Proposal for the establishment and funding of the Collaborative Research Centre 991

“The Structure of Representations in Language, Cognition, and Science”

for

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http://www.sfb991.uni-duesseldorf.de/sfb991/
3.1 General information about the project A03

3.1.1 Title: Grounded Cognition: Causal Indexicals and Affordances in Frames

3.1.2 Research areas:
Philosophy, Philosophy of Mind and Cognition

3.1.3 Principal Investigator:
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Do the above mentioned persons hold permanent positions? ☒ No

Vosgerau’s position is limited until Nov 2012; further employment is planned until Nov 2015.

3.1.4 Legal issues
This project includes:

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3.2 Summary

The project investigates the extent to which and also the manner in which concepts (understood as so-called “cognitive”, “high-level” representations) are “grounded” in basic sensory-motor representations. The focus of the project is on concepts that have direct implications for one’s actions. Two kinds of such concepts are distinguished: causal indexicals (e.g., “too hot for me to handle”), which are characterized by an implicit self-relation, and affordances (e.g., “sit-on-able”), which involve an explicit relation to a class of individuals (e.g., to adults, in the case of chairs being sit-on-able). Firstly, these concepts will be analyzed in terms of frames. Secondly, abstraction mechanisms will be characterized that allow the transformation of such obviously “grounded” concepts into more abstract ones. In this way, the relation between sensory-motor processes and abstract concepts will be described in detail, and general principles of frame transformation (abstraction) will be determined.

The first step of this project is a philosophical analysis of causal indexicals and affordances. Hereby, the structure of such concepts will be analyzed in terms of frames. One challenge in this endeavor is that objects always have a variety of affordances. This is most apparent for natural things (as opposed to arti-
facts that often have one conventionalized affordance in the sense that they are made to be used in one specific way) but is also true for artifacts: A chair, e.g., may be “sit-on-able” for most humans, but at the same time it might be “step-on-able” (e.g., in order to reach the books in the upper shelf) for the same humans. Therefore, affordances are not functional concepts (there is no one-to-one relationship between objects and affordances), such that the attribute AFFORDANCE cannot be simply introduced. An empirically adequate and theoretically coherent solution to this problem will be formulated in collaboration with related projects in the CRC.

A further question will be: how fine-grained can (and should) the attribute values for action components be described? One possibility is that in a given situation, the possible interaction with the represented object is specified in every detail that is required for actual movement control. Another possibility is that even at the motor level more abstract movement schemata are represented that are only specified if the movement is actually executed. This question has to be answered on the basis of empirical work (including the work of other projects in the CRC) revealing how affordances are represented.

The differences in the frame description between causal indexicals and affordances will already point to some possible abstraction mechanisms that are at work during the development of the human mind. For example, the implicit reference to the self (which is characteristic for causal indexicals) has to be transformed into an explicit self-reference by adding a node to the frame which refers to the representing system itself (in order to reach the level of affordances). This explicit self-relation can then be abstracted by changing the value in this node to more abstract values, namely to whole classes of individuals. On these grounds, general abstraction mechanisms will be identified. It will be checked whether these general mechanisms are also suitable for transforming basal (concrete) concepts into abstract concepts. If so, the “grounding” of abstract concepts could be described in much more detail then it has been up to date.

Since the concepts which will be investigated are (at least to the greatest extent) pre-linguistic concepts, a further step will be to relate these concepts to expressions in natural language. On the one hand, it is necessary to examine whether there are good examples of natural language expressions (“terms”) for such concepts at all. On the other hand, the explanatory value of adding affordances to object frames as used in the description of terms needs to be assessed. In the best case, the new frames will open up new ways of explaining linguistic data. Strong collaboration with other groups in the CRC will provide the basis for this line of research.

3.3 Starting point of the project

3.3.1 State of the art and preliminary work

Grounded Cognition: In psychology and philosophy of mind, the term “grounded cognition” refers to a family of approaches to the mind that proclaim a tight link between high-level cognitive abilities and low-level, basal sensory-motor processes. These approaches are best understood in contrast to the so-called “sandwich model” (Hurley 1998) of cognition, which has prevailed throughout the 20th century. According to the sandwich model, the sensory system is merely the input system, and the motor system merely the output system of cognition which takes place exclusively between the two. Thus, cognitive operations are assumed to constitute an autonomous realm that is strictly separated from the sensory and the motor domain. At the end of the 20th century, fundamental criticism on this view arose. The alternative view, namely “grounded cognition”, holds that cognitive capacities are based on sensory-motor abilities – namely, that they are grounded in the latter (Barsalou 2008).

Several more or less radical streams can be distinguished: On the one hand, there are theories that deny the existence of cognitive skills that are independent of sensory-motor abilities. This view is expressed in the idea that thoughts are (literally) motor processes (e.g., Campbell 1999, Ito 2005, Schmahmann 1998). On the other hand, more moderate versions claim that many or at least some cognitive skills are grounded in modal systems. For example, Barsalou (1999) claims that abstract concepts can be grounded in perception and nevertheless exhibit classical features of symbolic processing (e.g., systematicity and compositionality). However, this approach is classified as moderate since: 1) there is still a clear distinction between symbolic or symbol-like representations and sensory-motor representations, and 2) the abstract concepts are claimed to be grounded in perception, while it is not very clear to which extent perception has to be classified as cognitive itself (as opposed to pure sensory processing). Approaches of grounded cognition also differ in respect to their foci: While theories of embodied cognition
highlight the involvement of the body and the motor system in cognitive processes, theories of embedded cognition stress the interactive character of cognition and the importance of the environment (cf. Wilson 2002).

