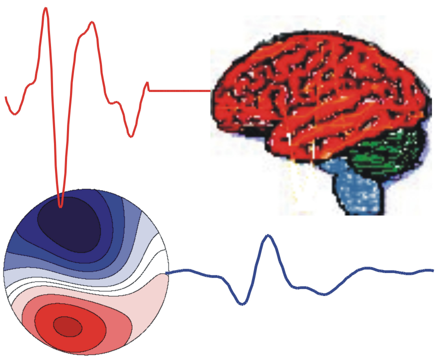
KOGNITIVE NEUROPHYSIOLOGIE DES MENSCHEN

HUMAN COGNITIVE NEUROPHYSIOLOGY



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Examples of reference format

Johnson, K., Hsiao, S., & Twombly, L. (1995). Neural mechanisms of tactile form recognition. In M. Gazzaniga (Ed.), *The Cognitive Neurosciences* (p. 253-267). Cambridge, Mass.: MIT Press.

Pascual-Marqui, R., Michel, C., & Lehmann, D. (1994). Low resolution electromagnetic tomography: a new method for localizing electrical activity in the brain. *International Journal of Psychophysiology*, *18*, 49-65.

Zani, A., & Proverbio, A. (Eds.). (2002). *The Cognitive Electrophysiology of Mind and Brain*. San Diego: Elsevier.

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Abstract

D. Eckstein, T. Koenig, M. Wyss, & W. J. Perrig (Bern, Switzerland) — Monitoring the Time Course of Perception without Awareness: A Comparison of Mirror Masked Words and Nonwords
Mirror masked words are embedded into a context that makes them appear as senseless patterns or as strings of unfamiliar letters. Thus, mirror masked words can be shown for several hundreds of milliseconds without being recognised as words. We sought to further investigate effects of nonsconscious reading by monitoring event-related brain potentials (ERPs) while participants observed mirror masked letter strings. ERPs were recorded while participants observed mirror masked words and nonwords. Data of 15 participants was segmented into periods of quasi-stable field topography (microstates). Microstates for masked words and nonwords were compared using randomization tests, statistical parametric scalp maps and Low Resolution Electromagnetic Tomography (LORETA).
ERPs to masked words and nonwords showed significant topographic differences between 136 and 256 ms, indicating that stimuli were nonconsciously discriminated. A LORETA model localised sources of activation discriminating between masked words and nonwords in left operculum, the right superior parietal lobe and right superior temporal gyrus indicating higher current density for nonwords than for words in these areas.
ERPs of mirror masked stimuli can indicate unconscious discrimination even in cases where behavioural priming is unreliable. This approach might be useful for investigating differences in early, nonconscious stages of word perception.

Keywords: Reading; Language; Subliminal perception; ERPs; LORETA

Monitoring the Time Course of Perception without Awareness: A Comparison of Mirror Masked Words and Nonwords

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Introduction

In the past few years, research on perception without awareness has obtained considerable attention in cognitive science. Effective masking techniques have been developed with which stimuli can be presented subliminally. Priming experiments with subliminally presented words and letter strings have been successfully used to investigate processing of linguistic properties of words (cf. Frost, Forster, & Deutsch, 1997; Grainger, Colé, & Segui, 1991; Kinoshita & Lupker, 2003), effects of attitudes and emotional content (cf. Bargh, 1992; Hassin, Uleman, & Bargh, 2006; Wentura, 2002) and effects on memory (e.g., Jacoby & Whitehouse, 1989). The usual method of masking is to embed to-be-masked stimuli in a rapid visual stream of pattern masks. This combination of short stimulus duration and overlapping visual percepts of stimulus and masks leads to the visual experience that the stimulus is invisible. However, this method only works within a narrow range of possible presentation times that exclude awareness of stimuli. It has also been noted that the onset of a mask that follows a stimulus has the effect of interrupting any bottom-up processing of the stimulus up to that point (Humphreys, Besner, & Quinlan, 1988; Kovacs, Vogels, & Orban, 1995; Rolls & Tovee, 1994). Because of its tight limits, the timing must ideally be empirically determined on an individual basis for every participant in a given experiment.

Another difficulty arises from the fact that subliminal perception must be indirectly inferred from participants' reactions. Earlier attempts to use direct measures (whereby participants were asked to indicate which word in a list appeared beforehand) have suffered from unreliability, which explains why indirect measurements based on priming are commonly used. The actual paradigmatic measurement of subliminal perception consists in assessing priming by subliminal primes on reactions to succeeding visible probes. These priming effects are not as large, and thus more difficult to replicate than priming effects obtained with visible primes. One way to increase the effect size is to familiarise participants with the test material used in the task. Indeed, effects can be quite robust when using this strategy (cf. Greenwald, Draine, & Abrams, 1996; Greenwald, Klinger, & Schuh, 1995), which explains why existing fMRI studies on subliminal perception have been based on this approach (e.g., Dehaene, Naccache, Cohen, & Rivière, 2001; Dehaene, Naccache, Le Clec'H, & Le Bihan, 1998; Naccache & Dehaene, 2001). However, it has become evident that frequently repeating the same set of stimuli with fixed response mappings leads to automatisation of all processes involved in responding. As a consequence, processes of perception, memory and response preparation become difficult to separate (Damian, 2001; Kunde, Kiesel, & Hoffmann, 2003). This issue is further complicated by the fact that the threshold of consciousness decreases with repeated presentation (Wolford, Marchak, & Hughes, 1988), which can lead to paradoxical priming effects, e.g. effects that appear to be related to the meaning of stimuli but are instead driven by low-level perceptual properties of the stimuli (Abrams & Greenwald, 2000; Greenwald, Abrams, Naccache, & Dehaene, 2003; Kouider & Dupoux, 2004).

To overcome these methodological difficulties of delicate timing issues or small effect sizes, we developed a masking method that does not rely on temporal masking, but instead uses spatial masking (Perrig & Eckstein, 2005). This masking technique, which we call mirror maskingüses each letter's mirror image to mask the word. As can be seen in Figure 1, letters are merged with their inverted counterpart at the letters' base line. In previous experiments of ours, mirror masking has proven effective in hiding prime words (that were shown for 750 ms) from awareness: Across a range of unpublished and published experiments with over 200 participants, 85% of participants reported not having perceived any of the prime words after the experiment (Perrig & Eckstein, 2005). The masking effect is in principle due to a visual neglect driven by attentional diversion, thus resembling the phenomenon of 'inattentional blindness' (Mack & Rock, 1998). The fact that the mirror masked letters form new symmetrical patterns resembling an unknown alphabet further enhances the masking effect. Indeed, when participants start seeing words in the patterns, they are usually unable to describe the masking at first, because the words tend to be seen as 'popping out' of the pattern. Due to its different mode of functioning, mirror masking has two outstanding advantages compared to pattern masking: (a) Reports of conscious perception do not depend on response criterion levels, because words are seen as popping out as a whole, and (b) presentation time is in principle not critical.

We have previously observed replicable priming of mirror masked primes with the word stem completion task and, less reliably, with the lexical decision task. In word stem completion, where participants are asked to complete a 3-letter word onset with two or three letters such that a valid word is formed, masked prime words that were only shown once in an experiment were reliably completed more often than control words, and this effect remained stable over stimulus onset asynchronies (SOAs) of 1 to 3 seconds (Perrig & Eckstein, 2005). Subsequent studies suggested that priming is not due to single letters or word-parts, because completion of words was not facilitated by substrings of primes (Eckstein, Sturzenegger, & Perrig, in preparation). However, it is possible that perception of words does not reach the semantic level, as semantic priming was found to depend on participants' reading ability (cf. Eckstein, Norris, Davis, & Henson, 2009). Our previous studies thus indicate that mirror masked words are unconsciously processed at a nonsemantic lexical level. Therefore, they can be used as a tool to investigate the mechanisms of nonconscious perceptual and lexical word perception that is not accompanied by awareness.

In all experiments so far, behavioural priming by masked words was weak. This is a usual finding in this field, when one uses non-repeated word presentation (cf. Damian, 2001). The present study was conducted because ERP measures have been found to be more sensitive to nonconscious priming than behavioural priming (e.g., Holcomb, Reder, Misra, & Grainger, 2005; Kiefer, 2002; Misra & Holcomb, 2003). The main idea was to locate temporal and topographic differences in ERPs recorded while participants observed masked words and nonwords. This approach is usually difficult to do because ERPs of the masked stimulus interfere with ERPs of the succeeding nonmasked stimulus in priming studies. Instead, we were able to present mirror masked words for 500 ms, which allowed us for on-line monitoring of processes occurring while participants fixed the masked letter strings. Because we could not assume to find the same ERP components for nonconscious perception as the ones reported for conscious word perception (cf. Compton, Grossenbacher, Posner, & Tucker, 1991; Grossi & Coch, 2005; Hinojosa, Martin-Loeches, & Rubia, 2001; Nobre & McCarthy, 1995; Schendan, Ganis, & Kutas, 1998; Sereno, Rayner, & Posner, 1998, for

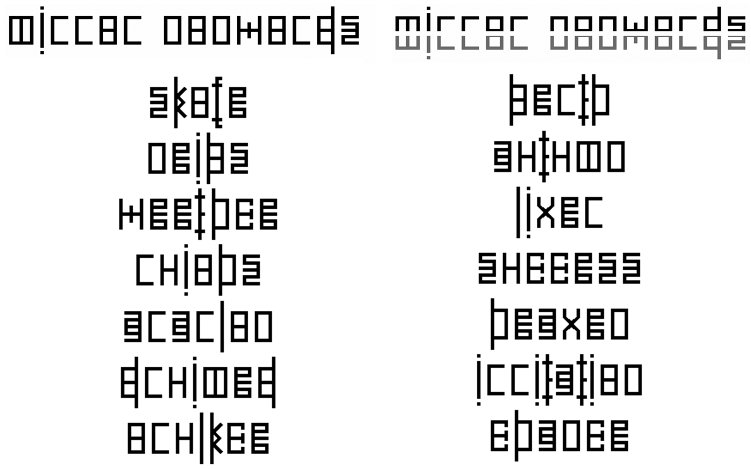

Figure 1: Example of the mirror masked term 'mirror nonwords'. Construction of mirrored letters is illustrated in the upper part of the figure. In the lower part, examples of mirrored nonwords (left, from top: "skofe", "neibs", "weethce", "ruiohs", "ararlon", "druimed" and "orulkce") and words (right, from top: "berth", "autumn", "liver", "success", "heaven", "irritation" and "chance") are reproduced. Note: The original language used was German.

prelexical processing; Cohen et al., 2000; Martin-Loeches, Hinojosa, Gomez-Jarabo, & Rubia, 1999; Nobre, Allison, & McCarthy, 1994; Rudell & Hua, 1997; Skrandies, 1998 for discrimination of word-forms or retrieval from word lexicon; Brown, Hagoort, & Chwilla, 2000; Dietrich et al., 2001; Holcomb, et al. 2005; Kutas & Hillyard, 1980; McCarthy, Nobre, Bentin, & Spencer, 1995; Wirth et al., 2006 for semantics, but see Penolazzi, Hauk, & Pulvermüller, 2007), we used the microstate and the TANOVA methods, which are both apt for explorative determination of significant differences in ERP topographies between time segments and conditions (McCarthy et al., 1995). Therefore, comparison with findings stemming from research with visible words, according which differences at about 200 ms would be expected with lexical differences between stimuli, can only be done with extreme caution.

Analysis was based on comparisons of ERP scalp topographies across conditions in different time segments, using the microstate approach. The time course of ERP topographies contains periods of relative stability during which change across time is minimal. These periods of quasi stable ERP topography have been called 'microstates' and are thought to correspond to basic steps of information processing (Lehmann, 1990). Because it is sensible to collapse across similar data from a statistical point of view, on- and offset times of microstates were used to define time windows of analysis. Using a bootstrap method, comparison of microstate topographies across conditions was then used to locate differences in active cerebral generators.

The experiment consisted in priming task using lexical decision, whereby each visible probe (word or nonword) letter string was preceded by a mirror masked (word or nonword) letter string shown for 500 ms. This was done to ensure that participants were looking at the masked stimuli when they appeared on the screen, although their attention was directed towards the succeeding probes. On the basis of a previous unpublished experiment, we tentatively expected priming effects for word-word compared to nonword-word trials which would indicate lexical processing of the primes. In order to rule out other reasons for such priming, orthographic and semantic relatedness of masked and visible stimuli was minimised and every stimulus was shown only once during the experiment.

Materials and Methods

Subjects

Participants were 8 male and 11 female volunteers aged 21 to 38 years (M = 28.5, SD = 5.7). They were all native German speakers with normal or corrected-to-normal vision, without any neurological or neuropsychological disorder and without psychoactive medication. 16 participants were self-reported right-handers and 3 were ambidextrous. All participants were naïve to the experimental hypothesis, had never been in contact with the mirror word masking paradigm and were naïve with respect to priming paradigms. The study was approved by the University's ethics committee and informed consent was obtained from all participants.

