standard model. Once we clear away these (relatively) uncontroversial commitments, the primary issue of contention becomes clear: can concepts be reduced to (or emerge from) sensory-motor primitives? I'll discuss this proposal in relation to conceptual theories, language acquisition and cognitive development, focusing on numbers as well understood concepts that are simultaneously abstract and grounded. Along the way, I'll make a plea for theoretical diversity, point out the perils of circularity in developmental explanations, and explore the popular notion that language acquisition can turn straw into gold.

## **Grounding spoken instructions using listener gaze in dynamic virtual environments.**

Maria Staudte, Matthew Crocker, Alexander Koller and Konstantina Garoufi

In situated dialogue, interlocutors are constantly anticipating what will be said next and speakers are monitoring the effects of their utterances on listeners. Furthermore, multi-modal cues such as gaze provide listeners with information about the speaker's next referent (Hanna & Brennan, 2007), while potentially informing speakers about whether listeners correctly resolved their references (Clark & Krych, 2004). Investigating listener gaze in response to spoken referring expressions – as well as the benefit of listener gaze for the speaker – requires a shared task, a sufficiently complex environment, the systematic production of referring expressions and an appropriate reaction to listener gaze.

We present a new paradigm with which we successfully demonstrate that monitoring listener gaze and giving appropriate feedback enhances reference resolution by the listener. This technique employs a visually-situated, interactive natural language generation (NLG) system that exploits real-time user gaze. Users must follow directional instructions, including pressing a number of buttons in the 3D environment that are identified by referring expressions generated by the system, in order to find a trophy (see GIVE; Koller et al., 2010). Users' eye movements in the dynamic virtual environment (Fig.1) are remotely monitored, and gaze to the intended referent during or shortly after a referring expression is taken as evidence of successful understanding and elicits positive feedback; by contrast, gaze to other objects triggers negative feedback.

We compare this gaze-based strategy of giving feedback with a system that generates feedback based on visibility of objects on the screen and the user's movement towards an object, as well as a system that generates no such feedback. Gaze-based feedback leads to significantly more successful button presses than either of the other strategies. Further, confusion – as indicated by the number of requests for help – is significantly lower with gaze-based feedback.

This suggests that listener gaze between a referring expression and the intended button press does indeed index the listener's resolution of the expression, and that real-time feedback leads to more efficient grounding of references.

Finally, eye movements further reveal that speaker feedback to listener gaze generally increases looks towards all potential referents, despite users reporting they were unaware of being eye-tracked. We take this as evidence that gaze-based feedback implicitly increases visual attention to potential targets. This study demonstrates that referential gaze findings from the visual world paradigm scale to dynamic and task-centered environments, and that gaze can be used in real-time to improve situated spoken language interaction.

## **I see/hear what you mean: Modality-specific attention implicitly engaged during reading affects how quickly and accurately a word is processed.**

Louise Connell and Dermot Lynott

Grounded theories of cognition hold that the conceptual system has co-opted the perceptual and motor systems for the purpose of representation (Barsalou, 1999), and studies have shown that directing attention towards a particular perceptual modality facilitates conceptual processing in that modality (e.g., Connell, Lynott, & Dreyer, 2012; van Dantzig, Pecher, Zeelenberg & Barsalou, 2008). As such, semantics and perception share representational and attentional resources when processing a word. In the present study, we tested whether modality-specific attention implicitly engaged during reading affects how quickly and accurately a word is processed. In a series of regression analyses on over 900 words, we examined the extent to which lexical decision and naming data from E-Lexicon (Balota et al., 2007) could be differentially predicted by ratings of visual and auditory perceptual strength from modality exclusivity norms (e.g., Lynott & Connell, 2009), once standard psycholinguistic variables had been partialled out.

By asking people whether or not a string of letters is a valid word, the lexical decision task inherently focuses visual attention on orthographic word form. We therefore expected strongly visual words to be judged more quickly and accurately than weakly visual words because having attention focused on vision means that visual information is automatically and rapidly simulated, which in turn facilitates the lexical decision. In contrast, by asking people to pronounce a word aloud, the word naming task focuses both visual attention on the orthographics and auditory attention on the phonological word form. Here, we expected both auditory and visual strength in a word's meaning to benefit its naming aloud. Results supported our hypotheses. Strength of visual information in the referent concept predicted time and accuracy in both tasks, while strength of auditory information predicted time and accuracy in word naming alone. Vision-related words like *red* are processed most effectively in lexical decision tasks, while sound-related words like *loud* are processed most effectively in word-naming tasks. These findings suggest that the active reading of text and production of speech influence how a word is processed by directing perceptual attention to different modalities and determining which aspects of the concept are preferentially simulated.

