In the beginning was the act: a plea for an action-oriented approach to cognitive psychology

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In the beginning was the act:
a plea for an action-oriented approach to cognitive psychology

Rede uitgesproken door

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Geschrieben steht: „Im Anfang war das *Wort*!“
Hier stock’ ich schon! Wer hilft mir weiter fort?
Ich kann das *Wort* so hoch unmöglich schätzen,
Ich muß es anders übersetzen,
Wenn ich vom Geiste recht erleuchtet bin.
Geschrieben steht: Im Anfang war der *Sinn*.
Bedenke wohl die erste Zeile,
Daß deine Feder sich nicht übereile!
Ist es der *Sinn*, der alles wirkt und schafft?
Es sollte stehn: Im Anfang war die *Kraft*!
Doch, auch indem ich dieses niederschreibe,
Schon warnt mich was, daß ich dabei nicht bleibe.
Mir hilft der Geist! Auf einmal seh’ ich Rat
Und schreibe getrost: Im Anfang war die *Tat*!

JW von Goethe: Faust (1224-1237)

Mijnheer de Rector magnificus,
geachte collega's,
zeer gewaardeerde toehoorders,

in this oratie I will have it about human behavior, and how to approach it scientifically. If I asked you why you came here today, you are likely to come up with a variety of answers: you may be interested in the talk, be eager to meet the new colleague, or to fulfill your job duties, or just want to get some entertainment. Whatever your answer may be, it is likely to refer to some personal goal that you expect your visit to satisfy. That human (and not only human) behavior is driven by goals may seem trivial to emphasize, and perhaps it is. Nevertheless, open a cognitive psychology textbook of your choice, and you will hardly find any appreciation of this obvious fact (Prinz, 1997).

In contrast, what you commonly learn is that behavior begins with some physical energy impinging on the surface of your sensory receptors, which is then transformed into some internal, neural codes, from which so-called percepts are constructed, hence, states underlying our conscious perception. These are fed into some decision mechanism that selects an appropriate response, which then is executed. According to Ulric Neisser's (1967, p. 4) well-known definition, „the term *cognition* refers to all the processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used“ and it is cognitive psychology's mission to accompany, so to speak, the stimulus energy through these stages and describe the transformation it undergoes. Human action, so it appears from this picture, is driven by external stimuli and emerges as a natural extension of stimulus processing.

This view is anything but new: many stage models of human information processing (for a selection, see Hasbroucq, Guiard, & Ottomani, 1990; Pashler, 1994; Sanders, 1980; Teichner & Krebs, 1974; Welford, 1968) are actually less elaborated versions of what Donders developed in his Utrecht lab as early as 1868—and even his experimental techniques are still in use (e.g., employing simple-reaction, go-nogo, and choice tasks to identify processing stages). Donders believed that after some increasingly complex elaboration of the stimulus representation, a „wilsorgaan“ would intervene to translate percepts into actions, an act of „will determination“ he estimated to take 36 ms[1]. Meanwhile, his somewhat outdated expressions have been replaced by more fashionable terms like „S-R translation“ or „response selection“, but Donders' basic conception still holds (Hommel, 2000a, 2000b). Thus, the theoretical analysis still begins with the stimulus that informs and triggers our intentions, which then make sure that appropriate responses are selected. In other words, behavior is thought to be induced by external stimulation, even though it may not be fully determined by it.

My main message is rather simple, namely that this view—however plausible it may seem—is at most half of the story. And inasmuch as it pretends to tell the whole story—and this is what psychological textbooks do!—it is even incorrect and misleading. This is so because reconstructing human behavior as a function of stimulus conditions neglects that it is also, and sometimes exclusively, driven by behavioral goals. Goals, however, bring into play the stimulus events that follow, and are produced by an action, not the stimuli preceding it. And about these post-action events, the intended consequences of our actions, mainstream cognitive psychology has very little to say. Which is the more surprising as it was no later than 1896 when Dewey turned himself against the upcoming behaviorist movement in emphasizing that Stimulus-Response relations are actually bilateral: that is, stimulus conditions affect behavior but behavior also modifies, and sometimes even creates the stimulus situation we experience. Unfortunately, however, Dewey's warning did not enjoy sufficient attention to have any impact on behaviorism or today's cognitive psychology.