Stimuli

180 non-associated word pairs were selected from a set of German nouns, most of which described concrete and emotionally neutral concepts. Word length varied between 3 and 8 letters and between 1 and 3 syllables. Orthographic similarity of words in word pairs was very low as measured by an index of orthographic similarity described in Weber, 1970. This set of word pairs was divided into four groups of 45 word pairs that were balanced with respect to word length, number of syllables, orthographic similarity and word frequency (Institut für Deutsche Sprache, 1991-2007), based on occurrences in Swiss Newspaper texts. Nonwords were constructed by concatenating letters that were randomly selected from each letter position of the experimental word set. 180 nonwords were constructed on the basis of the first word in the word pairs, and another 180 nonwords were constructed in the same way based on the second word in the word pairs. Hence, letter frequencies of words and nonwords were identical at each letter position. Pairings of masked and nonmasked stimuli were controlled. The four groups of word pairs were counterbalanced over participants and the four possible pairing conditions (masked word vs. nonmasked probe word, masked nonword vs. nonmasked probe word; masked word vs. nonmasked probe nonword, masked nonword vs. nonmasked probe nonword). Additional 15 nonwords and 5 words were used for practice.

Procedure

Participants were comfortably seated in a darkened, acoustically and electrically shielded recording chamber. A 15"' liquid display VGA screen and an IBM compatible personal computer was used for stimulus display. Participants were seated at a distance of about 50 cm from the screen, their heads positioned by a head-rest mounted on a small table in front of them. Left and right keys of a button box were used with the index fingers of the left and right hand for collection of responses. The experimental program was written in MEL 2.0 (Schneider, 1988).

10 practice trials and 180 experimental trials were shown. Each trial had a fixed sequence starting with a 1s blank screen which was followed by a 500 ms mirror masked stimulus, then a 500 ms blank screen, and finally a 500 ms nonmasked probe stimulus. The response window started at probe onset and lasted for one second. Inter-trial interval duration was one second. Participants were instructed to fixate the centre of the screen, where an abstract pattern (the masked letter string) would indicate the imminent onset of the letter string probe. They were asked to press as quickly as possible the key corresponding to the type of probe shown. Right and left button box keys were alternatively assigned to word and nonword probes across participants. Participants were also instructed to keep eye movements and eye blinks to a minimum during trials.

All stimuli were presented at the centre of the screen in white lettering on a black background. The mirrored letter strings were presented in mirror masked lower-case letters written in 'boxie17' font, subtending a vertical visual angle of about 1°and a horizontal visual angle of about 4°. Probe letter strings were presented in upper-case in 'FG-16' (MEL font) which had the same height as the mirrored font. Sequence of the 180 trials was randomized. Each participant saw 45 stimulus pairs in each of the four conditions of word-nonword combinations, whereby word groups were rotated between conditions and participants, and nonwords were randomly chosen from the nonword set. Each word and nonword in the stimulus set was shown maximally once during the experiment. A short break was given after 60 and 120 trials.

At the end of the experiment, participant's awareness of the masked words was assessed with three consecutive questions: Had they noticed anything unusual in the patterns? Had they seen single letters in them? And, had they seen words in them? These questions were used to determine which of the participants were not aware of the words throughout the whole experiment.

Electrophysiological Recording

EEGs were recorded by 74 Ag/AgCl scalp electrodes mounted on an elastic cap according to the international 10-10 system. To record eye blinks, two additional electrodes were placed below the eyes. Cz was used as recording reference. Electrode impedances were held below 10 kOhm. Signals were amplified, bandpass filtered at 0.5-70 Hz, digitized at 250 Hz and continuously stored for offline analysis. Stimulus onsets were recorded with a separate channel appearing in the EEG recordings.

EEG preprocessing and averaging

From the raw EEG data, electrooculographical signals (EOG) were computed as bipolar derivations between F9 and F10 (horizontal EOG) and the channels below the eye against Fp1 and Fp2 (vertical EOG). All 74 scalp channels were recomputed to average reference. After applying a 50 Hz notch filter and a 1.5 to 30 Hz bandpass filter, the analysis epochs were selected, starting at the onset of each stimulus and lasting for 500 ms. (After 500 ms, eye movements were more frequent). These epochs were DC corrected (baseline removal) and submitted to a semi-automatic artifact detection that rejected epochs with channels showing peak to peak amplitudes larger than 100 uV within 100 ms and artifacts identified by visual inspection. Over participants, the rate of rejection due to artifacts was about 10%. For each subject, separate mean ERPs were computed for masked nonwords, masked words, nonmasked nonwords and nonmasked words. For each of these four conditions, a grand-mean across all participants was computed.

Identification of microstates

Identification of microstates was based on Global Field Power (GFP) of the grand-mean ERPs for masked and nonmasked stimuli, respectively (Lehmann & Skrandies, 1980). Separate microstate analyses were done based on the post-hoc observation that the GFP time course and the topographies of the grand-mean ERPs were substantially different. GFP is a momentary, global index of topographic strength and is defined as the spatial standard deviation. Periods of high GFP assumingly correspond to near-synchronous activity of neural populations, and changes of ERP topography typically occur in local troughs of the GFP (Lehmann, 1986). We therefore used the troughs of the GFP curve to determine on- and offsets of the microstates used for further analysis. Microstates that had an on- or offset at the beginning or ending of the 0 to 500 ms post-stimulus analysis period were not further analysed. For illustration purposes, stability of microstates between GFP troughs was further quantified by computing the matrix of spatial correlations across time (Kochi, Koenig, Strik, & Lehmann, 1996).

Comparison of the ERPs

Statistical comparisons of word and nonword ERPs across subjects were done separately for masked and nonmasked stimuli. Separate analyses were conducted for comparison of microstate amplitude and topography in each microstate time window. For each subject and condition, individual mean microstate topographies were first computed. Differences between microstate amplitudes associated with words and nonwords were tested with paired two-tailed t-tests over subjects on GFP (statistical parametric scalp maps).

For the comparison of microstate topography between word and nonword conditions, a randomization statistic was applied using the 'TANOVA' program (available online at www.unizh.ch/keyinst/ NewLORETA/ LORETA01.htm). Using Global Map Dissimilarity (Lehmann & Skrandies, 1980) as a GFP-independent difference measure between conditions, TANOVA applies a randomization test (Edgington, 1980; Manly, 1997) to establish the exact probability of the observed difference by assuming a null hypothesis of zero topographic dissimilarity. This procedure has been used in earlier studies (Kondakor, Pascual-Marqui, Michel, & Lehmann, 1995; Lehmann et al., 2005; Strik, Fallgatter, Brandeis, &

Pascual-Marqui, 1998). In microstates where TANOVA indicated a topographic difference at $p < .05$, further analyses were performed: Firstly, t-maps were computed, thresholded at $p < .05$ (uncorrected) and displayed for comparison with other studies (note that these t-values were not used for further statistical interference, since the null-hypothesis was rejected by the TANOVA). Secondly, since evidence for a topographic difference implies that there must have been differences in the underlying sources, a distributed source localization procedure was employed to locate these putative intracerebral sources of significant differences.

Source localization was based on low resolution electromagnetic tomography (LORETA, Pascual-Marqui et al., 1999; Pascual-Marqui, Michel, & Lehmann, 1994) applied to individual, normalized (maximum GFP = 1) microstate topographies of both included stimulus conditions. This version computed the electric current density in the cortical areas of the digitized brain atlas of the Montreal Neurological Institute (MNI) at ˜7 mm resolution (2394 voxels). In those microstates where the TANOVA indicated significant differences of ERP topography between conditions, voxel-by-voxel t-statistics were used to identify those voxels that could putatively account for the differences observed on the scalp. For illustration purposes, the highest threshold of the t-statistics was set at an alpha level of 5%.

Results

Behavioral Data

Four participants saw at least one word in the masked letter strings and were therefore excluded from all subsequent analyses. All other participants reported that they did not notice anything unusual in the patterns and that they had seen no letters or words in them. When asked about the mirror masked strings, some of these participants guessed that they were strings of an unknown writing, as for instance hieroglyphics. All analyses were performed on the data of these remaining 15 participants who were ignorant of the information hidden in the mask. Response accuracy was reasonably high, with 95% correct responses for words (SD = 3%) and 92% correct responses for nonwords (SD = 5%). Average reaction times were faster for words, M = 579 ms (SD = 55 ms), than for nonwords, M = 639 ms (SD = 75 ms), $t(14) = 7.09$, $p < .001$. No effect of priming was found when comparing masked-string/visible string pairs that where congruent vs. incongruent in lexicality (e.g., word-word and nonword/nonword vs. nonword-word pairs; effect of type of masked string, $F(1,14) = 0.62$, $p > .20$ and interaction of type of masked string with type of visible string, $F(1,14) = 1.95$, $p = .18$).

Masked Words and Nonwords

Segmentation of grand mean ERPs yielded 3 microstates. Microstate topographies, microstate latencies and GFP time course for masked stimuli are shown in upper part of Fig. 2. The stability of microstates was further quantified with spatiotemporal correlation matrices of ERPs averaged across subjects and conditions (Fig. 3, left).

The first microstate was a P100 topography with a bilateral occipital positivity (88-136 ms). This was followed by a N200 that displayed an occipital bilateral negativity and a fronto-

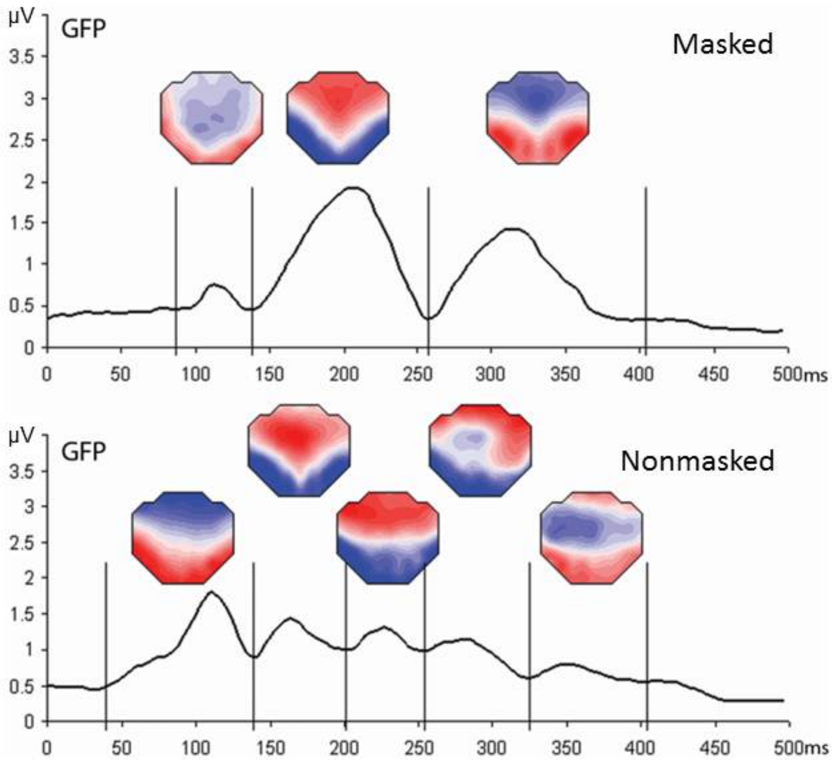

Figure 2: Topographies and latencies of the microstates identified in the grand mean ERPs for masked (upper graph) and nonmasked stimuli (lower graph). Each graph shows the mean microstate topographies, head seen from above; red indicates positive, blue negative values, referred to average reference. The topographies were scaled to maximal Global Field Power (GFP) = 1. The curve in each graph shows the GFP (vertical) of the ERPs as function of time (horizontal). Microstate borders were set at the local minima of the GFP curve (indicated by the vertical lines).

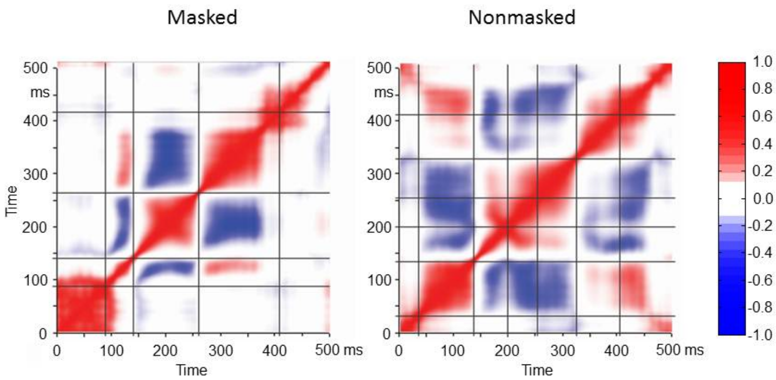

Figure 3: Illustration of stability of topographic maps over time. Both axes indicate time with respect to stimulus onset. Spatial correlations of ERP signals across time are shown for masked (left) and nonmasked (right) stimuli. Red areas correspond to positive correlations, and blue areas indicate negative correlations. Color saturation indicates strength of correlation. During dark red time segments (indicating inter-correlations higher than .9), topographies were stable.

central positivity (136-256 ms). A third microstate was characterized by a bilateral parietal positivity and a fronto-central negativity (256-404 ms).

Comparison of GFP differences between word and nonword stimulus microstates indicated no significant GFP differences between words and nonwords. The randomization test of topographic dissimilarity however indicated significant differences of microstate topographies in the 136-256 ms microstate (p = .034, cf. Fig. 4).

Results of the voxelwise comparisons of LORETA solutions in microstates with word-nonword topographic differences are shown in Fig. 5 and Table 1 (see also the supplementary material). According to the LORETA model, differences between masked words and nonwords between 136 and 256 ms were related to higher current density for nonwords than for words in left operculum, right superior parietal lobe and right superior temporal lobe (first row in Figure 5).