## **Brain “talks” over direct speech quotes: Mental simulation of voice in language processing or direct versus indirect speech.**

Bo Yao, Pascal Belin and Christoph Scheepers

In verbal communication, direct speech (e.g., Mary said: “I’m hungry”) provides more vivid depictions of the reported speaker’s voice whereas indirect speech (e.g., Mary said [that] she was hungry) provides mere descriptions of what was said. Grounded cognition theories predict that this perceptual vividness distinction would ground the mental representations of the two semantically equivalent but pragmatically-distinct reporting styles during language comprehension. We tested whether comprehension of direct speech would be more likely to engender mental simulation of voice than comprehension of indirect speech at both neural and behavioural levels.

We used fMRI to measure changes of neural activity when participants silently read or listened to short stories that contained either a direct speech or an indirect speech (matched for meaning and syntactic structure). In silent reading, we observed increased neural activity in the voice-selective areas of the auditory cortex in response to direct speech relative to indirect speech, suggesting an enhanced “inner voice” experience during reading of the former. Follow-up fMRI study revealed that virtually the same brain areas were additionally activated when listened to direct speech that was spoken in an unexpected, monotonous way. The observed activations may reflect top-down voice simulations as it was explained by “prediction error” (i.e., the level of incongruence between listeners’ expectation for livelier voices and their actual perception of “boring” voices) but not by the stimuli’s acoustic characteristics or subjectively-perceived vividness. The findings replicated “inner voice” in spoken (as opposed to written) language comprehension and provided evidence that the mentally-simulated voice may contain supra-segmental acoustic information (e.g., speech melody) which is limited in monotonous speech.

In line with our neuroimaging results, we showed behaviourally that readers spontaneously adjusted their reading rates (in both oral and silent reading) to contextually implied speech rates when reading direct speech as opposed to meaning-equivalent indirect speech, suggesting that speech rate may be an important aspect of voice simulation and that voice simulation is also reflected in behaviours.

Our research demonstrated grounding in the auditory domain at the pragmatic level, which was reflected both in brain-activation patterns as well as in articulation/production and eye-movement patterns. It forms a starting point for more sophisticated interdisciplinary research on auditory simulations in discourse processing.

## Mapping the similarity space of concepts in sensorimotor cortex.

Eiling Yee, Lisa Musz and Sharon Thompson-Schill

How are the meanings of words referring to concrete objects represented across sensory and motor cortex? Rather than merely demonstrating that retrieving a feature of an object concept, such as its shape, activates a relevant sensorimotor region, such as occipitotemporal cortex, we tested a stronger prediction of sensorimotor-based theories of meaning, namely that the similarity of the neural representations of two concepts in a given region should reflect their similarity on a specific dimension. We measured the magnitude of fMRI-adaptation (our index of neural similarity) to word pairs that varied according to their similarity on shape (bagel-tire) and manipulation (key-screwdriver). Degree of shape similarity was positively correlated with the magnitude of fMRI-adaptation in a region involved in visual object recognition (left lingual gyrus), whereas degree of manipulation similarity was positively correlated with adaptation in regions involved in planning and performing object-related actions (left inferior parietal and precentral gyri). That is, we identified two distinct neural similarity spaces that map onto conceptual similarity in different ways, and these effects confirm predictions of sensorimotor theories. Surprisingly, we also observed inverse-adaptation (i.e., more activation) in the same regions: In the visual region, greater manipulation similarity led to inverse adaptation; and in action regions, greater shape similarity led to inverse adaptation. We will discuss the possibility that these inverse-adaptation effects reveal interactions between conceptual representations, and that these interactions serve to magnify differences in the distinctive features of related concepts. These findings illustrate the importance of examining neural similarity for our understanding of conceptual representation.

## The role of recent versus future events in children's comprehension of referentially ambiguous sentences: Evidence from eye tracking.