In the following I would like to illustrate, by means of four empirical examples, how important action-related processes can be for the acquisition of information, the perception of stimulus events, the direction of focused attention, and the perceptual integration of their elements. As these examples will demonstrate, our actions can strongly affect basic cognitive processes in ways that are difficult to make sense of if we continue to begin our theoretical analysis with the stimulus, and if we try to understand human behavior as a consequence of perception. Accordingly, my plea will be for a more action-oriented approach to cognitive psychology, an approach that does not exclude intentions, action plans, and goals when talking about cognition.

Example 1: Acquiring Action

We perform actions to achieve intended goals, that is, to produce desired effects. To do that, we need to know which consequences our movements might have, hence, intentional action presupposes the learning of movement-effect relationships. According to the good old ideo-motor principle stated by Lotze (1852), Harless (1861), James (1890), and others, we associate motor acts with representations of their consequences automatically (for overviews, see Hommel, 1998a; Prinz, 1987; Scheerer, 1984). Once we have formed such an association, we merely need to „think of" the consequences we intend to produce and the appropriate action is carried out. Translated into more modern, mechanistic terms this means that voluntary action is acquired in two steps: first codes of motor patterns get associated with codes of the effects they systematically produce; then this association is used in a „backward" direction, that is, the code of the action effect is activated in order to carry out the associated motor act (Elsner & Hommel, 2001; Hommel, 1997).

Indeed, there is evidence that infants as young as 2 months of age are sensitive to stimuli that move, or appear contingently, with their movements. For instance, Watson

& Ramey (1972) installed mobiles above the cribs of their 2-months-old subjects. In one group of infants the mobile was programmed to move in a way that was contingent on the pressure the infant exerted on his or her pillow; in other groups the mobile moved noncontingently or not at all. As it turned out, the frequency of pillow responses was considerably higher in the contingent group than in the other two groups, suggesting that these infants were especially attracted by the close relationship between their movements and the effects they produced, and encouraged to explore this relationship in more detail. Comparable results were observed by Rovee and colleagues (Fagen & Rovee, 1976; Rovee & Rovee, 1969), who gave only slightly older infants the opportunity to manipulate mobile movements with strings attached to their feet. And we are not talking about short-term effects: When the infants were again presented with the mobile after 2 days or later, they immediately engaged in mobile-related behavior (Butler & Rovee-Collier, 1989; Fagen, Rovee-Collier & Kaplan, 1976). This demonstrates that the contingent action effects did not just motivate the infants to show the critical behavior more often; they actually associated the effects with the behavior they previously found out to produce them.

There are more examples of this sort. Rochat & Striano (1999) manipulated the pacifier of 2-months-old babies such that the pressure the babies applied to it systematically modified the pitch of a tone presented to them. Hence, the harder they sucked the higher the tone. As a result, sucking behavior increased and became more systematic. Kalnins & Bruner (1973) used a similar technique by presenting 5-12-week-old babies with a movie the optical clarity of which varied with the pressure exerted on the pacifier. Again, the babies were able to systematically adapt their sucking behavior so to ensure good visual quality of the film.

And there are comparable effects in adults, as Birgit Elsner and I were able to demonstrate in several studies. What we did was to have people perform simple keypressing actions, which always produced particular tones or sounds. Later, the same tones or sounds were presented while the subjects performed another task. As it turned out, presenting a tone facilitated performing the same response that previously produced it, but interfered with performing another response (Hommel, 1996; Hommel & Elsner, 2000). Likewise, if a tone was presented during a task in which subjects were to press a key of their choice, they tended to choose the key that had previously produced that tone (Elsner & Hommel, 2001).