Nonmasked words and nonwords

Grand mean ERPs and segmentation is shown in Figures 2 and 3. Five microstates were identified: A first microstate was a P100 with a bilateral occipital positivity (32-140 ms), which was followed by a N200 that displayed a strong occipital bilateral negativity and a fronto-central positivity (144-200 ms). Then, two microstates followed that lasted from 200 to 252 ms and from 256 to 320 ms, during which the posterior negativity expanded over central and left parietal sites. A fifth microstate from 324 to 404 ms was characterized by large negativity extending over midline and frontal electrodes.

Comparison of GFP differences between word and nonword stimulus microstates indicated no significant GFP differences between words and nonwords. The randomization test of topographic dissimilarity indicated significant differences of microstate topographies in the 32-140 ms microstate (p = .027), the 200-252 ms microstate (p = .008) and the 324-404 ms microstate (p = .005). T-maps of the microstates with significant topographic differences are shown in Fig. 4.

According to the LORETA model, differences between words and nonwords in the 32-140 ms segment were localized in right lateral fusiform gyrus, left mediotemporal gyrus and right superior frontal gyrus. During the 200-252 ms segment, differences were found in right temporal lobe, left temporal lobe, left posterior cingulate, right frontal operculum and left superior occipital lobe. Between 324 and 404 ms, differences were found in right orbitofrontal area, right superior frontal lobe, left middle temporal gyrus and right middle fusiform gyrus (Table I).

Discussion

This study investigated ERP time course of mirror masked words and nonwords that were not recognised by participants. Sequences of stable microstates were analysed, which are thought to reflect successive stages of word processing that correlate with successive activation of functional brain areas (Koenig, Kochi, & Lehmann, 1998; Koenig & Lehmann, 1996; Michel et al., 2001; Pegna, Khateb, Michel, & Landis, 2004).

Based on findings of earlier studies, differences between words and nonwords should appear in the 100-200 ms segment with vis-

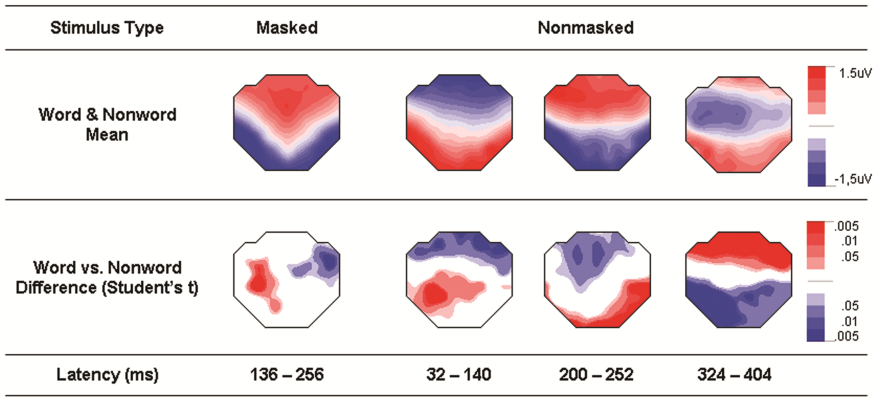

Figure 4: Upper row: Mean microstate maps, scaling as in Fig. 3. Lower row: Statistical parametric scalp maps for those microstates that showed significant topographic differences in the randomization tests. Blue areas indicate larger values in the nonword condition; red areas indicate larger values in the word condition. Increasing steps of color intensity indicate p values below .10, .05 and .01, respectively.

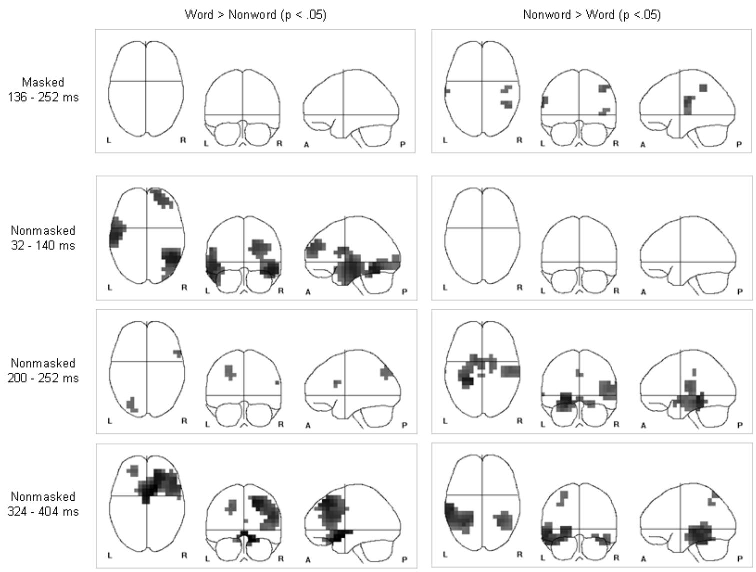

Figure 5: Glass brain images of voxels showing differences between words and nonwords ($p < .05$), darker voxels indicate higher t values.

Table 1: Results of the voxelwise comparisons of LORETA solutions

Segment (ms)	Left/right	Area at maximal t-Value	Brodmann Area	MNI Coordinates			t-Value
				X	Y	Z	
Higher source activation for words than for nonwords Nonmasked Stimuli							
32-140	R	Lateral fusiform	37	53	-53	-13	3.58
	L	Middle temporal	21	-52	-11	-13	3.42
	R	Superior frontal	10	25	59	29	3.00
200-252 ms	R	Frontal operculum	45,44	60	17	22	2.50
	L	Superior occipital	7	-24	-81	43	2.37
324-404	R	Orbitofrontal	25	11	10	-20	4.06
	R	Superior frontal	8	18	31	50	3.71
Higher source activation for nonwords than for words Masked Stimuli							
136-256	L	Operculum	43	-66	-11	22	-2.98
	R	Superior parietal	40	46	-46	43	-2.62
	R	Superior temporal	22/41	46	-18	1	-2.32
Nonmasked Stimuli							
200-252	L	Inferior temporal		-31	-32	-6	-3.57
	R	Superior temporal	22/41	53	-18	8	-2.70
	L	Posterior cingulate	31	-3	-25	36	-2.16
324-404	L	Middle temporal	21	-59	-32	-13	-3.42
	R	Middle fusiform	37	32	-46	-20	-2.92
	L	Superior parietal lobe	7	-24	-67	57	-2.35

ible words. Indeed, ERP differences of visible words vs. nonwords were found in a P100 microstate located on the left parieto-occipital lobe which is known to reflect font, letter and n-gram differences (Compton et al., 1991; Nobre et al., 1994; Sereno et al., 1998), and is associated with foci wandering from the occipital lobe to posterolateral fusiform gyrus (Binder & Price, 2000; Fujimaki et al., 1999; Gernsbacher & Kaschak, 2003; Petersen, Fox, Snyder, & Raichle, 1990; Pugh et al., 1996; Tarkiainen, Helenius, Hansen, Cornelissen, & Salmelin, 1999) and sometimes also combined with frontal areas (Hauk, Davis, Ford, Pulvermuller, & Marslen-Wilson, 2006). Just after the 200 ms point which appears to be a marker of lexical access, significant word-nonword ERP differences were found in a segment ranging from 200 to 252 ms. The difference map resembled regressor maps associated with word frequency reported by Hauk et al. (2006). Word frequency is closely related to word familiarity, which might have been used to discriminate words from nonwords in our study. The late differences in the 324 to 404 ms segment were reasonably in agreement with findings related to postlexical and semantic processing of words that are associated with posterior negativity for words vs. nonwords, which is seen with frontal lobe, middle temporal gyrus and medial fusiform activation.

The topographic ERP-differences with masked strings were different. Significant differences between stable ERP topographies when participants observed masked words compared to when they observed masked nonwords were found in a time segment from 136 to 256 ms after stimulus onset. Assuming the study participants validly were not aware of the words in the masked patterns, these ERP differences suggest that some word-related properties of masked stimuli were unconsciously processed. This segment of 132 to 256 ms after stimulus onset was used for further analysis to identify the processes differentiating between masked words and nonwords. First, ERPs averaged over the whole time segment of interest were analysed. Difference maps formed a characteristic pattern of focused temporo-parietal positivity on the left hemisphere (Fig. 4). This pattern bore resemblance with left-lateralised positivity around the temporo-occipital junction related to orthography which is discussed to be associated with N170 (Bentin, Mouchetant-Rostaing, Giard, Echallier, & Pernier, 1999; Salmelin, Service, Kiesila, Uutela, & Salonen, 1996, although this was reversed for nonwords vs. words in our case), and parietal positivity related to word frequency and lexicality (P3, Proverbio, Vecchi, & Zani, 2004). Hence, there were some similarities of masked stimulus word-nonword differences and ERPs of visible stimuli as reported in the literature.

In a second step, LORETA distributed source solution for this left lateralized positivity for masked words vs. nonwords was computed (cf. Fig. 5). Results suggested that the difference in topographies was due to stronger current density for nonwords than for words in two right hemisphere areas (superior temporal lobe, superior parietal lobe) and in one left hemisphere area (posterior operculum near the Sylvian fissure). Activation in middle and superior temporal lobe has frequently been found with word vs. nonword comparisons, although the activity tends to be left lateralised or bilateral (Cohen et al., 2000; Nobre et al., 1994; Salmelin et al., 1996; Schendan et al., 1998). Why the modelled temporal sources are localized in the right hemisphere is difficult to explain on the basis of the present results. It is not unusual to assume that language processing is bilateral but that activity is often stronger in the left hemisphere (cf. Damasio, Tranel, Grabowski, Adolphs, & Damasio, 2004; Scott & Wise, 2004). As one possible explanation, we suggest that unconscious processing of words might recruit language areas in a different fashion than visible words, leading to measurable activation in the right hemisphere (e.g., Grossi & Coch, 2005; Holcomb & Grainger, 2006). Another possible explanation might be that the activity results from an inhibition of word processing due to the masking. Such inhibition has been observed previously in masking studies (Eckstein, Kubat, & Perrig, 2011; Wentura & Frings, 2005). The other two areas, i.e. parietal lobe and posterior operculum, have also occasionally been reported to differentiate between words and nonwords or pseudowords (Compton et al., 1991; Hauk et al., 2006; Salmelin et al., 1996). It is however unusual to find higher activation for nonwords than words, especially in language areas in the left hemisphere. Given that the primes were not readable for the participants, it is possible that this difference in activity just represents a difference in resource allocation or in timing. That is, higher allocation of resources was needed to convert substrings of nonword primes to phonemes than for word primes and such a decoding probably took longer for nonwords than for words, which would explain the late timing. The sources of activation found with the LORETA model could thus tentatively reflect word recognition processes that are known to occur in the 136 to 256 ms time range or earlier components that were delayed, but we infer this with caution, as the temporal and parietal activation appeared to be in the right but not in the left hemisphere.

Although LORETA source models are not suited to make direct inferences as to which processes are responsible for word-nonword ERP differences, it is possible to compare LORETA solutions for different conditions in order to identify similarities and differences in modelled brain activations. Therefore, the masked stimuli LORETA solution for ERPs averaged over the 136 to 256 ms time segment was compared with the nonmasked stimuli LORETA solution for ERPs averaged over the 200 to 252 ms time segment (cf. Fig. 4). There was a small area of overlap in right superior temporal lobe which discriminated between words and nonwords for masked as well as for nonmasked stimuli (maximal t values at MNI coordinates 46/-18/1 and 53/-18/8 for masked and nonmasked stimuli, respectively). We tentatively suggest that this overlap represents a common process that was active in this time range, whereas the non-overlap of other areas indicate that most processes differentiating between words and nonwords were not shared when observing masked compared to nonmasked stimuli in this specific task.

In summary, differences were found between ERPs of masked words and ERPs of masked nonwords, and the source of these differences was located in an area that was also found as source with visible words and nonwords. Compared to visible stimuli however, differences were small. Given that mirror masked patterns look like nonsense patterns or unknown hieroglyphs, ERPs measured while participants see mirror masked words primarily reflect processes that lead to the conscious experience of seeing nonsense patterns. It is therefore not surprising that most of the ERP differences found between words and nonwords are different for masked compared to nonmasked stimuli. The task used did not require lexical processing of the mirror masked stimuli. Nevertheless, some of the processes involved in perception of masked stimuli appeared to differentiate between words and nonwords, indicating that some aspects of words are automatically processed even if there is no direct requirement for processing.

This study has shown that it is possible to monitor the time course of nonconscious processing of words vs. nonwords. Because words were presented only once during the experiment, we can exclude stimulus learning effects as a source of nonconscious perception. Hence, our results evidence that masked words were spontaneously 'read' up to a certain level, although they were consciously perceived as meaningless patterns. Further research will be needed in order to identify the stages of word processing involved in nonconscious processing of mirror masked words. We have done a few ERP and behavioural experiments that indicate that phonological processing is involved in the effect of mirror masked priming. It might be also appropriate to conduct some comparative studies to determine if the same processes occur with mirror masking (which is based on attentional distraction) compared to temporal pattern masking (which is based on perceptual thresholding). At the moment however, mirror masking appears to be a potential alternative to temporal masking, especially when there is need for longer presentation durations.