Lu Zhang and Pia Knoeferle

Findings from recent eye-tracking studies suggest that adults prefer to rely more on recently seen events than possible future events during sentence comprehension: When the verb in an NP1-VERB-ADV-NP2 sentence was referentially ambiguous between a recent action and an equally possible future action, adults fixated the target of the recent action more often than the not-yet-acted-upon object [1] [2].

We examined whether this preference for the recent event generalizes to five-year-old children. In an eye-tracking study, five-year-olds inspected a display with a clipart depiction of an animal (e.g., a horse) and two other objects (e.g., a red barn and a blue barn). On the next picture frame, the animal was depicted as performing an action (e.g., the horse galloped to the blue barn). On a third frame, the animal had completed the action and was depicted in the background, looking straight ahead (i.e., not looking at any of the barns). Together with that third frame (Figure 1a-c), a spoken German sentence referred either to the event involving the recently acted-upon target in the past tense (e.g., *Das Pferd gallopierte gestern zu der blauen Scheune*, literally: 'The horse galloped yesterday to the blue barn') or to an equally plausible future event in the present tense with future meaning (e.g., *Das Pferd galoppiert morgen zu der roten Scheune*, literally: 'The horse gallops tomorrow to the red barn'). While the children listened to the sentence and inspected the last picture frame, we monitored their eye movements.

The eye-gaze data showed that children fixated more often the recent event target (e.g., the blue barn) than the future event target (e.g., the red barn) during the adverb, both when they heard a past tense and a future tense adverb ( $p < 0.01$ ). As children heard the second noun phrase in the future ('red barn') compared to the past tense ('blue barn') condition, their preference for looking at the recent event target diminished and ultimately reversed. Accordingly, inferential analyses revealed a significant main effect of tense at the np2 region ( $p < 0.001$ ) but not at the adverb.

These findings confirmed clear similarities in how children and adults (Experiment 3 in [1] and [2]) direct their visual attention during spoken language comprehension. Just like adults, children relied more on the recent event than expectations of an event that could happen next. At the same time, visual context effects of the recent events were subtly delayed for children (vs. adults). For adults, the recent-event preference emerged during the verb; for children, by contrast, it emerged post-verbally during the adverb. Thus, similar attentional mechanisms underlie visual context effects in both 5-year old children and adults but their time course differs.



Figure 1: Example item pictures

[1] Knoeferle and Crocker (2007). The influence of recent scene events on spoken comprehension: evidence from eye movements. *Journal of Memory and Language*, 57, 519-543.

[2] Knoeferle et al. (2011). Preferential inspection of recent real-world events over future events: evidence from eye tracking during spoken sentence comprehension. *Frontiers in Cognition*. 2:376.doi: 10.3389/fpsyg.2011.00376

## **Embodied language learning and tacit distributional analyses: A comprehensive framework for learning new words.**

Kerstin Fischer, Davide Marocco, Anthony Morse and Angelo Cangelosi

Children learn language in a meaningful way, which means that the utterances they encounter are increasingly grounded in their own sensorimotor experience. Thus, more recently a research paradigm has developed in which embodied artificial learners, i.e. robots, learn language in a grounded manner (Marocco et al. 2010; Morse et al. 2010). However, children, and even young infants (Gómez 2007), have also been shown to carry out distributional analyses of the utterances they hear; they extract regularities and co-occurrence relationships for several language-related categorisation tasks, such as identifying the elements of the phonological inventory, segmenting words, distinguishing lexical ('content') from grammatical ('function') words, and bootstrapping syntactic categories (Saffran & Thiessen 2003; Küntay & Slobin 2001). In the child language learner, these two processes, embodied and distributional learning, interact and influence each other.

In the current paper, we present an architecture that allows our robotic humanoid robot iCub to learn new words from the interaction between distributional and sensorimotor grounded information. The proposed model builds upon the dynamical coupling of a module based on the Epigenetic Robotics Architecture (ERA), which provides the grounding of words, and, the ability to extract temporal features from serial order analysis of Recurrent Neural Networks (RNNs). The ERA module can learn cross-situationally, from ongoing experience, abstract representations that combine and interact dynamically to produce and account for multiple cognitive and behavioural phenomena.