In another study of ours (Elsner, Hommel, Mentschel, Drzezga, Conrad & Siebner, 2001), subjects carried out a couple of tone-producing keypresses before performing a purely perceptual, passive tone monitoring task. As the monitoring task was performed in a PET (Positron Emission Tomography) scanner, we were able to assess and compare the brain activity induced by neutral tones and tones that the subjects had actively produced in the keypressing task. As expected, self-produced, but not neutral tones, activated the SMA (Supplementary Motor Area)—a brain area that is known to be involved in voluntary action planning (Decety et al., 1996; Jeannerod, 1994; Passingham, 1993). Hence, re-experiencing a stimulus event that one previously had the chance to produce oneself induces the action plan to produce it again.

What these observations show is that people of nearly any age seem to be particularly sensitive to contingencies between the movements they make and the perceivable effects that produces. This makes sense, and is actually to be expected, from an action-oriented view, because the integration of action-contingent information is crucial for learning to control one's actions. From a stimulus-oriented information-processing view, however, it would be hard to explain why stimulus information attracts more attention and leads to better memory if it happens to be contingent on one's own action.

Example 2: Observing Objects
Admittedly, the case for a prominent role of action in cognition appears to be least plausible if it comes to purely perceptual judgements. Consider, for instance, a psychophysical color-perception task, where people are seated before a computer monitor and presented with patches of various colors, which they are asked to identify, categorize, or compare with each other. How should action get into this picture? Moreover, motor theories of perception—that is, theories assuming that perceptual content is coded in terms of motor activity—have been proposed from the beginning of scientific psychology (see Scheerer, 1984). Admittedly, with little success, mainly because perceptual performance was not found to be systematically related to particular efferent processes. So, why insisting on a role of action?

Well, the recent development of brain-imaging techniques, like PET, fMRI, and MEG, and the widespread use of single-cell recordings in animal research have provided us with new, very sensitive means to reveal contributions from action-related processes even in the absence of overt movement. And these means do point to a role of action-related brain structures in perception. A good example is the recent discovery of so-called mirror neurons in the macaque monkey and evidence of similar structures in humans. Using single-cell recordings, Rizzolatti and his coworkers (Gallese, Fadiga, Fogassi & Rizzolatti, 1996; Rizzolatti, Fadiga, Gallese & Fogassi, 1996) have studied populations of neurons in the macaque premotor cortex—a brain structure mediating action planning (Passingham, 1993). When the monkey performed a particular goal-directed action, such as grasping an object, particular neurons were active—which is to be expected from neurons in the premotor cortex! However, the same neurons fired when the monkey merely observed an experimenter performing the same action, without moving himself. Thus, the same motor structure was involved in controlling a particular action and perceiving it. And, very interestingly, the dual role of this structure was restricted to goal-directed actions—no activity was recorded if the monkey watched a hand movement without an object, or the object without a hand movement.

So much about monkeys. However, mirror neurons have been identified in humans as well. Fadiga, Fogassi, Pavesi & Rizzolatti (1995) excited the motor cortex of human subjects by means of TMS (Transcranic Magnetic Stimulation) while the subjects watched an experimenter grasping an object or performing aimless movements, or they only saw the object. As it turned out, the measured motor-evoked potentials were largely increased if subjects watched the goal-directed movement, as compared to the other conditions. Interestingly, increases were obtained only in those muscles that the subject would have used him- or herself when performing the grasp. In a way, these findings underscore what I just said: Seeing a possible goal prepares one to achieve it, even if one eventually resists. However, they also suggest that action does contribute to perception. But apart from these empirical examples, there are also logical arguments that question the apparent „mere receptiveness“ of perception.

First, even the observation that we do not overtly or covertly move while processing a stimulus does not rule out a crucial role of action in the ontogenetic history of the respective processes. For instance, identifying a stimulus event may require, or be done by covertly naming it. Obviously, our ability to name something covertly emerges from our earlier practice in naming things overtly, and from being supervised and corrected by parents or peers. The same applies to categorization: Everyone knows the sometimes very funny over- and undergeneralizations children exhibit in the first years of their struggle with language: everything with a tail is a bow-wow. Would the kids continue to apply their incorrect categories, they would not be able to communicate properly; and would they not overtly apply them, they could never be corrected. No doubt, the fact that we can learn to internalize these overt behaviors represents an enormous achievement and it certainly improves our cognitive life. But internalization presupposes something formerly external, which necessarily brings in action as a constituent of cognitive processing.