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Abstract

M. Wagner & W.-J. Kuo (Hamburg, Germany & Taipei, Taiwan) – Population-Adapted Averaged Head Templates for EEG and MEG Source Analysis
In electroencephalography or magnetoencephalography source localization studies where individual subject's magnetic resonance images (MRIs) are not available, averaged MRIs can be used instead. For populations of subjects with head shapes that are both homogeneous and sufficiently distinct from the head shape of an existing averaged MRI, the use of a population-adapted, averaged MRI is desirable. Examples for such populations are non-Caucasian or pediatric subjects. A population-adapted, averaged MRI can be created based on individual MRIs of subjects representing the population of interest. The extents of the bounding box containing the brain, together with the locations of the anterior and posterior commissure landmarks are measures facilitating this process. Based on their average values for the individual MRIs, it is possible to average these individual MRIs. Alternatively and also based on these measures, an existing averaged MRI can be adapted to better match the population's head shape. Based on individual MRIs of 62 Chinese subjects, the procedure is demonstrated, including the creation of standard electrode locations and realistically shaped boundary element method head models.

Keywords: Magnetic resonance imaging; Electroencephalography; Magnetoencephalography; Source localization; Averaged MRI; Talairach Co-registration

Population-Adapted Averaged Head Templates for EEG and MEG Source Analysis

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Introduction

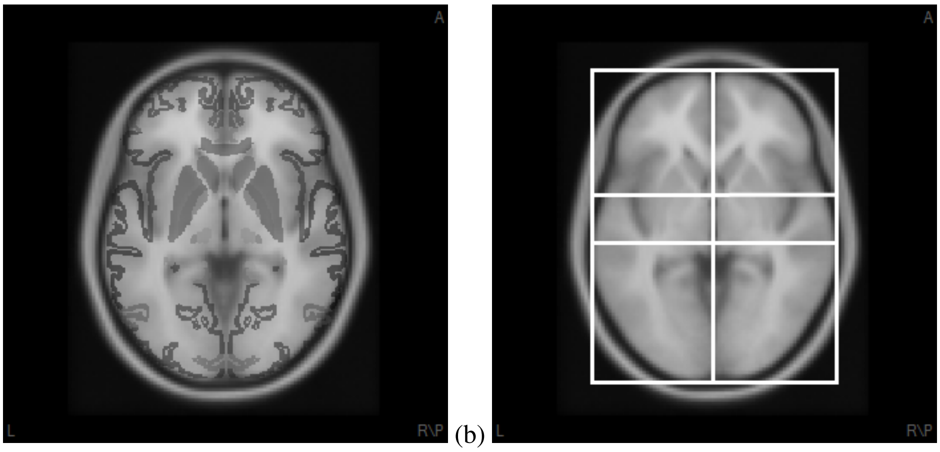
In electroencephalography (EEG) and magnetoencephalography (MEG) source analysis, medical image data such as magnetic resonance images (MRIs) can be utilized in a variety of ways. Localization accuracy is increased by means of individual, realistically shaped head models (Fuchs, Drenckhahn, Wischmann, & Wagner, 1998; Mosher, Leahy, & Lewis, 1999). Source analysis results can be displayed in their anatomical context by overlaying them onto structural brain mages such as MRI (Fuchs, Wagner, Wischmann, Ottenberg, & Dössel, 1994). Furthermore, anatomical features such as the gray matter may be used to constrain source analysis (Dale & Sereno, 1993; Wagner, Fuchs, Wischmann, Ottenberg, & Dössel, 1995).

Often, however, individual MRI data are not available or shall deliberately not be used. The latter can for example be the case in group studies, where performing source analyses in individual anatomical space and later pooling the results is more laborious than performing source analyses in a common, representative anatomical space. In such cases, it is good practice to use averaged MRI datasets instead (Fuchs, Kastner, Wagner, Hawes, & Ebersole, 2002; Pascual-Marqui, Esslen, Kochi, & Lehmann, 2002): An averaged MRI dataset (also commonly called an MRI template) shows anatomical features that are common to a population of subjects, without suggesting a level of detail (cortical folds) that could only be obtained by using the subject's own MRI. An averaged MRI still makes it possible to derive and use realistically shaped head models, view source results in their anatomical context, and constrain source analysis (albeit not to the level of cortical folds).

Today, a commonly used averaged MRI is the ICBM-152 dataset (Mazziotta et al., 2001), also called the Montreal Neurological Institute (MNI) brain. It represents an average Caucasian head shape. A consequence of the widespread use of the ICBM-152 is the availability of additional, co-registered three-dimensional (3-D) maps detailing e.g. tissue type probabilities (Mazziotta, Toga, Evans, Fox, & Lancaster, 1995) or cytoarchitectonic atlas information (Lancaster et al., 2000; Figure 1a). This availability makes it straightforward to guide source analysis based on tissue types, e.g. to constrain sources to the cortical gray matter, or to relate source analysis results to atlas information.

Another important reference frame is the Talairach atlas (Talairach & Tournoux, 1988), which is based on axial cross-sections of a single subject's brain. It includes detailed anatomical labels. The proportional grid-based coordinate system introduced in this publication has become the de-facto standard for reporting locations in the brain. The Talairach coordinate system is based on two landmarks, the anterior commissure (AC), which serves as the origin, and the posterior commissure (PC), together with the extents of the bounding box containing the brain. The mid-sagittal and the axial plane through AC and PC, together with the coronal planes through AC and PC, respectively, subdivide this bounding box into twelve cuboid-shaped compartments. Using a linear transformation per compartment, any brain, including the ICBM-152, can be co-registered with the Talairach reference frame (Desco et al., 2001, Lancaster et al., 2007). Figure 1b shows the Talairach bounding box overlaid onto an axial slice of the ICBM-152, while Figure 2 shows a 3-D rendering of the bounding box.

In order to bring EEG electrode or MEG sensor locations into the anatomical reference frame of an averaged MRI, a landmark-based transformation can be applied (Fuchs, M., Wischmann, Wagner, & Krüger, 1995). Alternatively, and only available in the EEG case, electrode locations based on the 10-20 system (Jasper, 1958) or one of its extensions (Chatrian, 1985; Oostenveld & Praamstra, 2001) can be determined by measuring distances on the averaged MRI's segmented skin and relating their locations to the actually mea-



(a) (b)

Figure 1: (a) an axial slice of the ICBM-152 averaged T1-weighted MRI dataset with overlaid Talairach atlas information where shades of gray encode anatomical features. (b) ICBM-152 slice with overlaid Talairach coordinate system bounding box through the locations of AC and PC.

sured data by means of label-matching (Wagner, Fuchs, & Kohlhoff, 1996).

In EEG analysis using an averaged MRI dataset, it is desirable to use electrode locations as close to the surface of the skin as possible. Else, electrode locations, head model, and the averaged MRI's anatomy would not match well: In the case of a (realistically shaped) head model based on the averaged MRI, electrodes need to be located on the head model's skin surface, while in the case of a (typically spherical) head model fitted to the electrodes, source results overlaid onto the MRI would be wrong.

The underlying problem is that of a possible shape mismatch between the averaged MRI dataset and the individual subject's head. It also exists in the MEG case. It is only trivial if a global spatial scaling factor suffices. A global scaling factor can easily be factored into all known head model calculations (Fuchs, Kastner, Wagner, Hawes, & Ebersole, 2002), but can only account for different overall head sizes. More general shape dissimilarities between individual and averaged MRI's head shape still lead to errors in head modeling, result overlay, and anatomical constraints.

There are situations where systematic differences between individual subject's heads and a standard averaged MRI such as the ICBM-152 occur. This is for example the case in studies involving elderly or pediatric subjects or subjects with psychiatric diseases, but also if non-Caucasian subjects are analyzed. In such cases, the use of an averaged MRI that is better suited for the subject's heads is advised.

In this paper, we describe a procedure for creating averaged MRIs for populations that exhibit such systematic differences, based on individual MRIs of subjects representative of the population. Such a population-specific averaged MRI will also be called MRI-A or MRI-XX-A with XX the number of individual MRIs that were used for averaging. The pro-

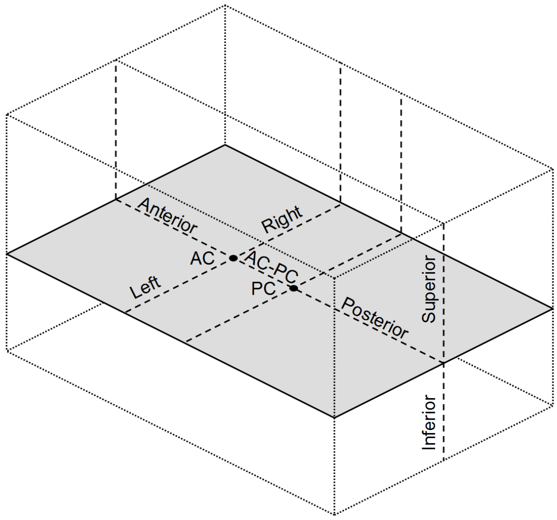


Figure 2: 3-D rendering of the Talairach bounding box with the AC and PC landmarks. The mid-sagittal plane through AC and PC, the axial plane through AC and PC, and the two coronal planes through AC and PC, respectively, define twelve compartments used for the piece-wise linear transformation between individual subject and Talairach coordinates.

posed procedure was designed to accomplish the following aims:

1) The averaged MRI should clearly show prominent features such as the brain, the skull, and the skin layers, equalizing within-group head shape variations. Therefore, individual MRIs need to be spatially normalized before averaging, so that matching features co-localize.

2) Furthermore, each individual MRI should have the same impact on the resulting average, independent of its overall intensity. This implies that MRI intensities have to be normalized before averaging.

3) The co-registration of averaged MRIs to the Talairach atlas as well as to averaged MRIs of different subject populations and to individual MRIs should be straightforward. This makes the Talairach landmarks and bounding boxes a natural choice as the basis of co-registration.

4) Group-intrinsic head shapes and brain dimensions should be preserved in the resulting average, making it necessary to spatially normalize individual MRIs to the average population's brain dimensions before averaging.

5) As an alternative to or extension of creating an averaged MRI from the individual MRIs used, it should be possible to spatially normalize an existing averaged MRI such as the ICBM-152 to match the population of interest. The result is a version of the ICBM-152 that exhibits a head shape and size matching the population of interest. This population-specific ICBM-152-based dataset will also be called an adapted ICBM-152 dataset or ICBM-152-A. For some populations (e.g. in pediatric studies), other existing templates besides the

ICBM-152 dataset might be preferable candidates for adaptation.

6) In preparation of an EEG or MEG study, the resulting averaged MRI dataset should be used to create a population-specific realistically shaped head model, and used as a basis for calculating the 10-20 electrode system positions on the shape of its segmented skin.

7) Finally, creating the averaged MRI should require little user interaction so that it can easily be applied for a given population.

Existing approaches for creating averaged MRI datasets are summarized in (Toga & Thompson, 2001). Most approaches achieve this by means of a template and use high-parametric, non-linear transformations (Klein et al., 2009), which allow a mapping of sub-cortical structures between individual and averaged MRI, but introduces the problem of choosing the right template to match the population-of-interest. The specific goals of this study in the context of EEG and MEG analysis gives the mapping of sub-cortical structures a lower priority, with the benefit that a template-free ansatz can be pursued, where image data are normalized onto the average of their Talairach bounding boxes.

In order to demonstrate the procedure, 62 individual MRIs of ethnic Chinese subjects have been processed and an averaged Chinese MRI-62-A dataset as well as an adapted ICBM-152-A dataset have been created

Previous studies (Tang et al., 2010; Chee et al., 2009; Kochunov et al., 2003) have already established that significant differences between Chinese and Caucasian head shapes exist. One previous study also created an averaged Chinese MRI dataset (Tang et al., 2010) but used a different co-registration technique, which involved matching all MRIs onto one MRI randomly selected from the population of interest as an intermediate step. Furthermore, this study did not demonstrate atlas co-registration nor the derivation of head models and electrode layouts.

Methods

MRI Acquisition

The subject sample consisted of 62 subjects (37 females and 25 males), with an average age of 22.4 years and a standard deviation (SD) of 2.1 years. At this age, all subjects had already attained their adult head shapes (Friede, 1981). All subjects were right-handed ethnic Chinese with no history of neurological disorders. Handedness was verified using the Edinburgh Inventory (Oldfield, 1971). All subjects negated when asked for psychiatric diseases. Written consent of the participants was obtained before MRI scanning, with the protocol approved by the Institutional Ethics and Radiation Safety Committees of National Yang-Ming University, Taipei, Taiwan.

Whole-head T1-weighted MRI datasets of all subjects were acquired at the Laboratory of Cognitive Neural Science, Yang-Ming University, Taipei, Taiwan. A magnetization-prepared rapid gradient-echo (MP-RAGE) sequence run on a 3T TrioTim scanner (Siemens, Erlangen, Germany) was used for the acquisition. The pixel dimensions and slice thickness were 1 mm each. The matrix size was 224x256, resulting in a field-of-view (FOV) of 224x256 mm. The number of slices was 192.

Landmark and Bounding Box Determination

MRI data were loaded into the Curry 7 software (Compumedics, Charlotte, NC, USA). In Curry, the locations of AC and PC were determined manually. An additional mid-sagittal landmark (MS) in a more superior slice allowed, together with AC and PC, to define the mid-sagittal plane. Based on this information, the 3-D bounding box containing the brain was gauged, comprising the following distance measures: AC-Anterior, PC-Posterior, AC-Superior, AC-Inferior, AC-Left, and AC-Right, in addition to the AC-PC distance already obtained. The averages of these measures were computed and compared to their equivalents in the ICBM-152 template and the Talairach atlas. A two-tailed z-test was used to assess whether the observed differences are significant.