A lot of research in grounded cognition is centered on the relationship between perception and abstract cognition (see, e.g., Barsalou 1999). Abstraction mechanisms are assumed to be at work from the very level of perception (e.g., attention and other filtering mechanisms), such that the crucial degree of abstractness which is necessary for symbol-like processing is claimed to be already present in “low-level” processing. However, in relation to motor processes, such basic abstraction mechanisms have not been described in detail up to now. One problem which is specific for actions is that motor control is always implicitly self-related (Vosgerau 2009b), i.e. I represent my movements (as opposed to visual perception, e.g., where I do not represent the color of an object as my perception of the color). This leads to a certain subjectivity of motor-based representations which can only be overcome by specific abstraction mechanisms.

Causal indexicals and affordances: With respect to sensory-motor grounding, two notions have been discussed in the literature which refer to concepts that categorize objects according to the possible representee’s (motoric) interactions with the objects. One such notion is the notion of causal indexicals, as introduced by Campbell (1993). Causal indexicals are concepts whose “causal significance has to do with the immediate implications for one’s own actions and reactions to the world” (Campbell 1993). Examples that are given by Campbell include “… is a weight I can easily lift” and “… is too hot for me to handle”. Once an object is categorized with such concepts, this very categorization has immediate implications for the subject’s interactions with the object (thus the name “causal indexicals”, which tries to express that these concepts refer to the causal significance that the object has for one’s own actions – in parallel to temporal and spatial indexicals that refer to points in time or space, respectively). Although the terms for causal indexicals might take a quite complex form (as above), the concepts themselves are introduced as very basic concepts. According to Campbell, this means foremost that neither a conception of “I” nor a conception of physical terms such as “weight” or “temperature” is needed in order to entertain these concepts. Thus, such concepts can be learned without specific conceptual knowledge about abstract notions, such that they can themselves build the basis of more abstract notions of the self and of physical terms.

In contrast, affordances are characterized as objective properties of objects “as they are related to animals’ capabilities for using them” (Gibson & Pick 2000). This term was introduced within a theory of direct perception which is also able to explain the ontogenetic development of humans (cf. Gibson 1979). The emphasis on the objectivity of affordances is due to the fact that affordances are construed as objects of perception. A purely subjective view of the objects of perception generally leads to the problem that the connection between the “world” and the percepts cannot be explained. To avoid these problems, affordances are not construed as self-related but as related to the capabilities of a whole class of individuals. Accordingly, examples taken from Gibson (1979) are: “sit-on-able” [for human adults] (e.g., chairs) or “climb-on-able” [for toddlers] (e.g., chairs) or even “bump-into-able” [no class of individuals specified by Gibson]. The idea is that these objective properties of the objects are directly perceived, and not – as traditionally assumed – inferred from more basic physical properties that are perceived.

However, one disadvantage of affordances as explained above is that they cannot explain the immediate impact on action as they are supposed to do. Take for example a toddler who directly perceives the objective property of the chair to be climb-on-able for toddlers. Direct implications for the toddler’s actions can only be inferred with a further premise, namely “I am a toddler”. The necessary inference would hence take the form of the following syllogism:

(1) This is climb-on-able for toddlers.
(2) I am a toddler.
(3) Therefore, I can climb on this.

However, it is highly implausible that toddlers run through this kind of syllogism every time they perceive an object. Partly due to this problem, Norman (1999) introduced the term “perceived affordances”. Perceived affordances are related to the perceiver alone. The toddler, for instance, does not perceive the abstract property of being climb-on-able for toddlers, but the property of being climb-on-able for his- or herself. In this sense, perceived affordances are able to bridge the gap between affordances and the immediate implications for the perceiver’s interaction with the objects. However, unlike causal indexicals,
the self-relation of perceived affordances has to be explicitly represented, since the perceived property still is construed as an objective property which can be perceived, in principle, by anybody else (e.g., being climb-on-able for toddler XY).

To sum up, there are three different notions that describe concepts directly related to the possible interactions between perceivers and perceived objects. The main difference lies in the specificity of the representation of the perceivers in question. While causal indexicals are exclusively related to the representing system itself and this only in an implicit way, affordances are explicitly related to a whole class of individuals. Perceived affordances lie in between these two notions, as they are (in my interpretation) best described as being only related to the representing system itself while this self-relation is explicitly represented. One thing all three forms have in common is that they are grounded in motor processes, although to a different degree of abstraction (see below). Therefore, the analysis of these notions is perfectly suited to produce a detailed picture of sensory-motor groundedness of concepts.