The recurrent neural network module is trained with a standard Error Back Propagation algorithm, which learns the dynamical sequences of input-output patterns as they develop in time. The architecture suggested allows the robotic learner to learn new words by pairing information from previous distributional analyses, provided by, for instance, word order regularities in the target language, with current sensorimotor data. Thus, if a word is unknown, the correct meaning will be assigned to the word by the ERA module thanks to the ability of the RNN module to infer the semantic category on the basis of the distributional information. The architecture suggested thus allows the robot to learn new words by combining sensorimotor grounded and distributional information.

## Effects of Bodily Experience in Children's Word Reading.

Michele Wellsby and Penny Pexman

In the study of conceptual development in children, there has been little attention given to the role of previous interactions with objects. Recently, a handful of studies have addressed the role of embodiment in children's language processing (e.g., Engelen, Bouwmeester, de Bruin, & Zwaan, 2011), and concluded that children's language comprehension is grounded in perceptual experience. There is, however, a lack of research examining the role of bodily knowledge in children's single word recognition. Previous literature suggests that by at least age 7, children's word recognition behavior is influenced by lexical and semantic variables (e.g., age of acquisition, Coltheart, Laxon, & Keating, 1988; context-availability, Schwanenflugel & Noyes, 1996). The purpose of the present study was to examine when and how bodily experience influences children's developing ability to read object words, by investigating whether children's word naming performance is facilitated by body-object interaction (BOI). The BOI variable measures people's perceptions of the ease with which a human body can physically interact with a word's referent (Siakaluk, Pexman, Aguilera, Owen, & Sears, 2008). A facilitory effect of BOI has been observed with adult participants in a series of language processing tasks, with faster and more accurate responses for high BOI words (e.g., bike) than for low BOI words (e.g., cloud) (e.g., Wellsby, Siakaluk, Owen, & Pexman, 2011). In the present study, we examined the development of this effect. Fifty children (aged 6 to 9) and a group of 21 adults completed a word naming task with high and low BOI words. The children also completed the Woodcock Reading Mastery Test-Revised. Adults showed a significant facilitory BOI effect in naming latencies, which suggests that adult readers access bodily experience information even in a basic naming task. Younger children (aged 6-7) did not show a significant BOI effect for either naming latencies or naming accuracy, but older children (aged 8-9) showed a significant facilitory BOI effect for naming accuracy. Emergence of the BOI effect in children's naming behavior was related to age and letter identification skills, which suggests that both experience with objects and developing lexical skills are important to the development of BOI effects.

## **The road to language learning is iconic: Evidence from British Sign Language.**

Robin Thompson, David Vinson, Bencie Woll and Gabriella Vigliocco

Languages are highly complex systems that, nonetheless, most children acquire easily and in the absence of formal instructions. The arbitrary link between a word's form and its meaning, generally considered to be a universal feature of language, appears as a particularly challenging feature of acquisition. Arbitrariness means that a child acquiring a language must solve the problem of how to map words, conventionalized symbols that have no meaningful links to the world, onto human experience or meaning. However, iconic (non-arbitrary) mappings between properties of meaning and phonological features of word forms are also widely present across languages, especially signed languages. While recent research has shown a role for sign iconicity in language processing, research on the role of iconicity in sign language development has been mixed.

In the present study we examined the degree to which iconicity plays a role in determining which signs very young children (11-30 months) comprehend and produce. We analysed a large sample of parental reports (from deaf parents only) of deaf children's sign production and comprehension from the British Sign Language (BSL) Communicative Development Inventory (CDI, Woolfe, Herman, Roy, Woll, 2010). The results show that iconicity facilitates sign learning from early development, rendering iconic signs easier to learn. More specifically, iconicity predicts early sign comprehension and production even taking into account familiarity, phonological complexity, imagability, concreteness, and the type of labels children acquire cross-linguistically (using data from British English CDI, Hamilton et al., 2000).

The iconic links between our perceptual-motor experience of the world and the form of a sign likely provide an imitative mechanism to support early sign acquisition (i.e., highlighting motor and perceptual similarity between actions and signs such as the sign DRINK which is produced by tipping a curved hand to the mouth simulating holding a cup and drinking from it). Importantly, these results from sign language can also be applied to spoken languages, where gestures, tone of voice, inflection, and face-to-face communication can help make the link between words and their meanings less arbitrary. We suggest that despite the traditional focus on arbitrariness in language, iconicity is also a fundamental property of all languages, providing scaffolding (a middle-ground) to bridge the "great divide" between linguistic form and bodily experience for both sign language and spoken language learners.