Averaged MRI Dataset and Adapted ICBM-152

Each MRI was then re-sliced according to the coordinate axes spanned by AC, PC, and the mid-sagittal plane, and its twelve sub-volumes defined by AC, PC, and the bounding box dimensions were individually, linearly and contiguously transformed. For details on this process, please refer to the Appendix. The average measures obtained in the previous step were used as the dimensions of the target bounding box. The outcome was 62 volumetric images with identical locations of AC and PC landmarks, identical mid-sagittal planes, and identical bounding boxes enclosing the brains. In these images, all brains occupied the same coordinate space. Then, MRI intensities were linearly scaled so that the 99th intensity percentile was the same across datasets. The 99th percentile was chosen as a noise-insensitive measure of the maximum. Finally, an averaged 3-D image was computed which will be called the MRI-62-A in the remainder of the paper.

In the same way as described above for the individual MRIs, the ICBM-152 was transformed such that its AC-PC distance as well as its Talairach bounding box extents matched the average values of the subject population, yielding an ICBM-152-A dataset. Figure 3 shows this procedure in a flowchart.

Electrode Locations and Head Models

For the original and the adapted ICBM-152 as well as for the MRI-62-A, the locations of the nasion, left and right pre-auricular point, and inion landmarks were determined. Based on these landmarks and the skin surface segmented from MRI, electrode locations for the extended 10-20 system were computed by the Curry software (Wagner, Fuchs, & Kohlhoff, 1996). Computations included measuring and subdividing distances on the outer surface of the segmented skin, replicating the procedure for manual electrode placement (Jasper, 1958; Chatrian, 1985). As a result, for these three datasets, 86 electrode locations were obtained, identified by their labels. These 86 electrode locations included ten sub-temporal locations, which could not be reliably estimated for the ICBM-152 and ICBM-152-A because of their limited inferior extensions. For the remaining 76 electrodes, the average and standard deviation of the distances between electrodes of the same label were determined across all three datasets.

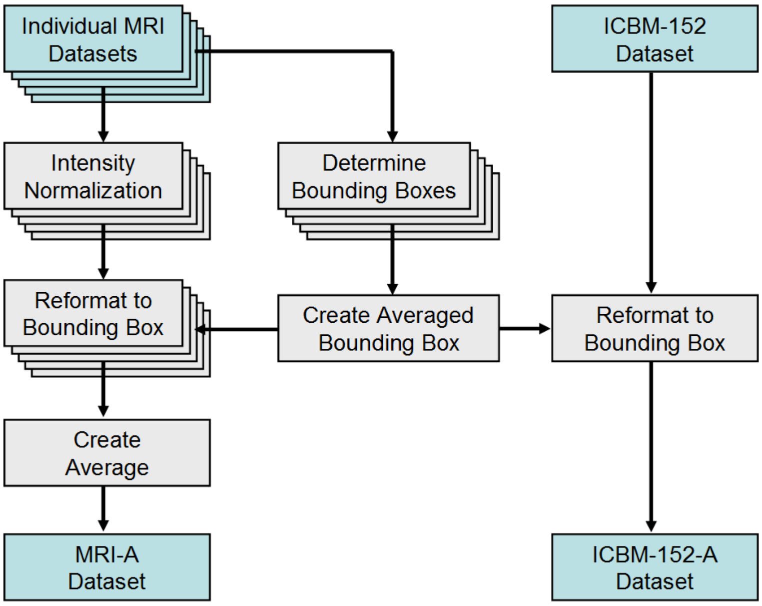


Figure 3: Flowchart for creating the MRI-A and ICBM-152-A datasets.

In a next step, realistically shaped three-compartment boundary element method (BEM) head models were created using the automatic BEM geometry setup algorithm implemented in the Curry software (Wagner, Fuchs, Drenckhahn, Wischmann, Köhler, & Theißen, 1997). Triangle side lengths for the inner skull, outer skull, and the skin boundary were 5 mm, 7 mm, and 8 mm, respectively. As a byproduct of this algorithm, triangle meshes representing the skin and the cortex are obtained.

Results

Chinese vs. Caucasian Brain Dimensions

Table 1 lists averages, standard deviations, and medians of the AC-PC distances, bounding box extents, and bounding box volumes obtained for the 62 individual MRIs and compares them with their counterparts for the Talairach atlas and the ICBM-152. Comparing the 62 Chinese subjects with the Talairach atlas, all bounding box extents as well as the width-to-length and height-to-length ratios turn out to be significantly different; the bounding box volume and the height-to-width ratio, however, are not. A comparison with the ICBM-152 dimensions shows significant differences for all but the mediolateral dimensions and the height-to-length ratio.

For a trained user, it took about two minutes per dataset to define the landmarks and

Table 1: Chinese vs. Caucasian Brain Dimensions. Averages, standard deviations (SD), and medians of the AC-PC distances, bounding box extents, bounding box volumes, and bounding box extent ratios obtained for the 62 individual MRIs together with their counterparts for the Talairach atlas and the ICBM-152 dataset. Length is the sum of the anterior, posterior, and AC-PC distances. Width is the sum of the left and right extents. Height is the sum of the superior and inferior extents. W/L is the width-to-height-ratio. H/L is the height-to-length-ratio. H/W is the height-to-width-ratio. Probability values p for the Null hypothesis obtained by means of a two-tailed z-test are shown for the Talairach and the ICBM-152 measures. Small values denote significant differences between the respective dataset and the group of 62 individual MRIs.

	Anterior [mm]	Post. [mm]	AC-PC [mm]	Sup. [mm]	Inf. [mm]	Left [mm]	Right [mm]	Length [mm]	Height [mm]	Width [mm]	Volume [l]	W/L ratio	H/L ratio	H/W ratio
Average	67.7	70.2	24.4	75.0	45.0	70.4	70.5	162.3	120.0	140.9	2.75	0.870	0.741	0.853
SD	2.5	4.3	1.0	2.7	2.2	2.6	2.6	6.7	4.2	4.9	0.23	0.044	0.029	0.033
Median	67.6	70.5	24.5	74.2	45.2	70.5	70.5	162.5	119.3	141.0	2.73	0.865	0.738	0.854
Talairach	70.0	79.0	23.0	74.0	42.0	68.0	68.0	172.0	116.0	136.0	2.71	0.791	0.674	0.853
p≤	10^{-5}	10^{-5}	10^{-5}	0.005	10^{-5}	10^{-5}	10^{-5}	10^{-5}	10^{-5}	10^{-5}	0.233	10^{-5}	10^{-5}	0.926
ICBM	71.0	78.0	28.0	83.0	47.0	70.0	70.0	177.0	130.0	140.0	3.22	0.791	0.734	0.929
p≤	10^{-5}	10^{-5}	10^{-5}	10^{-5}	10^{-5}	0.215	0.132	10^{-5}	10^{-5}	0.141	10^{-5}	10^{-5}	0.101	10^{-5}

bounding box dimensions required.

Averaged MRI Dataset and Adapted ICBM-152 Dataset

Figure 4 shows the MRI-62-A dataset based on 62 Chinese subjects and the ICBM-152-A. Due to the normalization of each individual dataset to the Talairach bounding box, the MRI-A is least blurry at the locations of AC and PC. The overall head shape of the ICBM-152-A is the same as for the MRI-62-A. For the MRI-62-A, the skull areas around the brain are not everywhere as sharply delineated as for the ICBM-152-A.

Electrode Locations and Head Models

A rendering of the three sets of extended 10-20 system electrodes obtained for the MRI-62-A, ICBM-152, and ICBM-152-A datasets is shown in Figure 5.

Table 2 shows the average distances and their standard deviations together with the median distances between electrodes of the same label for the three pairs of datasets. Electrode location differences are largest between the MRI-62-A and the ICBM-152. They are smallest between the MRI-62-A and the ICBM-152-A, with a mean displacement of less than 5 mm.

The realistic BEM head model representing the MRI-62-A dataset consists of 12,132 triangles connecting 6,072 nodes. The ICBM-152-A BEM contains 12,264 triangles and 6,138 nodes. Its inferior extension is smaller than for the MRI-62-A model. Figure 6 shows both BEMs together with cortical triangle meshes. These cortical triangle meshes do not show individual gyri and sulci, due to the non-individual MRIs they were created from.

Discussion and Conclusion

The proposed procedure meets the aims presented in the introduction: As a demonstration of the proposed procedure, an averaged MRI dataset representing a normal, adult Chinese population called the MRI-62-A dataset has been created. The MRI-62-A dataset shows prominent features such as the brain, the skull, and the skin layers. Group-intrinsic head shapes and brain dimensions have been preserved. Its co-registration to the Talairach atlas as well as to other MRIs can be performed using the same Talairach-based approach as used for averaging. A population-specific ICBM-152-based dataset called the ICBM-152-A has been created. It exhibits a head shape and brain size matching the population of interest. On the basis of the MRI-62-A and the ICBM-152-A, realistic head models and standard electrode layout shave been created.

With about two minutes of user interaction per individual MRI (all other calculations were automated), the process of creating a population-adapted averaged MRI is straightforward.

The size differences between Chinese and Caucasian brains are significant, with Chinese brains being e.g. comparatively shorter than both the Talairach atlas brain and the ICBM-152. These findings agree with the ones reported in (Tang et al., 2010), although it should be mentioned, that due to the brain-stripping approach employed in that study, measures are not directly comparable.

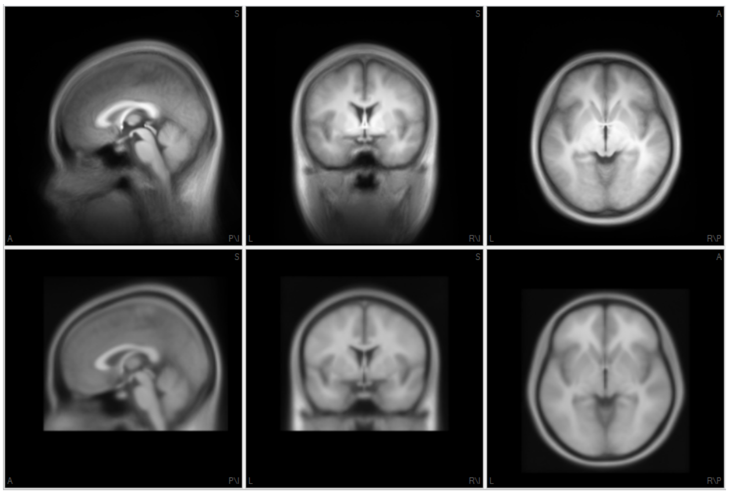


Figure 4: Upper row: MRI-62-A dataset based on 62 Chinese subjects. Lower row: ICBM-152-A dataset with the average Chinese subject's brain dimensions.

Table 2: Average distances and their standard deviations together with the median distances between electrodes of the same label for pairs of datasets. Electrode locations were obtained according to the extended 10-20 electrode system procedures.

	MRI-62-A vs. ICBM-152[mm]	MRI-62-A vs. ICBM-152-A[mm]	ICBM-152-A vs. ICBM-152 [mm]
Average	11.0	4.7	7.6
SD	3.7	1.8	3.0
Median	10.8	4.8	7.6

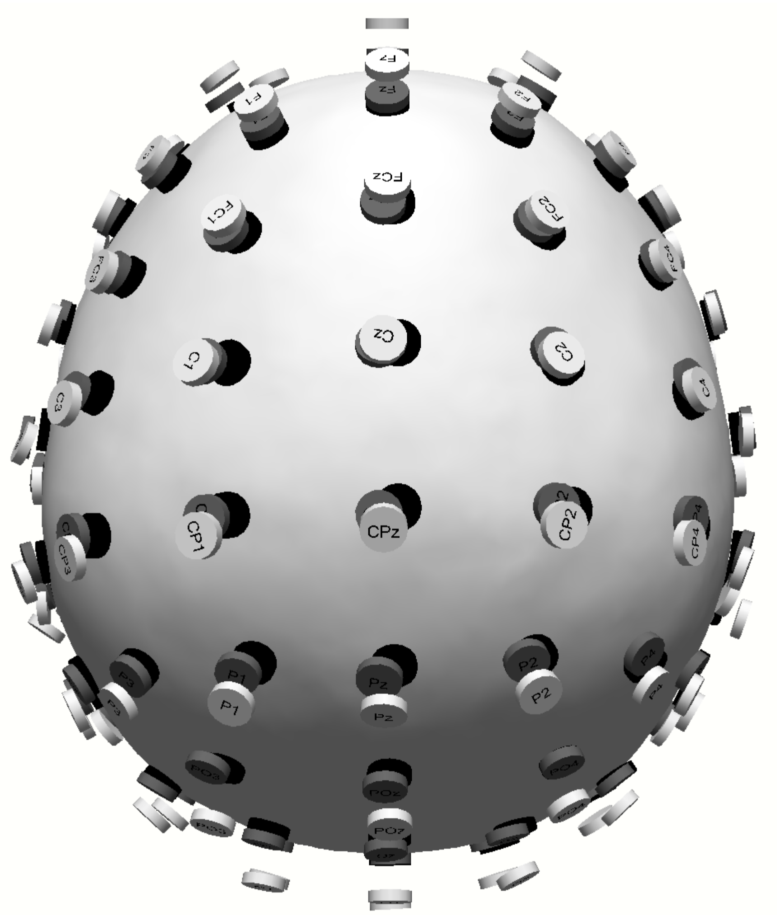
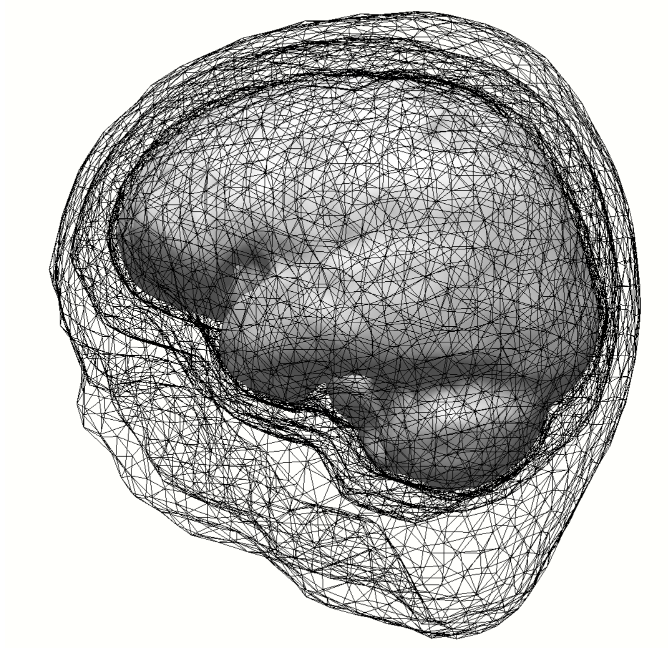
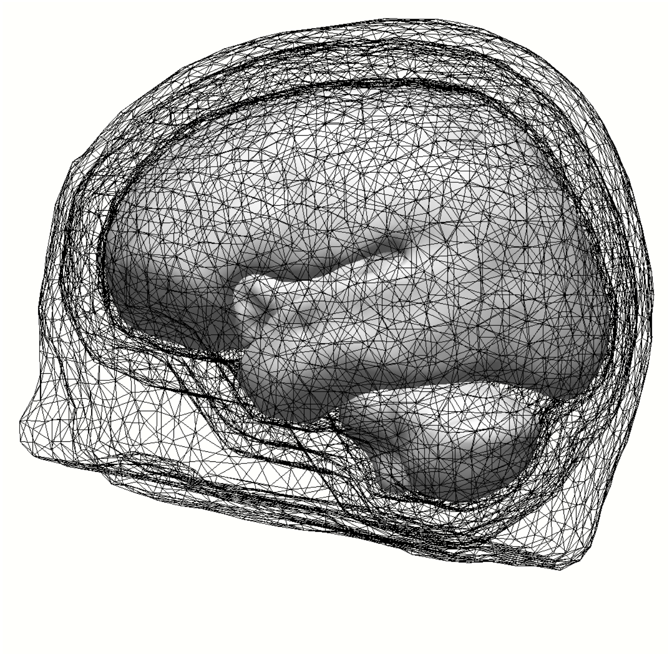