Second, there is little doubt that scientific progress in cognitive psychology depends on exact, highly controlled experimentation. Conducting a good experiment often requires investigating people under rather artificial circumstances by using rather artificial tasks, and that’s why in perceptual experiments subjects are made to passively await a randomly chosen stimulus that outside of any natural context flashes on the screen. In daily life, however, we are not passively awaiting randomly chosen stimuli! Instead, we actively seek and selectively pick up particular, interesting stimulus events. And processing them properly often requires the whole body: Scrutinizing the apple you consider to buy in the supermaket requires you to orient your body towards it, to move and then fixate your eyes so that its image is properly foveated, to coordinate movements of your arm, hand, head, and eyes to inspect it from all sides, all this while holding balance despite of the other customers bumping into you, and so forth. In fact, perceiving without acting is hardly possible in most cases we can imagine (Dewey, 1896; Gibson, 1979; Piaget, 1946). This does not only apply to vision: try to localize an auditory source without moving head and body; try to identify an object you touch without moving your fingers across its surface, or a piece of food in your mouth without pushing it around with your tongue; or try to characterize a smell without moving your nose. Difficult to impossible I would say, which illustrates how fundamental action is for perception.

One of the most beautiful demonstrations of that fundamental relationship has been provided by Hershberger & Misceo (1983). In their simple, but ingenious experiment subjects were asked to judge the relative weight of metal cylinders individually dropped in their hand. Unbeknownst to the subjects, they always judged the *same* object, hence the weight was always identical. The only manipulation concerned a warning light, which was lit either half a second before the weight was delivered or simultaneously with delivery. The authors reasoned that presenting the light in advance of the weight would allow subjects to prepare their motor system for catching the weight, which again should make the weight appear lighter. And this is what happened: the weights were judged lighter when preceded than accompanied by the warning light—illustrating how even the content of our perception can depend on action control.

Example 3: Attending & Acting

Another example for how action control can affect „earlier“ information-processing operations comes from research on the direction of focused attention. Focused attention is known to be necessary if an object is difficult to perceive or to discriminate from other available information, especially in the case of visual stimuli. Deubel & Schneider (1996) presented their subjects with a discrimination task that included such stimuli. Subjects faced a row of neutral symbols on a screen. At some point, the symbols changed very briefly into irrelevant distractors and one visually marked target stimulus, and then changed back into neutral symbols. The target was always an uppercase E, and subjects were to judge whether it was normally oriented or mirror-reflected—a difficult but solvable task.

The interesting manipulation was that subjects performed the discrimination task while planning a saccadic eye movement to some previously instructed location. When this location coincided with that of the to-be-discriminated letter, discrimination performance was nearly perfect. However, when saccadic target and target letter were separated by as little as 1 degree of visual angle—about 1 cm with normal viewing distance—discrimination performance broke down and was close to chance. Thus, the processing of the visual stimulus was fully dependent on action planning or, more precisely, on whether the locations of stimulus and spatial action goal were compatible.

Now, there is a close relationship between eye movements and visual attention, even at sub-cortical neural levels, which raises the question whether such interactions between attention and action generalize at all. To test that, Deubel, Schneider & Paprotta (1998) replicated the Deubel & Schneider (1996) study in all respects, except that subjects were to point with their right hand to some specified location while keeping their eyes fixated at the center. The results were the same as with eye movements: Discrimination of the target letter was excellent when it appeared at the location to which the pointing movement was programmed, but close to chance when the locations of target letter and pointing movement differed. Along these lines, Hommel & Schneider (in press) had subjects to perform a visual-search task while planning a manual keypress. Again, search performance was strongly affected by the spatial correspondence between visual target stimulus and manual action. That is, a target stimulus appearing among distractor stimuli is identified more accurately if its relative location is shared by the location of a keypress that was just being planned.