Thursday 30<sup>th</sup> August

## **Sensorimotor processing of action verbs in second language speakers.**

Nikola Vuković

Over the past years, the theory of embodied cognition has given us a novel and much welcome perspective on how to study the neurocognition of language. Contrary to predictions of classical amodal theories, by now there exists a wealth of research done on native speakers which points towards an intimate relationship between language and sensorimotor areas of the brain (Barsalou 2008; Pulvermüller & Fadiga, 2010). However, any theory that seeks to explain linguistic processes cannot call itself complete without at the same time accounting for how these operate in the majority of the world's population i.e. bilinguals (Gordon, 2005). With the realization that over half of the current generation speaks more than one language, this study aims to test the predictions of embodied cognition on people other than monolinguals.

The central question posed is whether the semantic representations of action verbs are embodied in second language (L2) speakers the way they are in native speakers. In a reaction time based translation task, participants used a microphone or a response pad to make judgments on whether an English verb was a good translation of a previously shown verb in their native language. In critical trials, the English verbs they responded to referred to actions performed using hands or the mouth. Data analysis indicates that there was a proficiency-modulated interference in the motor system during language understanding. More proficient L2 speakers took significantly longer to respond with their hands to previously seen hand-related verbs, but not mouth-related ones. Conversely, responding using a microphone led to slower latencies in the case of mouth-verbs, but not hand-verbs. In the group of less proficient speakers, however, comparable results have not been observed in either of the two conditions.

Amidst virtually exclusively monolingual research on embodied cognition, these findings indicate that reading action verbs interferes with subsequently performed manual or verbal responses in second language speakers as well. We can conclude that the meaning of these verbs is distributed over neural substrates which underlie manual and verbal interactions. The fact that the experiment revealed interference, as opposed to facilitation, points toward a functional dependency between language and motor regions of the brain. In addition to informing current theoretical perspectives, these data provide novel evidence for processing differences in speakers of varying proficiencies, thus highlighting the role of experience in language comprehension.

## Linking language and space: Verb trajectory effects in motion event processing.

Yuki Kamide, Shane Lindsay, Christoph Scheepers and Ronald Gordon Brown

Recently, an increasing volume of research has explored how comprehenders process linguistic input describing motion events. In particular, the issue of the updating of spatial representations has attracted much attention in research that investigates the mapping between linguistic and visual stimuli (e.g., Richardson & Matlock, 2007; Zwaan et al., 2004;). Such studies have implications for accounts claiming that language comprehension involves mental simulations of states/events described in the linguistic input (Barsalou, 1999; Glenberg, 1997).

Previously, Kamide (2007) showed that, using a signal detection task, the locus of listeners' attention can be modulated by the trajectory implied by a verb (e.g., *"The ball will be thrown /rolled into the bin."*), while viewing a visual display with a theme and goal object. Results suggested that the signal was detected faster when the position of the signal roughly matched the (implied) motion path than when it didn't. However, a follow-up eye-tracking experiment (without signals) did not produce such trajectory effects, indicating a possible difference in trajectory effects in overt and covert attention shifts.

In the present study, we created visual stimuli, such as shown in Figure 1, presented with a spoken sentence containing either an upper-trajectory (1a), lower-trajectory (1b) or no-movement (1c) verb:

(1) Grenbosh will (a) jump into / (b) crawl into / (c) think about the door.

We added 'obstruction' objects in the middle of the potential trajectory (the bookcase in Figure 1) to test whether verb trajectory (i.e. the trajectory associated with the action entailed by the verb) would modulate the locus of attention in visual contexts. Also, fantasy animate creatures were created to act as the Agents, so that the sentences would be in active voice, and the actions would be 'intentional'.

First, to confirm our intuitions about the implied trajectories in our stimuli, a mouse-tracking task was employed whereby participants were presented with visual stimuli, and moved the agents using a computer mouse to represent the event in the sentence they had just heard. This revealed that the mean Y-coordinate was higher in (1a) than (1b).