Figure 5: Extended 10-20 system electrodes for the ICBM-152 (light gray), the ICBM-152-A (dark gray), and the MRI-62-A (black), together with the skin surface of MRI-62-A.



(a)



(b)

Figure 6: Realistically shaped BEM head models enclosing the cortical surface for a) the MRI-62-A dataset and b) the ICBM-152-A dataset.

In a population-specific EEG or MEG study, finding significantly different brain dimensions between the population-of-interest and an existing, candidate MRI template should motivate the creation and use of an MRI-A or an ICBM-152-A dataset instead of just using the template.

An important practical question is, which of the two adapted MRIs, the MRI-A or the ICBM-152-A, is better suited for being used in a given study:

Both adapted datasets can be linked to additional atlas data because their Talairach parameters are known.

Due to the bounding box-based head shape normalization before averaging, the quality of the MRI-A dataset is not uniform: it is highest around the AC and PC landmarks and where the brain touches the planes of the bounding box, but and lower in other areas, such as the dorsolateral prefrontal cortex (Brodmann area 9). This is not the case for the ICBM-152-A, because a different, template-based approach was used for normalizing individual MRIs in the course of the ICBM-152 creation.

Due to the larger field-of-view of the individual MRIs used for averaging in this study, sub-temporal electrode locations according to the extended 10-20 system can be computed for the MRI-62-A but not for the ICBM-152-A. For the same reason, the MRI-62-A BEM has a wider inferior coverage, which commends the use of the MRI-62-A for studies involving sub-temporal electrodes. For the other 76 electrode locations, a mean difference of less than 5 mm between both adapted datasets is still lower than the electrode location errors brought about by using caps with labeled electrodes, so that in such a setup no clear recommendation can be spelled out.

Of course, the quality of individual MRIs for a given population may vary, so that using the ICBM-152-A may be a welcome alternative if a low number of individual MRIs are available or if these are of low quality.

Furthermore, it should not be forgotten that the ICBM-152 has by now become part of the community's viewing habits, so that presenting one's results in that context may make them easier to perceive. This is of course not true, if the subject population is pediatric. In this case, either an existing pediatric template (Sanchez, Richards, & Almli 2011) may be adapted using a process analogous to the one described above for the creation of the ICBM-152-A, or the MRI-A should be used.

Whichever dataset is chosen for a particular study, the possibility to use electrode locations and a head model that are fit for the population of interest, to overlay source results onto an anatomical image with matching head shape, and the possibility to use adapted atlas data to constrain source analysis and report results recommend using an adapted averaged MRI for studies involving non-Caucasian or pediatric populations.

While it has been shown that brain extensions and standard electrode locations vary significantly between the ICBM-152 and the population-specific MRIs, this is only a hint that differences in source localization are also to be expected. A follow-up study will examine the effect of the different MRIs and their derived head models and electrode locations onto source localizations.

Acknowledgments

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Appendix

Transformation from MRI Space to Template Space

The co-registration of a specific image "dataset" (identified by the letter d) into a common "template" space (identified by the letter t) is described below. In the scope of this paper, the interpretation of what the "dataset" and "template" exactly are differs, depending on which part of the process we are looking at: When averaging individual MRIs to create an MRI-A dataset, d denotes the individual MRIs while t refers to the average space based on measures obtained for all individual MRIs. When creating an ICBM-152-A dataset, d refers to the ICBM-152 dataset while, as above, t refers to the average space based on all individual MRIs. When transforming the MRI-A or the ICBM-152-A to Talairach atlas space (or vice versa), d refers to the former, while t represents the latter.

The locations of AC and PC in template space are t_{AC} and t_{PC}. t_{AC} is always in the origin, and t_{PC} is always on the negative y axis, so that

$$t_{AC} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} \text{ and } t_{PC} = \begin{bmatrix} 0 \\ -t_{AC-PC} \\ 0 \end{bmatrix}$$

where t_{AC-PC} is the AC-PC distance. The positive x axis points right, y points anterior, and z points up. The bounding box dimensions (see Figure 2) are given by the AC-Anterior distance t_{AC-A}, the PC-Posterior distance t_{PC-P}, the already mentioned AC-PC distance t_{AC-PC}, the AC-Superior distance t_S, the AC-Inferior distance t_I, the AC-Left distance t_L, and the AC-Right distance t_R.

If t denotes Talairach space, the bounding box dimensions (see Table I) are $t_{AC-A} = 70\text{mm}$, $t_{PC-P} = 79\text{mm}$, $t_{AC-PC} = 23\text{mm}$, $t_S = 74\text{mm}$, $t_I = 42\text{mm}$, $t_L = 68\text{mm}$, and $t_R = 68\text{mm}$.

Analogously, d_{AC-A}, d_{PC-P}, d_{AC-PC}, d_S, d_I, d_L, and dR describe the bounding box measures in dataset space. The locations of AC and PC in dataset space are d_{AC} and d_{PC}. Additionally, the location of a superior mid-sagittal location, d_{MS} serves to unambiguously identify the orientation of the z axis.

The transformation from dataset space into template space consists of three steps: translation, rotation, and scaling. In a first step, a translation maps d_{AC}, onto t_{AC} (the origin). Next, a rotation maps d_{PC} onto the negative y axis and d_{MS} onto the y-z plane. The scaling step ensures that the bounding box dimensions co-localize:

$$x \rightarrow \begin{cases} x\frac{t_L}{d_L} & \text{for } x \leq 0 \\ x\frac{t_R}{d_R} & \text{for } x > 0 \end{cases}$$

$$y \rightarrow \begin{cases} (y + d_{AC-PC}) \times \frac{t_{PC-P}}{d_{PC-P}} - t_{AC-PC} & \text{for } y \leq -d_{AC-PC} \\ y\frac{t_{AC-PC}}{d_{AC-PC}} & \text{for } -d_{AC-PC} < y \leq 0 \\ y\frac{t_{AC-A}}{d_{AC-A}} & \text{for } y > 0 \end{cases}$$

$$z \rightarrow \begin{cases} z\frac{t_I}{d_I} & \text{for } z \leq 0 \\ z\frac{t_S}{d_S} & \text{for } z > 0 \end{cases}$$

This scaling step ensures a contiguous mapping without any jumps at the compartment boundaries.

Abstract

M. Ruchsow (Göppingen) — Personale Identität aus Sicht der Neurowissenschaften und der analytischen Philosophie
The problem of personal identity is discussed very controversially in analytical philosophy and contemporary neuroscience. Descartes' approach was a dualism of substances (res cogitans and res extensa). This solution was rejected by Locke and other empiricists, because substances can never be the object of possible experience. Locke proposed (autobiographic) memory as warrant of (diachronic) personal identity. Alternatively, the criterion of bodily continuity was suggested, with body, brain or "relevant parts" of the brain facilitating diachronic identity. As Parfit showed, both naturalistic (neuroscientific) criteria (autobiographic memory and "enough of the brain") are contradictory. Taylor's concept of narrative identity might be a continuative approach.

Keywords: Personal Identity, Introspection, Narrative Self

Personale Identität aus Sicht der Neurowissenschaften und der analytischen Philosophie

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Einleitung

Mit Beginn der Neuzeit geht der Glaube an einen sinnvollen, identitätsstiftenden Kosmos zunehmend verloren. Der kanadische Philosoph Charles Taylor sieht diese Entwicklung durchaus ambivalent und spricht, Max Webers Diktum von der „Entzauberung der Welt" aufnehmend, von einem „Unbehagen an der Moderne". Aus Taylors Sicht wurde mehr individuelle Freiheit dadurch errungen, dass wir uns von einem älteren Moralhorizont gelöst haben. Damit einhergehend gerieten auch die alten Ordnungsgefüge in Misskredit und die Vorstellung, dass die „hierarchical order in the universe was reflected in the hierarchies of human society". Gleichzeitig verliehen die alten Ordnungen aber auch „meaning to the world and to the activities of social life" (Taylor, 1991, S. 3). Die neuzeitliche Entwicklung führt also zu einem Zuwachs an individueller Freiheit, andererseits aber auch zu einem Verlust an Orientierung bzw. sozialer Freiheit (d.h. Sittlichkeit im Sinne Hegels). Das Konzept der sozialen Freiheit bzw. Sittlichkeit greift den antiken Polisgedanken auf, demzufolge die Bürger „had such a deep subjective attachment to their polis that their social membership could be said to constitute a central part of their own identities" (Neuhouser, 2000, S. 34).

Das Problem der personalen Identität ist also eine neuzeitliche Fragestellung, die den geschilderten historischen Prozess zur Voraussetzung hat. Typische Vertreter dieser neuzeitlichen Konstellation sind Descartes und Locke, für die Personen „desengagierte“ neutrale Beobachter einer weitgehend mechanistisch zu erklärenden äußeren Wirklichkeit sind (vgl. Taylor, 1989, S. 143 ff.).

Nach einer kurzen Präzisierung, was in der vorliegenden Arbeit unter „Identität“ zu verstehen ist, wird zunächst Descartes’ Personbegriff als substantielle Einheit von res cogitans und res extensa vorgestellt. Die Ablehnung von Substanzen als möglichen Gegenständen von Erfahrung durch den Empiristen Locke führt u.a. zum Problem der diachronen Identität, das er durch das Erinnerungskriterium zu lösen versucht. Im weiteren Verlauf wird sich zeigen, dass sowohl das Kriterium der psychischen Kontinuität (Erinnerung) als auch das der physischen Kontinuität (des Körpers oder des Gehirns) widersprüchlich ist. Als ein möglicherweise weiterführender Lösungsansatz wird dann Taylors Konzept der narrativen Identität erläutert.

1. Identitätsbegriffe

Der Begriff der Person ist historisch wie systematisch mit den beiden eng zusammenhängenden Problemkreisen der

1. Identität von Personen und der
2. Autonomie von Personen verbunden (vgl. Krebs, Kambartel & Jantschek, 1995, S. 89 ff.).

Hinsichtlich 1.) ist zu unterscheiden zwischen numerischer und qualitativer Identität.

Von numerischer oder logischer Identität sprechen wir, wenn folgende Kriterien erfüllt sind:

a.) Symmetrie ($x = y \rightarrow y = x$),

b.) Transitivität ($x = y \wedge y = z \rightarrow x = z$) und

c.) Reflexivität ($x = x$) (vgl. Gillitzer, 2001, S. 24)

Zwei Dinge sind numerisch identisch (also der Zahl nach ein einziges Ding), wenn sie hinsichtlich aller ihrer Eigenschaften gleich sind.

Demgegenüber bezeichnen wir zwei verschiedene Gegenstände als qualitativ identisch, wenn sie sich lediglich ähnlich, also nur in einer bestimmten Eigenschaft (oder mehreren) gleich sind. Numerische Identität ist somit ein Grenzfall qualitativer Identität (Gleichheit hinsichtlich aller Eigenschaften vs. Gleichheit hinsichtlich einer/mehrerer Eigenschaften; Tugendhat & Wolf, 1983, S. 168 f.).