Frames as the general format of representation: As described in the general part of the application, Barsalou-frames are recursive attribute-value-structures which are assumed to be a general format of representation (Barsalou 1992). Within the DFG Research unit (RU 600) “Functional concepts and frames”, Barsalou’s framework was further specified and refined (Petersen 2007). The refined frame graphs are “formally explicit and cognitively adequate” (Peterson 2007, p. 154). For this reason, all merely technical elements are avoided (Petersen & Werning 2007). The most important refinements for the proposed project are: 1) Attributes are taken to assign unique values to objects, such that every attribute describes a functional relation (the value, although unique, can still be a complex frame). 2) Central nodes can occur everywhere in a frame, while in Barsalou’s frames central nodes are always root notes. This allows for a categorization of frame-types which reflects different types of concepts (sortal, functional, and proper relational concepts; Petersen 2007).

The specific advantage of frames for the proposed project is that they involve explicit representation of values. Grounded concepts can thus be understood as concepts which contain only sensory-motor values in the end-nodes. Sensory-motor values are here understood as values that either occur in the basic sense-mechanisms or figure in motor control. Since the focus of the project is on motor values, I shall now describe the embedding of motor values in motor control in more detail. Since frames are taken to be a general format of representation, it should also be possible to describe the specific representations relevant for motor control in terms of frames (see Figure 1). Usually, motor control mechanisms are depicted in flow charts (e.g., in Synofzik, Vosgerau & Newen 2008). The general idea is that each movement (with the exception of reflexes) starts with a motor intention, which is a usually unconscious and nonconceptual part of motor control (as opposed to the so-called “primary” intention; see Vosgerau & Synofzik 2010). For example, if you are going to chop up an onion, your primary intention is to chop up the onion (completely). In contrast, for every individual slicing motion there is a separate motor intention to move the knife in a specific way. This motor intention is usually unconscious and is already in a motor format (something like to move the knife forward while pressing it down). However, the motor intention does not suffice for executing a movement, since sev-

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Figure 1: Frame description of motor control.
eral background conditions have to be taken into account. For example, the movement will depend on the actual posture (e.g., where the hand holding the knife is) and from the surroundings (e.g., where the onion is). Moreover, general facts about the kinematics of the subject’s body have to be taken into account (specified in the so-called “body schema”; see e.g., Vosgerau 2009a). The part of the motor control process, in which the exact parameters of the movement are specified, is often called “specification of movement”. The output of the specification is then a motor command which can be sent to the effectors to elicit the movement. However, this last step is not obligatory – indeed, our ability to imagine movements is usually explained by the capacity to run through the motor control sequence without actually executing the movement. Thus, the motor control mechanisms can be used off-line to represent a movement rather than to elicit a movement.

This aspect of frame analysis provides two main advantages over other formats of description (e.g., logical notations). First, motor processes can be described as processes in which certain parameters play a role (e.g., motor intentions, posture). Therefore, the specific features of motor control mechanisms can be displayed, as opposed to logical notations in which there is no difference (explicitly) displayed between motor attributes and conceptual attributes (they are, in logical terms, all predicates). This allows us to reformulate the question of how grounded abstract concepts are in terms of frames: Are the values of the end nodes of frames of concepts values that we can also find in sensory-motor processes? In other words: concept frames can be combined with motor control frames (as displayed, e.g., in Figure 1) if and only if there is a certain overlap, i.e. if motor values occur in the concept frame. This formulation of the thesis of grounded cognition directly shows its explanatory benefit: It would explain how and why concepts can have a direct impact on our behavior. For example, the motor intentions in the example above (onion chopping) could be values that also occur in the concept frame for “knife”, since cutting is an affordance of knives. Thus, if the analysis of such affordances reveals that they involve motor intentions, then the direct causal implication for one’s own actions is easily explained.

Second, the conceptual categorization of an object does, of course, not automatically lead to a behavior. By seeing a knife, I do not automatically start cutting. Therefore, affordances and causal indexicals are inherently modal in the sense that they represent actions I can do with objects. In logical notations, this modality has to be expressed by explicit modal operators. In the frame analysis above, however, modality is analyzed in terms of the possible execution of the motor command. This means that the production of a motor command does not always lead to a movement but only represents a possible movement. Therefore, modality is represented in frames in a much more natural and cognitively adequate way since frames are able to represent motor control mechanisms as such (a concrete example is given in Figure 2a).

Thoughts and motor processes: In the interdisciplinary research project “Are Thoughts Motor Processes?” (principal investigator and Matthis Synofzik, Cognitive Neuroscience; funded by VolkswagenStiftung; ending May 2010), we critically investigated the thesis that thoughts are motor processes or at least processed in a parallel way. The main reason to propose this thesis in philosophy was the attempt to explain the pathological phenomenon of thought insertion (a first-rank symptom of schizophrenia where patients experience that some of their thoughts are not their own) analogously to the according phenomenon in motor control, namely delusion of control (where patients experience some of their movements to be controlled by others). The special interest in such theses for the present project has its basis in two points: 1) If thoughts are just motor processes, the strong version of grounded cognition is logically implied. 2) The specific impairment that we find in the pathological conditions mentioned above concern the self-relatedness of representations. A detailed analysis of inserted thoughts and delusion of control revealed that these phenomena (both the pathological phenomena as well as the nonpathological phenomena of authorship for thoughts and agency for actions) cannot be explained on the basis of motor processes alone (Vosgerau & Newen 2007, Synofzik, Vosgerau & Newen 2008). Therefore, the strong version of grounded cognition has to be rejected.