A visual-world eye-tracking experiment revealed that attention shifts can be modulated as early as in the post-verbal prepositional region (*'\_into\_the\_'*): the probability of looks to the upper half of the obstruction object (Region 1 in Figure 1) was higher in (1a) than (1b) or (1c), whereas the lower half of the object (Region 2) was looked at more often in (1b) than (1a) or (1c). The same pattern was also obtained for the top (Region 3) and bottom space (Region 4), but the difference for the latter was not significant. During the goal region (*'door'*), all four comparisons were statistically significant. (A follow-up experiment is currently underway to investigate trajectory effects on scenes without obstructing objects to test whether these effects depend on the obstruction.)

Overall, our results suggest that overt attention is rapidly shifted according to the trajectory of the moving object as implied by the verb, indicating that mental simulations of motion events can occur immediately after the verb.

## Body specificity in action sentences.

Madeleine Beveridge, Daniel Casasanto, Roberto Bottini and Martin Pickering

Embodied cognition accounts of language are supported by research demonstrating body-specificity in language comprehension. Specifically, left- and right-handed participants show body-specific activation in the motor cortex when reading simple action verbs (Willems, Hagoort, & Casasanto, 2010). However, it is unclear what role body-specificity plays in understanding full action sentences, as opposed to single word utterances.

In the current study, we investigate how body-specificity interacts with perspective taking in language. In Experiment 1, we used a sentence-picture matching paradigm to demonstrate body-specificity in first-person action sentences: participants read sentences describing first-person actions (e.g. I am cutting the tomato), and then viewed photographs in which the action was carried out by either a left or a right hand. Results showed a significant interaction between dominant hand of the participant, and the hand carrying out the action in the photograph: right-handed participants were slower to correctly match sentences to photographs showing right-handed actions, and left-handed participants were slower to correctly match sentences to photographs showing left-handed actions. No such interaction was observed in filler trials (in which sentence and picture did not match), indicating that the significant interaction was not simply a result of viewing left-/ right-handed images.

Experiment 2 extends this paradigm by manipulating participants' perspective (internal/ external). Brunye, Ditman, Mahoney, Augustyn and Taylor (2009) showed that action sentences using third person pronoun encourage participants to adopt an external, rather than internal, perspective (i.e. they represent the action as being carried out by someone other than themselves). We are currently testing whether participants also demonstrate body-specificity when comprehending third-person action sentences. In this way, we aim to establish whether the motor simulations implicated in language processing embody the way the comprehender herself would execute an action, regardless of the linguistic perspective of the sentence; or whether the perspective of motor simulations in language comprehension is contingent on linguistic perspective taking. In the first case, we expect to see body-specificity in both first- and third-person sentences. In the second case, we expect to see body-specificity only in first-person sentences, with all participants favouring a right-handed perspective in third person sentences.

The results are discussed in terms of (a) how body-specificity helps ground motor simulations in language processing, and (b) how perspective taking in language influences the nature of these motor simulations.

## Visual context effects on thematic role assignment in children versus adults: evidence from eye tracking in German.

Lu Zhang and Pia Knoeferle

Adults but not children[1] can rapidly use visual context (referential contrast) for syntactic structuring and disambiguation. In two eye-tracking studies we examined whether children (unlike adults[3]) also struggle to use other visual context information (depicted events) for real-time language comprehension.

Children (Exp1) and adults (Exp2) inspected either a clipart depiction of three characters (e.g. a worm, a bear and a bull), or of two events between these characters (e.g., a worm(AGENT) painting a bear(AMBIGUOUS) and the bear pushing the bull(PATIENT)). During picture inspection (2000ms preview time), they heard either a German subject-verb-object (SVO) sentence (e.g., literal translation: 'Look, the bear (subj) pushes soon the bull (obj)') or an object-verb-subject (OVS) sentence (e.g., literal translation: 'Look, the bear (obj) paints soon the worm (subj)'). Post-listening, participants named the event agent or patient when asked (e.g., Who pushes?/Who is being painted?) We recorded eye movements, response accuracy, and (for children) their working-memory (WM) scores (Kauffmann-ABC).

Both SVO and OVS word orders are grammatical, but OVS is non-canonical, and without event depictions five-year olds are at chance in understanding even unambiguous OVS sentences[2]. If children can rapidly use depicted events for syntactic structuring, we should find similar gaze pattern -indicating visual context effects- for them as for the adults in Experiment 2 and in [3]. If WM is essential for using visual context, we should see rapid event effects only for high-WM children.