We can conclude from these observations that spatial attention to visual stimuli is not as ignorant with respect to what goes on in action control as the idea of a linear processing stream from stimulus to response suggests. From an action-oriented view, however, this coupling of perception and action makes sense: it not only prepares the cognitive system for processing information from the location a planned action is directed to, but also reduces the likelihood of interference from perception on action.

Example 4: Integrating Information

My last example comes from research on the integration of information. There is converging evidence showing that our brain processes and stores the different features of perceptual events in different neural systems and cortical areas (Cowey, 1985; DeYoe & Van Essen, 1988). Given these distributed representations it is an interesting research question of how the respective features are integrated or, in other words, how the brain „knows“ which representational elements belong together and to which event (Treisman, 1996). The physiological details of integration do not need to bother us here (see, e.g., Damasio, 1989; Hummel & Biederman, 1992; Niebuhr, Koch, & Rosin, 1993; Schillen & König, 1994; Singer, 1990), but there is increasing behavioral evidence that features belonging to the same event are temporarily bound, glued together, so to speak, to cognitive structures that have a longer lifetime than the perceptual event itself (Kahneman, Treisman, & Gibbs, 1992).

One possible function of these bindings might be to mediate object constancy—our impression that an object continues to exist even when temporarily hidden from view, such as when it disappears behind another object. Thus, there might be internal representations or models of events that are sufficiently „inert“ to survive the temporary absence of external stimulation. Consistent with this idea, people have been demonstrated to be very sensitive to the repetition of feature combinations. For instance, when being presented with two visual objects in short succession, subjects find it easier to process the second object if it either is the same object as the first, or an entirely different object, than if it shares some but not all features with the first object (Gordon & Irwin, 1996; Henderson, 1994; Henderson & Anes, 1994; Hommel, 1998b, 2001; Kahneman et al., 1992). It is as if re-using an already existing event model is as easy as creating a new one, whereas disassembling an existing model to re-combine its elements in a new way is difficult.

The human brain uses distributed representations not only for coding perceptual events but also for planning actions (Keele, Cohen & Ivry, 1990; Stoet & Hommel, 1999; Wickens, Hyland & Anson, 1994). Both single-cell studies in monkeys and electrophysiological measurements in humans have shown that different neural codes are used to represent different intended movement features, such as direction (Alexander & Crutcher, 1990; Georgopoulos, 1990), distance (Riehle & Requin, 1989), duration (Requin, 1992; Vidal, Bonnet & Macar, 1991), and force (Bonnet & MacKay, 1989; Kalaska & Hyde, 1985; Kutas & Donchin, 1980).

Now, if perception and action are really related as closely as suggested here, one might speculate that action plans are made the same way as perceptual event representations, that is, they may also consist of temporary feature bindings. Indeed, Stoet & Hommel (1999) observed that planning an action is more difficult if it shares features with another, already prepared action, be it in terms of effector or body side. For instance, we asked human subjects to prepare, but not yet carry out a a sequence of keypresses with their left or right hand. Next, we presented a stimulus that signaled performing a brief tap with the left or right foot as soon as possible. What we were interested in was whether the action plan subjects held in memory would affect the reaction time for the foot response.

How might such an effect look like? Assume that action plans are really made up of distributed feature codes that are bound together to form a coherent cognitive structure. And assume further that a code that is already bound to one plan is difficult to bind to another. Just as a friend who is less likely to follow your invitation to a restaurant if he or she has already joined another group of people to go to a concert. If so, we would expect that creating an action plan that involves the feature LEFT, say, would make it more difficult to create another plan with the same feature. Hence, planning a LEFT action and maintaining this plan should make it more difficult to plan another LEFT action, as compared to planning a RIGHT action. And this is what we observed: Maintaining the plan to perform a movement sequence with the left hand made it more difficult to perform a speeded response with the left foot. Suggesting that a feature code that was already bound to a particular action plan was temporarily „occupied“ and not easily available for integration into other action plan.