In addition, we developed a detailed “cognitive” account of thoughts (Vosgerau & Synofzik 2010). We argue that a sharp distinction between thoughts and motor processes (as well as other mental phenomena such as imaginations and emotions) has to be drawn, since the according core features are too different. Thoughts are characterized as conceptual, amodal, abstract mental representations that make contents available to different modules. By contrast, motor representations (that figure in motor processes) are nonconceptual, modal (i.e. restricted to the motor domain) and nonabstract. Being conceptual, for example, includes the properties of compositionality and systematicity (see also below). Thoughts are
compositional in that they contain analyzable parts that can be recombined, whereby the content of complex representations can be determined by the content of the parts (at least to a certain degree). The thought component (concept) RED, for example, can be combined with other concepts like CAR and BALL to yield new representations with a more or less determined new content. This is not generally true for movements. For example, if I combine a grasping movement with an arm movement (to approach the object to be grasped), the resulting movement will still be a grasping movement (and thus not a new kind of movement). Moreover, thoughts stand in mutual inferential relations, which is not true for movements. These points allow us to conclude that thoughts cannot be equated with or even be described in parallel to motor processes. However, it does not allow for the conclusion that thoughts are not grounded at all. Quite on the contrary, this discussion provides different points that have to be spelled out by any comprehensible theory of grounding: 1) How can compositionality and systematicity (or, more generally, conceptuality) arise on the basis of nonconceptual representations? 2) How are inferential relations established? 3) Which mechanisms lead to the loss of modality of mental representations? And, in most general terms: Which abstraction mechanisms can explain the emergence of typical thought features if they are grounded in such different sensory-motor processes?

Explicit and implicit representation: In the principal investigator’s doctoral thesis “Mental Representation and Self-Consciousness” (Vosgerau 2009a), a theory of representation is developed that is able to systematically distinguish between different levels of representation (see also Vosgerau 2008). The most relevant distinction for this context is the distinction between nonconceptual and conceptual representations. Conceptual representations are representations that contain concepts (or representations of concepts, depending on whether concepts are assumed to be mental particulars or abstract entities). Since concepts are ascribed to objects, conceptual representations must have a structure such that one analyzable part represents the object while another analyzable part represents the ascribed property (concept). This kind of object-property structure makes it possible to exchange just one part while keeping the other constant. This means that one and the same property can be ascribed to different objects. It also means that different properties can be ascribed to one and the same object (Vosgerau 2007). Nonconceptual representations, on the other hand, are representations which lack this kind of structure. If I feel my own hunger, for example, I have a representation of my own hunger in which no part can be analyzed that would represent me. If I had such a part, it would be possible to exchange this part while leaving the other part (for the property of being hungry) equal – I would be able to feel the hunger of other persons just in the same way I feel my own hunger. Because this is impossible, the representation underlying my hunger feeling has to be classified as nonconceptual, such that the relationship to me is only represented implicitly (Vosgerau 2009b). In contrast, conceptual representations have an analyzable part that stands for the representing system itself and thus allow for explicit self-representations. (One such example is the representation that my hair is brown).

The crucial point for the proposed project is that a clear distinction is made between the structure of representations and the description of the content of representations. Only analyzable parts are reflected in the structure (are represented explicitly) and can hence be reflected in frames. Other aspects are only represented implicitly. We need to mention them to describe the content of the representation although they are not reflected in the structure and thus not reflected in frames. This idea can be captured in frames if we allow frames with no central node to describe nonconceptual representations and frames with central nodes to describe the object to which different properties (described by the other parts in the frame) are ascribed. As one example, consider the (egocentric) representation of a specific location. An ant represents the location of its nest in terms of the angle to the sun in which it has to walk and the number of steps it has to make to reach the nest (Gallistel 1993; Wittlinger et al. 2006). However, the ant probably is not able to represent this location as a property of the nest (for details see Vosgerau 2007). In Figure 2, two frames are shown: the one on the left (a) represents the nonconceptual representation of the ant, and the one of the right (b) represents a conceptual version of the representation which ascribes the property of being in this and that location to an object. The latter representations are so-called “egocentric” representations as they are found, for instance, in humans (Vosgerau 2007 assumes that in egocentric representations the object-part is missing). One case is (probably) the representation of the coffee cup on my desk – I represent it in terms of the movement which I have to perform in order to grasp it. (Needless to say, humans have a much wider array of formats for spatial representation at their disposal.)
The implicit self-relation that is contained in both frames is only revealed by the fact that the same values are involved in a motor program. This is exemplarily shown in 2(a), in which the very simple motor program of the ant is displayed: the continuously updated values that represent the location of the nest are not dependent on further background conditions (as in figure 1), since the values are already dependent on the actual position of the ant. Thus, they can directly serve as the motor command in this simple case. The fact that the pure representation of the location of the nest does not lead to the homing behavior itself, a possible condition for the execution of the represented motor command is displayed in gray: it states that in case the ant’s search for food was successful, the motor command is executed, and if it was not yet successful, it is not executed (of course, there probably are more constraints on execution for the ant). For reasons of space, the motor part is omitted in 2(b). However, since the two values “α” and “n” are motor intentions, the frame could be easily complemented with the motor frame shown in figure 1.