Hinsichtlich 2.) bleibt festzuhalten, dass der Begriff der qualitativen Identität auch in einer erweiterten Bedeutung gebraucht wird. Er bezieht sich dann auf den autonomen Lebensentwurf von Personen und die damit einhergehenden existentiellen Fragen: „Wer bin ich?“ und: „Wer will ich sein?“ Durch ihre Antworten orientieren sich Personen gleichzeitig in einem „moralischen Raum“ bzw. verorten sich auf einer „moralischen Landkarte“ (Taylor, 1989, S. 25 ff.).

In der vorliegenden Arbeit wird der Terminus „numerische Identität“ verwendet, wenn die Zahl der zugrundeliegenden Entitäten relevant ist, also die Frage, ob von einer oder mehreren Personen geredet wird. Der Begriff der „qualitativen Identität“ wird ausschließlich in der erweiterten Bedeutung verwendet, also wenn die qualitativen Aspekte von Personalität und insbesondere die moralische Dimension von Lebensentwürfen im Vordergrund stehen (vgl. Ruchsow & Hermle, 2007).

Es wird außerdem zwischen dem Problem der

I synchronen und dem der

II diachronen Identität unterschieden,

also der Identität einer Person zu einem bestimmten Zeitpunkt und der Identität im Zeitverlauf.

Im Rahmen seines Substanzendualismus war für Descartes die Lösung von I.) besonders vordringlich, während II.) aufgrund der Unveränderlichkeit von Substanzen bzw. der Unsterblichkeit der Seele(nsubstanz) unproblematisch war. Für Locke ergab sich nach Preisgabe des Substanzbegriffs genau die umgekehrte Problemkonstellation: II.) war deutlich schwieriger zu lösen als I.).

2. Descartes

2.1.Descartes' Personbegriff

Descartes gebraucht den Begriff der Person eher selten (Thiel, 2011, S. 36). Wenn Descartes von „persona" bzw. „personne" spricht, versteht er darunter „die Vereinigung von (Menschen-) Körper und (Menschen-)Geist". Kemmerling unterscheidet in diesem Zusammenhang drei Ichbegriffe:

1. Den Ausdruck „das Ich", also die substantivierte „ich"-Redeweise, verwendet Descartes, um sich auf die eigene Seele bzw. den eigenen Geist zu beziehen, während „ich" sich
2. sowohl auf den eigenen Körper, als auch
3. auf die Vereinigung von eigenem Körper und Geist bezieht, d.h. die Person (Kemmerling, 2005, S. 123).

Den drei Ichbegriffen sind dementsprechend drei Weisen der Erkenntnis zugeordnet:

1. Die (eigene) Seele („das Ich") kann nur durch den Intellekt erkannt werden. Der reine Intellekt wird nach Descartes durch metaphysische Gedanken trainiert, die uns mit dem Begriff des Geistes vertraut machen sollen.
2. Bei der Erkenntnis des (eigenen) Körpers (d.h. Ausdehnung, Gestalt und Bewegung) muss der Intellekt von der (bildlichen) Vorstellungskraft unterstützt werden. Die Vorstellungskraft wird vor allem durch mathematische Studien geschult; sie gewöhnen uns daran, deutliche und klare Begriffe von Körpern zu bilden.
3. Die Person, d.h. die Vereinigung von Körper und Geist, wird weder durch den reinen Intellekt, noch durch den von der Vorstellungskraft unterstützten Intellekt adäquat erfasst. Nur „das gewöhnliche Leben und das alltägliche Gespräch lehren uns, die Vereinigung von Körper und Geist zu begreifen, und zu diesem Zwecke solle man sich tunlichst jedweder metaphysischen und mathematischen Betätigung enthalten (Kemmerling, 2005, S. 124)."

An verschiedenen Stellen betont Descartes diese enge Verbindung von Körper und Geist, die seinen Personbegriff ausmacht. So schreibt er in der Sechsten Meditation, dass sich seine Seele nicht einfach in seinem

Körper befinde wie ein Schiffer in seinem Schiff, sondern aufs innigste mit ihm vereint sei und ihn gleichsam durchdringe (Descartes, 1641/2009, S. 88). Wiederholt weist er darauf hin, dass Körper und Geist eine „substantielle Einheit“ bzw. „essentielle Einheit“ bilden (Perler, 2006, S. 213). Geist und Körper sind „in gewissem Sinn“ unvollständige Substanzen. Zu vollständigen (funktionsfähigen) werden sie erst in der essentiellen Einheit. Descartes unterscheidet dementsprechend zwischen „ens per se“ und „ens per accidens“. Wenn zwei Substanzen zufällig miteinander verbunden sind („ens per accidens“) „und alle ihre Funktionen auch unabhängig voneinander ausüben können, bilden sie zusammen eine akzidentelle Einheit - ein bloßes Konglomerat, das nicht mehr ist als die Summe seiner beiden Bestandteile. Wenn hingegen zwei Substanzen derart miteinander verbunden sind, dass sie nicht alle ihre Funktionen unabhängig voneinander ausüben können, bilden sie zusammen eine essentielle Einheit - etwas Komplexes, was mehr ist als die Summe seiner Bestandteile. Genau dies ist bei der Verbindung von Körper und Geist der Fall“ (Perler, 2006, S. 213).

Die enge Verbindung von res cogitans und res extensa in der Person zeigt sich insbesondere im Bereich der Sinneswahrnehmung und der Schmerzempfindung, die weder der Geist noch der Körper allein ausüben können. Bei der Analyse der Sinneswahrnehmung unterscheidet Descartes wiederum „drei Grade“ oder Stufen voneinander:

1. Eine rein körperliche Stufe, die sich bei Tieren und Menschen findet, und durch direkte Einwirkung eines Objektes auf den Körper eine Nervenreizung verursacht.
2. Eine körperlich-geistige Stufe.
3. Eine rein geistige Stufe, die genau dann vorliegt, wenn ein Urteil über das äußere, auf den Körper einwirkende Objekt gebildet wird.

Im Kontext von Descartes’ Personbegriff ist die zweite Stufe von besonderer Bedeutung, „die nur aufgrund der essentiellen Einheit von Körper und Geist möglich ist“ (Perler, 2006, S. 214).

2.2. Die aristotelisch-scholastische Tradition

Descartes’ Personbegriff muss vor dem Hintergrund der aristotelisch-scholastischen Tradition gesehen werden, der zufolge „eine Person eine natürliche Substanz ist, die aus Form und Materie besteht: Die Seele ist die Form, der Körper die Materie“ (Perler 2006, S. 210). Im Rahmen seines hylemorphistischen Ansatzes betrachtete Aristoteles die Seele als Lebensprinzip, das ein Stück Materie erst zu einem funktionierenden, lebendigen Körper macht. Dieser Ansatz hat den Vorteil, dass die Person von vornherein als Einheit (im Sinne synchroner Identität) aufgefasst werden kann, jedoch den Nachteil - insbesondere für die christlichen Kommentatoren des Mittelalters - dass die Seele nicht unsterblich ist, sondern mit dem Körper untergeht.

Die spätmittelalterlichen Aristoteliker wie z.B. Thomas von Aquin versuchten dieser Konsequenz u.a. durch eine differenzierte Theorie des Intellekts bzw. der Seele zu entgehen. Demnach bildeten nur die „niederen“ Teile der Seele das Lebensprinzip und gehen mit dem Tod des individuellen menschlichen

Körpers zugrunde. Der Intellekt als der „erhabene“ Teil der menschlichen Seele überlebt den Tod und geht nicht mit dem Körper unter. Durch eine solche Erklärung wurde versucht, die Einheit der Person und die Unsterblichkeit der Seele zusammen zu denken (vgl. Perler, 2006, S. 211).

Eine besonders einflussreiche Kritik an der aristotelisch-scholastischen Lehre formulierte Der Renaissancephilosoph Pietro Pomponazzi in seiner Schrift „De Immortalitate Animae“ („Über die Unsterblichkeit der Seele“) aus dem Jahr 1516. Er zeigt dort, dass die Aristoteliker, insbesondere Thomas von Aquin, die Seele einerseits als sehr eng mit dem Körper verbunden dachten, andererseits aber als eine Entität, die auch unabhängig vom Körper existieren kann. Die Seele ist also einmal etwas, wodurch etwas lebendig ist (ein „quo est“) ein andermal etwas, was an sich existiert (ein „quod est“). Nach Pomponazzi lässt sich dieser Widerspruch im Rahmen einer aristotelisch-scholastischen Theorie der Person nicht auflösen.

Unklar ist, ob Descartes Pompanazzis Text gelesen hat, auf jeden Fall war er mit der daran anschließenden Kontroverse vertraut (vgl. Perler, 2006, S. 212). Descartes versucht, das von Pompanazzi formulierte Problem durch Annahme eines Substanzendualismus (von res cogitans und res extensa) zu lösen. Auf diese Weise versucht er die enge Einheit von Seele und Körper mit der Unsterblichkeit der Seele zusammen zu denken. Dabei soll

1. sein Personbegriff, verstanden als substantielle Einheit von Körper (res extensa) und Seele (res cogitans), den hylemorphistischen Ansatz der aristotelisch-scholastischen Tradition ersetzen.
2. sein Substanzbegriff die Unsterblichkeit der Seele garantieren, da sich Substanzen nach klassischem Verständnis nur hinsichtlich ihrer akzidentellen Eigenschaften ändern können.

Für Descartes ist die Seele zudem - im Gegensatz zum Körper - eine besondere („reine“) Substanz, da sie unteilbar sei (d.h. unzerstörbar = unsterblich). So betont er „dass wir einen Körper nur als teilbar, einen Geist dagegen nur als unteilbar einsehen können: Denn die Hälfte eines Geistes können wir nicht begreifen, wie wir es doch bei jedem beliebig kleinen Körper können; so dass wir ihre Naturen nicht nur als verschieden, sondern sogar als gewissermaßen entgegengesetzt erkennen“ (Descartes, 1641/2009, S. 14). Aus der Teilbarkeit (= Sterblichkeit) des Körpers folgt also keineswegs die Vernichtung des Geistes (= Sterblichkeit der Seele), wie Descartes einige Zeilen später deutlich herausstellt. Jedoch muss er den endgültigen Beweis der Unsterblichkeit der Seele - zumindest im Rahmen der „Meditationen“ - eingestandenermaßen schuldig bleiben. Darüber hinaus ist das Argument für die Unteilbarkeit (= Unsterblichkeit) der Seele nur dann stichhaltig, wenn Descartes entweder zeigen kann, dass

1. die Zerstörung der Seele durch Teilung die einzige Art ihres Zugrundegehens ist oder
2. alle anderen Arten des Zugrundegehens die menschliche Seele nicht betreffen (Perler, 2006, S. 179 f.).

2.3. Cartesianischer Dualismus

Descartes’ dualistische Substanzenlehre ist eine Voraussetzung seines Personbegriffs.

Baker und Morris unterscheiden zwischen Descartes' Dualismus („Descartes' Dualism") und dem von ihnen sogenannten Cartesianischen Dualismus („Cartesian Dualism"), der im wesentlichen auf einer Legendenbildung („Cartesian Legend") im Bereich der Analytischen Philosophie beruht (Baker und Morris, 2002). Zentraler Bestandteil des Cartesianischen Dualismus ist die Fähigkeit zur Introspektion („Cartesian Introspection"), die Baker und Morris folgendermaßen charakterisieren: „Physical objects are public and observable, though fallibly, via the senses; mental objects are private and (quasi-) observable via the infallible faculty of introspection" (Baker und Morris, 2002, S. 11). Auch die scharfe Kontrastierung von „physical objects" und „mental objects" gehört zur Cartesianischen Legendenbildung: „There are two worlds, the one populated by physical objects, the other by mental objects." Physikalische Objekte können rein mechanistisch erklärt werden („physical objects are essentially (bits of) clockwork"), während mentale „Gegenstände" als Bewusstseinszustände aufzufassen sind („mental objects are essentially (states of) consciousness"; Baker und Morris, 2002, S. 11). Diese „Two-Worlds View" führt dann zum Problem der Interaktion von physikalischen Gegenständen (wie z.B. dem eigenen Körper) und Mentalzuständen, bzw. zur Asymmetrie von Erster- und Dritter-Person-Perspektive. So macht es zum Beispiel Sinn zu sagen „Ich spüre meine Schmerzen", wohingegen der Satz „Ich spüre seine Schmerzen" sinnlos ist. Meine Mentalzustände sind privat, während mir die der anderen Menschen nur indirekt zugänglich sind (z.B. über ihr Verhalten). Im Rahmen der Cartesianischen Legendenbildung sind somit die „doctrines of 'the epistemological transparency of thought' [...] and of 'Cartesian Privacy'" von entscheidender Bedeutung (Baker und Morris, 2002, S. 19), wobei die Doktrin der epistemologischen Transparenz besagt, dass „introspection is essentially and universally infallible" (Ryle, 1949, S. 14). „If I think, hope, remember, will, regret, hear a noise, or feel a pain, I must, ipso facto, know that I do so" (Ryle, 1949, S. 158).

Die Doktrin der Cartesianischen Privatheit führt demgegenüber nicht nur zur bereits beschriebenen Asymmetrie von erster- und dritter Person, sondern ermöglicht auch einen direkten, unmittelbaren bzw. nicht-inferentiellen Zugang zu meinen inneren Zuständen („by acquaintance"; s. unten). So habe ich z.B. (aus der Ersten-Person-Perspektive) unmittelbaren Zugang zu meinen Schmerzen, ohne das aus meinem Verhalten erst irgendwie erschließen zu müssen.