In other studies we went one step further and asked whether integrating a feature into an action plan would even impair perception. Assume, for instance, you plan a left-hand keypress. And assume that this involves binding the LEFT feature code to the corresponding action plan. Does that mean that you encounter difficulties in perceiving a left stimulus while maintaining your action plan? Several studies conducted by Müsseler, Hommel, and colleagues (Hommel & Müsseler, 2001; Müsseler & Hommel, 1997a, 1997b; Müsseler, Wühr & Prinz, in press) suggest that this is actually the case. For example, preparing a left- or right-hand keypress strongly impairs the identification of briefly presented arrows pointing in the same direction. Likewise, preparing the utterance „LEFT“ or „RIGHT“ strongly impairs the identification of the briefly presented words „LEFT“ and „RIGHT“, respectively. People have even difficulties to detect the presence or absence of stimuli sharing a spatial feature with a planned action. More recent observations of Stoet & Hommel (in press) confirm that these effects go either way. That is, having people to attend to a stimulus—which presumably leads to feature integration—makes it more difficult to plan a manual action on the same side.

In sum, these findings suggest that a feature code used to represent an intended action or a perceived event is temporarily bound to a coherent cognitive structure, and therefore difficult to integrate into other action plans or event representations. Moreover, these findings demonstrate that the effects of feature integration can extend from action planning to perception and vice versa. This does not only provide another example of how our actions can affect our perception. The observation that feature-related similarities between perception and action matter at all also suggests that perception and action may not be that different anyway. At least they seem to share some representational codes.

Babies & Bathwaters

I don’t know whether these few examples were sufficient to already convince you that it is about time for a more action-oriented approach to human cognition. Personally, I would be satisfied if they at least raised some doubts in the generality of the traditional concept of human cognition and action as a extensions and consequences of transforming stimulus energy into neural codes. A concept that, after all, dominates psychological textbooks and that our students take to provide a fair picture of how our cognitive system works!

Of course, I’m a bit beating at strawmen, and it would be unfair to give the impression that users of stimulus-oriented stage models were unwilling to admit that human behavior is affected by goals. Indeed, there are already numerous recent attempts to investigate how they do so, ranging from studies on task-switching to investigations of prospective memory (for a recent overview of such work see, e.g., Monsell & Driver, 2000). Nevertheless, it is fair to say that today’s cognitive psychology is characterized by a pronounced imbalance between perception- and action-related issues, and between input- and output-oriented approaches. As long as this is so, and there is not much evidence of a dramatic change, it may be acceptable to emphasize, perhaps even over-emphasize, the relevance and role of action in and for human cognition.

An Alternative Approach

But where to go from here? What perspective to assume for guiding research and theorizing, for making sense of human cognition and behavior? As a first step, my former Munich colleagues and I have developed what we call a Theory of Event Coding (Hommel, Müsseler, Aschersleben & Prinz, in press). Actually, it is not so much a theory that would make specific predictions of reaction time differences in particular tasks. Rather, it is a general framework for how to look at phenomena—a meta-theory to be replaced by something more detailed in the hopefully near future.

Our basic assumptions are these: First, we assume that cognitive structures are *assembled*, that is, created by combining and integrating more basic representational elements. These elements, we believe, are codes of perceived features that events in the world possess. Second, we assume that these feature codes refer to the *distal* attributes of events, not to their sensory or motor representations: a rectangular shape, not a retinal pattern; a straight movement, not a particular muscle coordination. Of course, to be effective, feature codes must also be *associated* with sensory and motor patterns, but they do not *represent* them. Third, and this is the most challenging part, we claim that feature codes, and the cognitive structures the make up, always represent *events*, independent of whether an event is a perceived stimulus or a planned or performed action. Hence, perception and action planning do not only interact, they actually use the very same representational codes!

We feel that these ideas have extremely interesting implications, apart from allowing us to understand the effects and phenomena I just went through. In fact, our approach removes any logical border and distinction between perception and action, and we ourselves have sometimes difficulties to grasp what that really means. Nevertheless, we did find this an exciting starting point that already permitted us to discover such odd and counter-intuitive phenomena as the „action-effect blindness“ of Müsseler and colleagues or the „code-occupation effect“ of Stoet and Hommel. If you are interested, let me invite you to see where this leads us!