In the second frame 2(b), however, the location is represented as a property of an object. Since causal indexicals are assumed to be properties of objects, the frame 2(b) constitutes an example for a causal indexical, expressible roughly by “being located such that I can reach it by this and that movement” (or simply “being within reach”, if the values are interpreted as ranges). (The important role of causal indexicals for spatial representations is discussed in Campbell 1993 and Vosgerau 2007.) In contrast to this, perceived affordances are assumed to involve an explicit self-relation. In terms of frames, this means that an extra node has to be added which contains “I” as a value. The according frame is shown in figure 3(a) for the perceived affordance of a knife being for cutting (again, the motor part of the frame is considerably shortened for reasons of space). Since this frame represents the affordance of cutting perceived in a specific situation, the node for knife refers to a specific knife (and hence is round). Figure 3(b), in contrast, shows a frame in which the “I” part is exchanged by a representation of a whole class of individuals, namely adults. This frame describes the typical affordance of knives, namely being used by adults for cutting. Since affordances are properties of objects which they have in relation to classes of actors, both the knife node and the adult node are interpreted as argument nodes. Thus, being typically used for cutting is a property of things belonging to the type knife which they have in relation to things belonging to the type adults.

In sum, the varying degrees of abstractness can be straightforwardly represented in frames. While nonconceptual representations lack an object node, conceptual representations present properties as properties of objects by explicitly containing an object node. Implicit and explicit self-reference is also marked by the absence or presence of specific I-nodes. Moreover, the distinction between specific objects and classes of objects is represented by the distinction between nonargument nodes (round nodes) and argument nodes (rectangular nodes).

In Vosgerau (2009a), the principal investigator argued that nonconceptual representations are phylo- and ontogenetically more basic. Furthermore, nonconceptual representations form the basis for the development of conceptual representations (and even higher levels of representations). This claim is shown to
be not only theoretically plausible but empirically adequate. Thus, causal indexicals (being based on non-conceptual abilities) should also form the basis for the development of the representations of affordances (being based on other concepts). Moreover, while nonargument nodes represent specific things, argument nodes require concepts to represent types of things. Therefore, the given analysis of action-related concepts includes both an ontogenetic dimension (which is also highlighted by the theory of affordances) and a phylogenetic dimension (which allows for a strong connection to behavioral sciences and the investigation of increasingly complex representations in different species).

Abstraction mechanisms: The depiction of such representations in frames already reveals possible abstraction mechanisms that are able to explain the specific development. First, implicit representations are made explicit by adding nodes to the frame. At first sight, it might seem implausible that adding notes should count as an abstraction mechanism. However, the frame 2(a) is most concrete since it basically represents a specific movement. It is concrete in the sense that this movement is not represented as a property of an object. By adding the object node to the frame 2(b), the movement part of the frame is now representing the property of an object, namely its location. This representation is still very specific, but more abstract in the sense that the object is represented as having a property, which opens up the possibility to represent other properties of the same object as well as ascribing the same property to other objects. The transition from representing a specific movement to representing a (spatial) property of objects is plausibly a form of abstraction. Likewise, the transition from 2(b) to 3(a) constitutes an abstraction since the movement is now represented as a property of a specific individual, which opens up the possibility of representing the movements of other individuals as well. Thus, it is a transition from representing my movements simpliciter to representing movements in a more abstract way as being movements of a certain individual.

The second abstraction mechanism at work is the generalization of values. The difference between 3(a) and 3(b) lies only in the generality of the values in the two root nodes. These two nodes are no longer representing specific individuals but are representing classes of things. Interestingly, this step also in-
volves the transition from an indexical representation ("I") to a nonindexical representation ("adults"). In this sense, one specific abstraction mechanism might consist in the loss of indexicality. Similarly, the values that specify the movement can be abstracted to ranges of values, which would then represent a whole class of possible movements. For example, the specific values of the movement that constitutes cutting with a knife will, of course, depend on various factors such as the size and weight of the knife and the object to be cut. Indeed, if we have a look at the classical examples of affordances, the movements that play a role here are very generalized (i.e. abstract): climbing, bumping into, walking, drinking, eating, etc. Thus, classical candidates for affordances will typically include very abstract motor intentions that can be interpreted as movement schemata.

Specific open questions: One major problem in analyzing affordances is that AFFORDANCE is not functional and thus cannot serve as an attribute in frames. It is not functional since one object has many different affordances. For example, a chair has (among others) the affordances to be sit-on-able for adults and to be step-on-able for adults. The open question is how can one find an attribute which specifies one specific affordance for a given object? For perceived affordances, it might be conceivable that context and goals of the perceiver specify only one affordance which is then perceived. However, other objects (especially artifacts) might have what can be called “conventionalized” affordances, e.g., the affordance of a fork that it can be used to eat with. In this way, still different kinds of affordances might have to be distinguished. Moreover, the technical details of frame analysis have to be further specified in order to reach at a philosophically apt and formally adequate definition of affordances.