Children's response accuracy was higher for SVO than OVS sentences, and for depicted (vs. no depicted) events ( $p < .01$ ; SVO: 85% vs. 77%; OVS: 62% vs. 44%). Qualitatively, children's gaze pattern resembled that of adults[3]: With event depictions, children anticipated the PATIENT (the bull) more often for SVO than OVS sentences, and the AGENT (the worm) more often for OVS than SVO sentences during the adverb. Without event depictions, that pattern emerged only as the target character was named (NP2). Analyses further revealed an interaction between sentence structure and event depiction (subjects,  $p < .01$ ; items,  $p < .10$ ), suggesting case marking at the first noun phrase alone was insufficient for incremental thematic role assignment in children; the events, however, enabled correct thematic role assignment. That interaction was significant for high (but not low) accuracy children and marginal by subjects for high (but not low) WM children (median split). Adults' eye movements revealed even earlier visual-context effects, during the verb ( $p < .005$ ;  $p < .01$ ).

Thus, events depicting who-does-what-to-whom incrementally influenced both adults' and 5-year-olds' visual attention and thematic role assignment. Depicted-event information and case marking (but not case marking alone) helped children revise their initial SVO preference when interpreting OVS sentences. However, visual context effects were subtly delayed in children (vs. adults), and varied as a function of their accuracy and WM.

[1] Trueswell et al. (1999). The kindergarten-path effect. *Cognition*, 73, 89-134.

[2]Dittmar et al. (2008). German Children's Comprehension of Word Order and Case Marking in Causative Sentences. *Child Development*, 79, 1152-1167.

[3]Knoeferle et al. (2005). The influence of the immediate visual context on incremental thematic role-assignment. *Cognition*, 95, 95-127.

## The multimodal meaning of speed in language.

Laura Speed and Gabriella Vigliocco

The retrieval of semantic information in language is thought to involve the shared activation of resources used in perception and action. Experiments have been performed that show how comprehending action or motion language, for example, can interact with physical action (e.g. Glenberg & Kaschak) or motion perception (Kaschak, Madden, Therriault, Yaxley, Aveyard, Blanchard & Zwaan, 2005). The present research investigates a new semantic domain, speed, and shows how language can be embodied for words referring to different speeds. Speed is an interesting novel domain to investigate because it requires integration of spatial and temporal information and therefore might be thought of as more abstract than other dimensions already explored (e.g., manner of motion). In particular, we hypothesise that because processing speed requires integration of different information, language referring to speed may equally affect processing of speed information in different modalities.

In both experiments a lexical decision task was used with verbs denoting fast or slow motion (e.g. amble, dash), filler words (e.g. globe) and non-words (e.g. tades). In Experiment 1, participants viewed a dynamic visual display that moved at a fast or slow speed for 3 seconds before being presented with each item. The visual display contained lines moving outwards from the centre of the screen, creating a sense of motion. Results showed a significant interaction between speed of verb and speed of visual display: response times to verbs were fastest when the speed of the verb matched the speed of the visual stimulus. Experiment 2 combined the same lexical decision task with an auditory stimulus. For 3 seconds before the item appeared on screen, participants listened to fast or slow beeps through headphones. The beeps travelled from left to right ear with a gap between each beep of either 50ms (fast) or 1000ms (slow). Results again showed an interaction between the two forms of speed, but a different pattern to Experiment 1 was observed. Response times to the fast and slow verbs were similar after listening to fast beeps, whereas response times were faster to fast verbs than to slow verbs after listening to slow beeps.

These results indicate that first; speed in language is simulated and interacts with speed in other modalities. Second, results show a different pattern when a speeded auditory stimulus is used than when a speeded visual stimulus is used. This suggests that information recruited from different modalities may differ in nature or temporal pattern.