Plans & Projects

So far, I have attempted to give you some insights into my and our general theoretical and empirical interests. But, of course, you may also like to know in some more detail what to expect from this new colleague and his coworkers, at least with respect to science. Let me therefore end with a short list of research projects that already were or are going to be started, and a few plans for the near future. Perhaps you find it sufficiently interesting to hear more about it, and perhaps there are some interests that you share.

- We investigate how people attach meaning to their actions, and when and how they are able to adapt this meaning if the task and context changes. Obviously, the same movement can have several, sometimes quite different, context-specific meanings, which raises the question of how this context-specificity is learned and cognitively represented.

- We want to find out more about the development of voluntary action and study interactions between intentional and automatic processes in infants between 6 months and 7 years of age. There are dramatic discontinuities in the early development of action control—possibly related to the maturation of the frontal cortex—the study of which might increase our insight into how action control works.

- We further investigate positive and negative influences of action planning on the perception of objects and events. This is likely to increase our knowledge about both the representation and formation of action plans, and the relationship between perception and action.

- We examine interactions between concurrently performed tasks, to learn more about how action plans are made up, organized, and controlled. These studies have also implications for application, such as the design of working places.

- We study the integration of features in perception and action planning, in students, in elderly people, and in patients suffering from Alzheimer’s or Parkinson’s disease.

- We look at the temporal dynamics of feature integration in both behavioral experiments and studies using brain-imaging techniques, such as MEG.

- We also analyze the role of emotions and emotional goals in and for action control. We are especially interested in whether emotions play a special role that differs from cognition.

This & Thanks

Dear colleagues, I hope this plea and brief overview have made you curious about what is going on in Funktieleer en Theoretische Psychologie in the next years. Personally, I’m very impressed by, and very grateful for, the open-hearted and open-minded reception in this university in general and my new section in particular. And I would like to thank my new colleagues for their valuable help and advice, and their touching patience with me. I'm also very enthusiastic about my new colleagues in the department, and I'm grateful for the encouraging support I received in many respects and from all sides. Especially the unique and charming mixture of highly professional attitude and personal friendliness is a very special experience for me.

In looking back, there would be of course many people to say thanks to: supporting and inspiring friends and colleagues, curious students, and all the poor subjects that must have been bored to death in my experiments. Or Martin Kumpf, whose exciting social psychology lectures convinced me that psychology is *it*. Or Odmar Neumann, whose brilliant thoughts and thinking attracted me to cognitive psychology and made me modest at (about) the same time. But career-wise I guess the one I owe most is Wolfgang Prinz, director of the Max-Planck Institute for Psychological Research in Munich. He was able and willing to stand me even in my wilder years—personally speaking—and provided virtually everything I needed to grow: A job, wonderful working conditions, personal support and understanding, patience in times of improvable output. And he is the best role model you can have in terms of organization, strategy, and social intelligence.

And yes, scientists do have a private life and even family. Sadly, this day came a couple of years too late for my father, who I'm sure would have been the proudest man in this room. *Danke von Herzen*, to him and to my dear mother, for whom the travel would have been too much. It goes without saying that I would not be here without their care, support, and sacrifices. And of course I cannot end without saying *grazie* to Lorenza, my dear wife, for sharing her life *con uno moppolo locino*.

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Ik heb gezegd.

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Footnotes

1 To measure how long the *wilsorgaan* would need to make a decision, Donders (1868) manipulated stimulus-response uncertainty in an experiment in which subjects responded to the electrical stimulation of their left or right foot by moving their left or right hand, respectively. Subjects were faster to respond correctly if they knew in advance which stimulus would occur than when they did not, and Donders took this difference in reaction time as an estimate for the combination of stimulus discrimination and „determination of the will“. To further disentangle these two processes, Donders employed a Go-Nogo task that required the selective responding to a specified subset of the stimulus set. Since the response was already known to the subject, Donders reasoned that such a task would not require any further will-determination processes, so that their duration can then be estimated by subtracting the Go-Nogo reaction time from that obtained in conditions that require a response decision. As a result, he calculated will determination to take 36 ms.