This question will also be answered in collaboration with other projects of the CRC, especially projects working on the analysis of verbs. Although verbs denoting (mostly) actions and affordances can be expected to have a similar structure, a sharp distinction seems to be in order. Affordances are conceived of as properties of objects, while actions are not. Reducing affordances-representations to action-representations in this way might, on the one hand, go hand in hand with a radical version of grounded cognition, but contradicts the idea of affordances as properties of objects (at least at first sight). Nevertheless, the theory of affordances can be criticized for exactly the reason that affordances are characterized as objective properties of objects. If affordances are objective properties, then they should be reducible to physical properties (physical relational properties): the fact that chairs are sit-on-able has to do with the physical make-up of chairs and of humans. If so, however, the role of actions in affordances becomes a mere physical role, such that the fundamental difference to other (physical) properties of the chair (such as its material) vanishes. Thus, the loss of the objectivity of affordances might not be a very high price to pay.

References
3.3.2 Project related publications of the principal investigator(s)

a) Peer-reviewed publications


3.4 Project outline

The overall aim of the project is a detailed analysis of the thesis of grounded cognition which states that concepts (high-level, cognitive representations) are grounded in sensory-motor abilities. This thesis will be scrutinized and its specific implications will be explained. The project focuses on specific types of action-related concepts, namely causal indexicals and affordances. A doctoral student will develop a detailed analysis of these action-related concepts, while a post-doc will specifically work on the thesis of grounded cognition and its implications for the architecture of the mind.

In the doctoral project, two main questions will be answered: 1) In what way are sensory-motor processes specifically reflected in the structure of concepts? 2) Which degrees of abstraction distinguish the different kinds of action-related concepts and which mechanisms exist to move from more basal types to higher-level types? The steps to be taken are:

(a) The notions of causal indexicals and affordances (including perceived affordances) will be analyzed in detail. Relevant literature will be reviewed and discussed to reach a detailed description of the two notions. The special focus of the discussion and description will be on the explanatory role these notions play for an understanding of action-related concepts.

(b) This scrutinized description will provide the basis for the analysis of action-related concepts in terms of frames. Core examples of causal indexicals and affordances will be carefully selected. The representation of these core examples in frames will reveal the specific formal difficulties for frame representations that action-related concepts pose. These specific formal difficulties will be discussed with other projects in the CRC (see 3.5) and solutions will be developed in close collaboration with other CRC projects. These solutions will meet the special constraints of action-related concepts developed in step (a) as well as conform to the overall framework developed in the CRC.

(c) Building on the two first steps, the first main question can be answered. Based on the formal precision of causal indexicals and affordances, the specific role of sensory-motor processes for action-related concepts will be analyzed. The theoretical considerations will not only be contrasted with similar and with opposing views in the literature, but also discussed in the interdisciplinary context of the CRC (see 3.5). In this way, the empirical plausibility of the theoretical proposals will be assessed. The results will be used to refine the theoretical reflections according to the empirical data.
(d) In the next step, detailed notions of implicit and explicit representations will be developed and applied to the core example frames. Relevant literature on the implicit/explicit distinction as well as the related distinction between nonconceptual and conceptual representations will be reviewed and discussed. A definition of these notions will be developed with a focus on sensory-motor abilities as opposed to conceptual abilities.

(e) Based on the specified understanding of implicit and explicit representation, the different levels of abstractness of causal indexical, perceived affordances, and affordances will be described in detail. As pointed out in 3.3.1, the relation to the self of these concepts will be of major concern for this task. Thus, this step will involve a discussion of different theories of nonconceptual self-representation as well as different accounts of implicit self-representation, as they are discussed in the philosophy of mind and the philosophy of language.

(f) The last step will involve the precise description of mechanisms of abstraction that explain the transition from lower to higher levels of abstraction. Here, two main types of abstraction mechanisms are distinguished: First, abstraction can take place on the level of frame structure (e.g., by adding nodes). Different types of such abstraction mechanisms will be identified, formally described, and categorized. Second, abstraction can take place on the level of attribute values (e.g., by abstracting from single referents to whole classes of referents). Again, these types of abstraction mechanisms will be identified and categorized.

The post-doc project will complement the doctoral project both in the sense of working out the details of fundamental aspects and in the sense of integrating the results of the detailed analysis of action-related concepts into a wider scope. The three main questions of the post-doc project are: 1) What exactly are sensory-motor values and how can they be specified? 2) What does the thesis of grounded cognition amount to and which readings can be distinguished? 3) What are the implications of the thesis of grounded cognition for the architecture of the mind? The post-doc project will be advancing in eight steps, where the first three steps are necessary to answer question 1), steps (iv) through (vi) to answer question 2), and the last two steps to answer the third question.

(i) In the first step, theories of sensory-motor processing will be reviewed and critically discussed. The focus will be on empirically informed philosophical theories. The leading question in the analysis of these theories will be how sensory-motor processing can be defined in contrast to conceptual processing, and how adequate such definitions are in empirical terms.

(ii) Based on the definition of sensory-motor processing developed in the first step, the specific representation of sensory-motor values will be analyzed. Thereby, the level of abstraction of sensory-motor coding will be determined. To this end, the literature, specifically the literature on proposed “common coding” formats, will be reviewed and critically discussed. Moreover, close collaboration with related projects in the CRC (see 3.5) will lead to a systematic assessment of the different formats of sensory-motor processing.

(iii) In the third step, the philosophical implications of the analysis provided in step (ii) are explored. The central question in this step will be as to whether action-related aspects of objects can be directly perceived, as assumed by affordance theory. To answer this question, a detailed discussion and evaluation of arguments for and against theories of direct perception of nonvisual properties is necessary. The result of this discussion will allow a reformulation of the description of affordances in a philosophically justified way, eventually dismissing the idea of direct perception of affordances.

(iv) Starting with the fourth step, the thesis of grounded cognition will be analyzed in detail and be scrutinized in a philosophically fruitful way. For this task, the different approaches to grounded cognition existing in the literature need to be reviewed and compared. The critical investigation will reveal commonalities and redundancies in the different formulations and also detect departures from the basic idea in specific approaches. It will result in a systematic description of the different approaches usually subsumed under the heading “grounded cognition”.

(v) On the basis of the systematic description of existing approaches, the core thesis of grounded cognition will be scrutinized. Using the frame framework, specific readings of the thesis will be distinguished
in a detailed and formal way. This step will also rely on the results of step (d) of the doctoral project, since the notions of implicit and explicit representations in frames will be crucial for this step. Additionally, a clear distinction between constitutive parts of frames and facultative parts of frames has to be developed, since different readings of the thesis of grounded cognition will differ in requiring the “grounding” part of a concept to be constitutive or merely facultative. This distinction will be developed in close collaboration with related CRC projects (see 3.5).

(vi) The next step will be the evaluation of the different readings of the thesis of grounded cognition. This evaluation will first be based on philosophical considerations of conceptual coherence and intuitive plausibility. Moreover, the preferred reading will additionally be tested for its empirical plausibility by reviewing the relevant empirical literature.

(vii) Since the thesis of grounded cognition states that sensory-motor abilities are pivotal for conceptual abilities, it seems to contradict theses of modularity of the mind. Theses of modularity assume that different abilities are modular, i.e. based on very different mechanisms that work relatively isolated from each other. In this step, the apparent contradiction will be analyzed in detail. To this end, arguments for modularity will be critically reconstructed and contrasted with both theoretical considerations on and empirical evidence for the thesis of grounded cognition.

(viii) The last step of the post-doc project will integrate the results of the previous steps. If the thesis of grounded cognition turns out to contradict the thesis of modularity, the possibility of distinguishing different levels of processing (namely conceptual and sensory-motor processes) vanishes. If it is true that conceptual processing is basically sensory-motor processing, the distinction between the two levels becomes blurry. However, in order to formulate the thesis of grounded cognition, such a distinction is presupposed. Thus, the last step of the project will explore the question whether the thesis of grounded cognition is conceptually coherent or whether it ultimately results in a no-levels-theory of mental abilities.

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<tr>
<th>Year</th>
<th>Doctoral Project</th>
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<tbody>
<tr>
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<tr>
<td>2012/2</td>
<td>Step (c)</td>
<td>Step (iii)</td>
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</tr>
<tr>
<td>2013/1</td>
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<td>Step (iv)</td>
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<td>2013/2</td>
<td>Step (e)</td>
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<td>2014/1</td>
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<td>2015/1</td>
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### 3.5 Role within the Collaborative Research Centre

The topic of grounded cognition in general and the notion of affordances in particular are highly relevant for many projects in the CRC. The reason is that a comprehensive description of many concepts involves the dimension of possible interactions with the objects that fall under the concept. Only if this dimension can be spelled out in detail, will it be possible to bridge the existing gap between acting on the one hand and abstract thinking and speaking on the other. In particular, the idea of groundedness plays an important role here since it allows an approach involving the semantics of linguistic expressions as well as the content of abstract mental representations in a way that incorporates all abilities (perceiving, thinking and acting) from the very start. Moreover, since sensory-motor abilities are assumed to be more basic both in phylo- as well as in ontogenetic terms, it opens up the possibility of addressing developmental questions and linking the work of the CRC to research in the behavioral sciences, especially to research in (non-human) animal cognition. From a formal point of view, the special structure of causal indexicals and affordances will help us to understand the relation between verb-frames and object-frames and to establish a coherent formal description for both. Additionally, the formalization of the abstraction mechanisms will constrain the general formalism and will provide tools for the systematic description of relations between frames.
In particular, strong collaboration is planned with the following projects (listed in order of application, not in order of importance):

**A01 Mathematical modeling of frames**: The formalization of affordance-frames involves some specific difficulties as mentioned above. For example, one problem that has to be solved is that AFFORDANCE cannot be used as an attribute since it is not a functional concept. Moreover, other difficulties concern other projects as well, for example special difficulties regarding action frames. These different difficulties will be discussed and solved in close collaboration with project A01 to guarantee a uniform formalization throughout the CRC. In addition, the abstraction mechanisms which will be characterized in A03 will need to be formalized within the given standards of the CRC. A03 can hence contribute to the more general aim of project A01 to give an accurate formal description of transitions between different frames.

**A05 Presuppositions of frame theory in the history of philosophy**: The project A05 investigates historical precursors of the frame idea underlying the CRC, especially the notion of a scheme. Since project A03 has a focus on the transition between frames by means of abstraction, it will be most valuable to explore different characterizations of such transitions between frame-like structures in close collaboration with project A05. Primarily, reasons for not pursuing specific ideas will be analyzed, and the results of this analysis will be used to guide and constrain the characterization of abstraction mechanisms in project A03.