## Poster session 1- 6:30pm, 28 August

1. Knott: *Chomskyan minimalism as a vehicle for embodied models of language.*
2. Wallentin/Nielsen/Rynne: *Go far away fast: Distances in semantic space are inversely correlated with response time in a one-back task for words.*
3. Vulchanova/Dahl: *A possible source for added material in a sentence repetition task: Situation models in language development.*
4. Skilters/Burgmanis: *Space as a part of social identity.*
5. Vigliocco/Vinson/Ponari/Vaghi/Anderson/Ratoff/Bahrami: *Emotional connotations affect preconscious processing for abstract, but not concrete words.*
6. Ullwer/Drummer/Welke/Raisig/Hagendorf/van der Meer: *Eyes in time: Eye movements in processing temporal event descriptions.*
7. Guerra/Knoeferle: *Comprehending facilitation and interference effects in picture-sentence processing: Effects of recent spatial distance on abstract semantic interpretation.*
8. Feng: *The mental simulation of visual features during L1 and L2 reading comprehension: Evidence from behavioral and ERP studies.*
9. Lindsay/Scheepers/Kamide: *Dynamic representations of speed in sentence processing.*
10. Anderson/Matlock/Spivey: *Further down the path to understanding the on-line processing of grammatical aspect.*
11. McGarrigle/Stewart/Connell: *Can language help to shape the way we think? A cross-linguistic investigation into the effect of noun-adjective order on conceptual representation.*
12. van Ackeren/Casasanto/Bekkering/Hagoort/Rueschemeyer: *Pragmatics in action: Indirect requests for action engage ToMareas and the neural motor system.*
13. Lam/Dijkstra/Rueschemeyer: *Priming of nouns denoting man-made objects shows independent and slow activation of action and visual features: A behavioural priming study.*
14. Cotroneo/Connell/Holler: *Gesture and the embodiment of auditory perceptual information.*
15. Tian/Breheny: *A dynamic pragmatic view of negation processing.*
16. Hartley/Dunn/Taylor: *Does semantically processing words result in physiological arousal?*
17. Greenwood/Matlock/Spivey/Matthews: *Looking at how social affordances change viewpoint through presence of agents and verb agency.*

## Poster session 2- 5:00pm, 29 August

1. Vinson/Ponari/Fox/Vaghi/Vigliocco: *Different language experience does not modulate preconscious processing of affect: Detection of words and faces by deaf and hearing individuals.*
2. Wöstmann/König/Bosch: *Integrating semantic and referential information - Converging evidence from electrophysiological and behavioral methods.*
3. Eerland/Zwaan: *The influence of direct and indirect speech on mental simulations.*
4. Tenbrink/Jamrozik/Gentner: *Spatial meaning and abstract contexts in English as a second language.*
5. Guiliani/de Ruiter: *Combining classical and embodied multimodal fusion for human-robot interaction.*
6. Zijlmans/Dijkstra/Eerland/Post: *How body balance influences the ascription of statements to political parties: A Wii balance board study.*
7. Carminati/Knoeferle: *Priming the processing of emotional sentences with facial expressions: Evidence from the visual world paradigm.*
8. Takáč/Beňušková/Knott: *Language learning with meanings as stored sensorimotor sequences: A connectionist model.*
9. Sionti/Claudino/Rose/Aloimonos/Markantonatou: *Grounding action verbs in arm-related actions.*
10. Lachmair/Dudschig/Kaup: *A number - object word priming effect: Low numbers prime "root" and high numbers prime "roof".*
11. Lam/Bastiaansen/Dijkstra/Rueschemeyer: *Action verb comprehension reflects on-line sensitivity to motor specificity and sentence meaning: An EEG study using mu oscillations.*
12. Zarr/Glenberg: *(Almost) Definitive evidence for mirror neuron system contributions to language comprehension.*
13. Gilmour/Kamide/Scheepers: *Contextual Knowledge Mediates 'Looks to Nothing'.*
14. Vandenberg/Eerland/Zwaan: *Out of mind, out of sight: Language affects perceptual vividness in memory.*
15. Post/van Gog/Paas/Zwaan: *The use of gestures in language animation study.*
16. de Nooijer/van Gog/Paas/Zwaan: *Words in action: Using gestures to improve verb learning in primary school children.*
17. Engelen/Bouwmeester/de Bruin/Zwaan: *Eye-catching stories: Using the visual world paradigm for studying narrative comprehension.*
18. Chang: *Minimal structure and implicature in visual discourse.*



All talks will be in the Great Hall, Sutherland Building (32 on map)  
Poster sessions and lunch breaks will take place in the Student Union building (31 on map)

...AND A NOTE OF THANKS TO OUR SPONSORS:

