search whether or not children changed their scientific understanding or models of plate movements as a function of observing another 's gestural representation or the act of producing one's own gestural representation, or both.In the present study, we extend these findings in several ways: (1) experimental manipulation of gesture input (versus observing naturally occurring gesture input) and (2) assessing whether gesture plays a role in adult learning of science concepts (versus children's learning).

Method: College students participated individually in a short, one-on-one instructional session on plate tectonics.Students were randomly assigned to instruction with gesture (i.e., representational gestures illustrating plate movements and tracing gestures on maps of plate boundaries) or instruction without gesture (i.e., presenting diagrams and maps on a screen without gesture).Students in both conditions were presented with diagrams of plate movements and maps of plate boundaries on a computer screen, the only difference was whether or not they received gesture in the instruction.Students were individually administered five, open-ended questions on plate tectonics both before and after instruction in order to assess their learning.The entire session was videotaped and the students' responses to the open-ended questions were transcribed and coded for plate tectonic concepts/models using a previously developed coding system for plate tectonics (Singer, Radinksy, & Goldman, 2008).

Results: Preliminary results revealed that overall students who were instructed with gesture made correct and specific changes to their models of plate movements in both speech and gesture after instruction compared to students who were instructed without gesture.For example, before instruction some students produced vague hand motions to represent plate movements in response to the open-ended questions (e.g., using one hand to make a circular motion).However, after instruction with gesture these same students refined their models by producing a more specific and correct plate movement in gesture (e.g., indicating with two hands how plates move and converge/diverge in space and time).These results indicate that observing gesture plays a causal role in making abstract, spatial phenomena in science more concrete

Towards a formal description of gesture and the speech-gesture interface: Panel

Speech-gesture-interface constructions for gestures accompanying German verb phrases

Florian Hahn, Insa Lawler, Hannes Rieser

We currently study speech-gesture occurrences where gestures accompany three different classes of German verbs: verbs of motion, verbs of perception and stative verbs. In our talk, we give an overview on our findings regarding the three verb classes and our work concerning how their meanings can be interfaced in order to yield a multi-modal proposition. The empirical basis for our work is a systematically annotated corpus: the Bielefeld Speech-and-Gesture-Alignment-corpus (Luecking, 2013). It consists of 25 fine-grainedly annotated dialogues of dyads engaged in a route-description task about a "bus ride" through a Virtual Reality town.

Regarding the three different verb classes, we have observed the following: While gestures accompanying verbs of motion often depict (the direction of) the path to take, verbs of perception are not only accompanied by gestures representing the object seen or the line of gaze, but also by discourse gestures used to support dialogue structure; as for stative verbs, the accompanying gestures are used to depict the objects described, their location or some of their properties.

We also have found that speech-gesture-overlap can be sensitive to the use of "sentence bracket" ("Satzklammer") constructions. In such constructions the prefix of a verb can be separated from the finite verb stem to be put to the end of the sentence. Prefix and stem together embrace the German "Mittelfeld". One example is the verb "hindurchgehen" ("walk through") in the utterance "Du gehst zwischen den beiden Kirchen hindurch" ("You walk in between the two churches through"). In examples from our corpus the stroke of accompanying gestures extends from the finite verb to the prefix, even when PP- or NP-constructions are integrated between the stem and the prefix.

For analyzing the contribution of gesture meaning to verb phrase meaning, we have developed the following methodology (Rópke et al., 2013): Concentrating on the static semantics of speech-gesture occurrences and assuming that gesture and speech are semantically related, we aim at constructing a multi-modal proposition. We provide first a compositional semantics for the speech part and a compositional semantics for the gesture part. The meaning for the gesture is reconstructed from the SaGA-annotations and the use of motion capturing technology in order to classify the gesticulated shape. For interfacing, both representations are extended adding a parameter in order to compositionally combine them. Subsequently, the extended presentations are fused into the interface proper. Here, the speech representation overrides gesture representation due to scopal considerations. In the end, the interface provides a multi-modal meaning for the speech-gesture occurrence, hence, the idea of a "unified semantics" is maintained. However, due to the workings of the interface procedure, we also get independent semantics for the speech part, the gesture part and the function of the interface. Compositionality is modelled using typed lambda-calculus and ideas from Combinatory Logics. Formal solutions are based on the works of Reichenbach (1947), Montague (cf. Thomason, 1974) and Parsons (1990).

Pointing and iconic gestures in multidimensional semantics

Cornelisa Ebert