**B01 Verb frames at the syntax-semantics interface**: Affordances can very roughly be characterized as the actions that can be performed on or with the object of which they are properties. Since most actions are lexicalized as verbs, verb frames can be expected to be very similar to affordance frames. Therefore, project A03 can profit from the results of project B01 not only with regard to formal aspects of special difficulties with action frames (e.g., the formalization of verb dynamics and of causal relations) but also with regard to content aspects as to which factors have to be represented explicitly in action frames and which aspects are only implicitly given (e.g., typical instruments, locations, and context factors).

**B03 Neural representation of action-related concepts**: Project B03 will identify reflexes of action-related constituents of abstract concepts in the brain. The aim is to record the activation of action-processing areas in the brain during the processing of abstract concepts. In this way, the data from project B03 will be most valuable to project A03 in at least two ways: 1) They will provide evidence for the thesis that affordances (action-related concept parts) play an important role for different abstract concepts. 2) They might give hints to the specific contents of represented affordances by identifying brain areas that represent certain parts of the body. In turn, the conceptual analysis of project A03 will serve as a background on which new experimental paradigms can be developed in strong collaboration between the two projects.

**B06 Frame analysis of mental disorders**: The project B06 investigates the representation of mental disorders in frames. One example which will be investigated in detail is the frame for schizophrenia. Schizophrenia is characterized, among a multitude of other symptoms, by ego disturbances (“Ich-Störungen”) caused by impairments of several types of self-related representations. For example, delusions of control may be conceptualized as altered states of agency representation. That is to say, people with schizophrenia may have the experience that some of their movements are not initiated and controlled by themselves but by other people. Likewise, the symptom of thought insertion is characterized by the experience that thoughts are inserted by other people. Hence, self-related representations may be at the core of various symptoms of ego disturbance in schizophrenia and thus will be a topic of investigation in project B06. Since one central concern of project A03 is the description of the transition from implicit self-relatedness to explicit self- and other-relatedness, A03 promises to gain insights that are valuable for project B06. In turn, the analysis of pathological breakdowns in self-related representations in mental disorders will provide further insights into the neurocircuits and the principal psychological concepts underlying such representations and may thus contribute to the endeavor of project A03.

**C05 Frames and nominal word formation**: The project on nominal word formation investigates deverbal nouns and noun compounds. As described in the C05 application, many such nouns explicitly refer to or implicitly contain reference to the typical action associated with the referent of the noun. Obviously, these typical actions can be interpreted as affordance of the referents of the nouns. If this kind of analysis is on the right tracks, deverbal nouns and noun compounds are largely based on affordances that are sometimes explicitly and sometimes only implicitly reflected on the linguistic surface. Therefore, a de-
Detailed analysis of affordance frames is of major importance for project C05. In turn, C05 will provide further evidence of affordances underlying language meaning and so enrich the focus of project A03 as well as contributing to the investigation of abstraction mechanisms. Moreover, in a longer-term perspective, further investigation of the difference between natural affordances and conventionalized affordances is planned.

C06 Frames and associative anaphora: The project on frames and anaphora analyses anaphoric constructions in terms of frames. The main task here is to uncover implicit information that is not reflected on the linguistic surface. In this way, the project is able to contribute important data about implicit information associated with specific frames and thus can reveal insights about implicitly contained affordances. Thus, C06 could provide valuable data for project A03. In turn, A03 might stimulate and enrich C06 in respect to the characterization of a new class of anaphora: action-related anaphora. While the research on anaphora is focused on nouns, the use of verbs might also be better understood under this perspective. Consider, for example, that Tina is a climber; the following sentences “Tina arrived at the rock. She started climbing.” can be interpreted to involve an anaphoric use of “climbing” which refers back to the affordance that the rock has for climbers.

3.6 Demarcation from other funded projects by the principal investigator(s)

The CRC project B06 aims to analyze psychiatric disorders in terms of frames. This topic is not directly related to the topic of A03, although in some points synergetic effects may occur (see 3.5).

The project “Who is Thinking? Authorship and Control of Thoughts” funded by VolkswagenStiftung (Az II/85 155) investigates pathological disturbances of authorship of thoughts in schizophrenia and obsessive compulsive disorder and is thus not related to the present project.

The project “Grounding Thoughts in Actions: Interdependencies between Thoughts and Motor Control (ThinkAct)” funded by VolkswagenStiftung (Az II/85 068) is also dealing with the thesis of grounded cognition and the connections between concepts and motor abilities. However, in contrast to the proposed project, this project 1) does not appeal to the theory of frames and 2) is not dealing with the analysis of specific concepts but rather with the general question as to whether pathological disturbances of motor abilities always implicate disturbances in conceptual abilities. The focus in the project ThinkAct is on concepts for actions (e.g., the concept GRASP). The aim is not to analyze such concepts in detail but to specify in which sense motor abilities play a role for possessing such concepts. Methodologically, ThinkAct primarily investigates pathological conditions in which motor abilities are disturbed or absent, measuring the effect of such motor disturbances on conceptual abilities. Thus, although there is a certain overlap between the projects, the focus and the methods of the projects differ fundamentally, such that the two projects will complement each other.