2.4. Erkenntnistheorie

Descartes' Überlegungen zum Personbegriff führten uns zu seinem substanzdualistischen Ansatz, der wiederum aus seinen erkenntnistheoretischen Überlegungen resultierte. Insofern lässt es sich auch bei Abhandlungen über Descartes' Sicht der Person kaum vermeiden, auf seinen epistemologischen Ansatz näher einzugehen.

Descartes' Erkenntnistheorie ist im wesentlichen motiviert durch die Suche nach einem sicheren und unbezweifelbaren Fundament des Wissens angesichts der Möglichkeit eines systematischen Skeptizismus. Er beginnt mit der alltäglichen Erfahrung, dass uns unsere Sinne täuschen und dementsprechend die meisten unserer Überzeugungen falsch sein können. Es ist gar nicht notwendig, „zu zeigen, dass meine Meinungen allesamt falsch sind, [...]; sondern weil schon allein die Vernunft dazu rät, dass dem nicht völlig Sicheren und Unzweifelhaften die Zustimmung nicht weniger gründlich entzogen werden muss als dem offenbar Falschen, wird es schon ausreichen, alles zurückzuweisen, worin ich auch nur irgendeinen Grund zum Zweifeln antreffe“ (Descartes, 1641/2009, S. 20).

In einem zweiten Schritt radikalisiert Descartes die Möglichkeit des Zweifels, indem er feststellt, „dass der Wachzustand niemals aufgrund sicherer Anzeichen vom Traum unterschieden werden kann“ (Descartes, 1641/2009, S. 21).

Als dritten Zweifelsgrund nennt Descartes die Möglichkeit, dass mich Gott bzw. ein böser Dämon täuscht, so dass ich mich frage, ob „es überhaupt keine Erde, keinen Himmel, kein ausgedehntes Ding, keine Gestalt, keine Größe, keinen Ort gibt - und all dies mir trotzdem genau so wie jetzt zu existieren scheint?“ (Descartes, 1641/2009, S. 22).

Bekanntermaßen findet Descartes’ systematischer Zweifel zu Beginn der Zweiten Meditation im Cogito, d.h. in der Selbstgewissheit des Ichs sein Ende, indem „festgestellt werden muss, dass dieser Grundsatz Ich bin, ich existiere, sooft er von mir ausgesprochen oder durch den Geist begriffen wird, notwendig wahr ist“ (Descartes, 1641/2009, S. 28). Aus dem Cogito Argument leitet Descartes eine Hierarchisierung des Wissens ab. Das Wissen über unsere Mentalzustände (mittels Introspektion) ist gewisser und grundlegender als das Wissen über äußere Gegenstände (mittels Sinneswahrnehmung): „Wenn ich etwa aufgrund dessen, dass ich ihn berühre oder sehe, urteile, dass der Erdboden existiert, so ist daraus sicherlich noch viel mehr abzuleiten, dass mein Geist existiert: Es ist nämlich vielleicht möglich, dass ich urteile, den Boden zu berühren, obwohl gar kein Erdboden existiert, nicht jedoch, dass ich dieses Urteil fälle, und mein Geist, der dieses Urteil fällt, nicht sei [...]“ (Descartes, 1644/2005, S. 19 ff.).

Diese Priorisierung introspektiven Wissens führte dazu, Descartes’ erkenntnistheoretische Position als

- fundamentalisch und
- internalistisch zu charakterisieren.

Descartes’ Fundamentalismus („foundationalism“) zeigt sich vor allem in seiner Auffassung, dass das mittels Introspektion gewonnene Wissen unmittelbarer, sicherer und zuverlässiger ist, als das mittels Sinneswahrnehmung, was impliziert, dass ersteres als das Fundament für letzteres aufzufassen ist: Descartes „sees self-knowledge as providing a foundation for the thinker’s general body of knowledge“ (Gertler, 2011, S. 33).

Der (epistemologische) Internalismus lässt sich folgendermaßen charakterisieren:

- „Epistemic internalists (generally) accept, and externalists deny, that knowledge requires that one has accessible reasons for one’s belief, whereas externalism rejects this access requirement.“
- „[...] knowledge must be supported by reasons that are within the thinker’s mind“ (Gertler, 2011, S. 31 f.).

Legt man die klassische Wissensdefinition Platons als wahre, gerechtfertigte Meinung (vgl. Platon, Theätet, 201d-206b) zugrunde, dann unterscheiden sich (epistemologische) Internalisten und Externalisten primär hinsichtlich des Rechtfertigungsbegriffs; der Internalist findet die Rechtfertigungsgründe für seine Wissensansprüche ausschließlich „im Kopf“, während dies für den Externalisten nicht gilt. Da Descartes beide internalistischen Kriterien erfüllt, wird er von vielen als „the arch internalist“ (z.B. Gertler, 2011, S. 32), aber auch als ein paradigmatischer Vertreter eines „klassischen“ Fundamentalismus gesehen. Als „klassisch“ wird ein Fundamentalismus bezeichnet, wenn er postuliert, dass

- „das Fundament aller Rechtfertigung [von Wissensansprüchen; Ergänzung: M.R] aus unfehlbaren und unanfechtbaren Überzeugungen besteht“,
- wobei „diese basalen Überzeugungen so beschaffen sind, dass sie selbst einen Grund für die Einsicht in ihre Wahrheit liefern“ (Grundmann, 2008, S. 284).

Internalismus und Fundamentalismus sind Möglichkeiten, einem grundsätzlichen erkenntnistheoretischen Trilemma zu entgehen, das in der Antike als Agrippas Trilemma, und in der gegenwärtigen Diskussion als Münchhausen-Trilemma bekannt ist (Albert, 1991, S. 15). Möchte ich z.B. Überzeugung A rechtfertigen, kann ich das mit Hilfe einer weiteren Überzeugung B tun, wenn sich A aus B inferenziell erschließen lässt. Wodurch wird jedoch B gerechtfertigt? Es gibt drei Möglichkeiten, die alle inakzeptabel sind:

1. Unendlicher Regress: B wird durch C, C durch D gerechtfertigt, usw. ad infinitum.
2. Rechtfertigungszirkel: B, der Grund für A, wird wiederum durch A selbst gerechtfertigt.
3. Abbruch der inferenziellen Begründungen: B, unser Grund für A, wird nicht weiter gerechtfertigt, sondern (willkürlich) als evident, intuitiv einleuchtend, basal, etc. deklariert.

Es ist intuitiv einleuchtend, dass Descartes’ internalistischer Fundamentalismus Möglichkeit 3 favorisiert. Descartes’ Idee, dass Personen mittels Introspektion einen privilegierten Zugang zu ihren Mentalzuständen haben und mit diesen unmittelbar (d.h. nicht-inferentiell) bekannt sind (im Sinne von „acquaintance“), ist nicht nur von philosophiehistorischem Interesse. Auch in den gegenwärtigen Diskussionen ist Descartes’ Grundidee, den Personbegriff mit der Fundierung von Erkenntnistheorie zu verbinden, von großer Relevanz und wird kontrovers diskutiert.

2.5. Moderne Versionen des internalistsischen Fundamentalismus

Viele Philosophen des „Wiener Kreises“ und aus der Frühphase der analytischen Philosophie vertraten Versionen des internalistischen Fundamentalismus. So war Russell der Auffassung - ähnlich wie Descartes (vgl. das Zitat aus den „Prinzipien“, siehe oben, Abschnitt 2.4) - dass zwar an der Existenz der Gegenstände der Außenwelt gezweifelt werden kann, nicht aber an der Realität unserer Sinneswahrnehmungen: „We have seen that it is possible, without absurdity, to doubt whether there is a table at all, whereas it is not possible to doubt the sense-data“ (Russell, 1912, S. 74). Sinneswahrnehmungen („sense-data“) sind als Mentalzustände aufzufassen, von denen wir unmittelbare Kenntnis („acquaintance“) besitzen: „[...] Russell claims that awareness of sense data is direct, whereas awareness of tables is indirect.“ Das führt dazu, dass „sense data 'stand between' you and the table, so to speak, that your awareness of the table is only indirect. Sense data play this mediating role in every example of perceptual awareness, [...]“ (Gertler, 2011, S. 89).

Parrallel zu Russell hat auch Moore ab 1910 eine Theorie der Sinnesdaten vertreten. Auch er plädiert dafür, zwischen Wahrnehmung und den von dieser unabhängig existierenden Gegenständen zu unterscheiden: „[...] in every sensation or idea we must distinguish two elements, (1) the 'object', or that in which one differs from another; and (2) 'consciousness', or that which all have in common - that which makes them sensations or mental facts“ (Moore, 1903/1993, S. 37).

In analoger Weise sind auch für Carnap Sätze der Realwissenschaften (Physik, Psychologie, etc.) rückführbar auf das wirklich Gegebene. Er schreibt: „Jeder Satz der Wissenschaft muss sich bei logischer Analyse als sinnvoll bewähren. Dabei wird entweder gefunden, dass es sich um eine Tautologie oder um eine Kontradiktion (Negation einer Tautologie) handelt; dann gehört der Satz zum Gebiet der Logik einschließlich der Mathematik. Oder der Satz ist eine gehaltvolle Aussage, d.h. weder tautologisch noch kontradiktorisch; dann ist es ein empirischer Satz. Er ist zurückführbar auf das Gegebene und daher grundsätzlich als wahr oder falsch entscheidbar“ (Carnap, 1931, S. 25 f.).

Bereits im „Logischen Aufbau der Welt“ (1928) entwickelte Carnap ein Konstitutionssystem, das die Rückführung aller wissenschaftlichen Begriffe auf „unmittelbar Gegebenes“ erlauben sollte. Unmittelbar gegeben sind Carnap zufolge „die Bewusstseinsvorgänge oder Erlebnisse des Ichs“. Diese bezeichnet er als „Elementarerlebnisse“; sie sollen „ihrem Wesen nach unzerlegbare Einheiten“ darstellen, die „einfach so hinzunehmen“ sind, „wie sie sich geben“ (Carnap, 1928/1998, S. S. 86 ff.).

Eine (zeitgenössische) Version der „Acquaintance Theory of Self-Knowledge“ wird z.B. von Fumerton vertreten. Zum unmittelbaren, d.h. nicht-inferentiellen Wissen schreibt er. „My suggestion is that one has a noninferentially justified belief that P when one has the thought that P and one is acquainted with the fact that P“ (Fumerton, 1995, S. 75).

Die „Acquaintance Theory of Self-Knowledge“ lässt sich somit folgendermaßen zusammenfassen:

- Aufgrund unmittelbarer Kenntnis („acquaintance“) sind wir mit unseren Sinnesdaten vertraut, z.B. dass wir Schmerzen haben.
- Aufgrund unmittelbarer Kenntnis sind wir zu dem Urteil „Ich habe Schmerzen“, bzw. „Schmerz ist vorhanden“ gelangt.
- Aufgrund unmittelbarer Kenntnis sind wir uns der Korrespondenz zwischen unserem Schmerzempfinden und unserem Urteil „Schmerz ist vorhanden“ bewusst (Gertler, 2011, S. 101).

Die Methode der Introspektion ist nicht nur für die Erkenntnistheorie und die Philosophie des Geistes von großem Interesse, sondern auch für die modernen Neurowissenschaften. Dies soll im nächsten Abschnitt kurz referiert werden.

Introspektion und Neurowissenschaften

Die Frage, ob die Introspektion eine zuverlässige und damit zulässige wissenschaftliche Methode ist, wird seit Beginn des 20sten Jahrhunderts sehr unterschiedlich bewertet. Der Behaviorismus und sein Nachfolger, der kognitive Funktionalismus, „declared war on introspective psychology.“ (Schwitzgebel, 2010, Zugriff: 03.02.2012) Es wurden im Wesentlichen vier Einwände vorgebracht:

1. „Introspective claims are unreliable because they are not regularly replicated in others.
2. Subjects confabulate (make up stories) about what is going on in themselves when they need to do so to make sense of behaviour.
3. Introspection has access only to a tiny fraction of what is going on in oneself cognitively.
4. It is impossible for introspection to access brain states“ (Brook & Mandik, 2004, S. 390).

Die Unzuverlässigkeit introspektiver Berichte (Einwand 1.) ist Gegenstand von Wittgensteins Privatsprachenargument, das im folgenden Abschnitt 2.6. ausführlich diskutiert werden wird.

Brooks und Mandiks Einwände 2. und 3. fanden ab Anfang der 1960er Jahre zunehmend empirische Bestätigung in Experimenten, in denen die Methode der Introspektion selbst zum Untersuchungsgegenstand wurde. Es zeigte sich insbesondere, dass viele höherstufige kognitive Prozesse introspektiv nicht zugänglich sind, wodurch sich die „anti-introspectivist view“ unter kognitiven Psychologen deutlich verstärkte. Mandler (1975, S. 245) fasst die Resultate dieser Experimente folgendermaßen zusammen: „There are many systems that cannot be brought into consciousness, and probably most systems that analyze the environment in first place have that characteristic. In most of these cases, only the products of cognitive and mental activities are available to consciousness.“

Der Bostoner Philosoph Daniel Dennett (1991, S. 122) kommt zu einer ähnlichen Einschätzung. Wir können nicht direkt wahrnehmen, „[...] what happens on our retinas, in our ears, on the surface of our skin. What we actually experience is a product of many processes of interpretation - editorial processes, in effect.“ Dies hat Implikationen für die Bedeutung der Introspektion und den Cartesianischen Fundamentalismus insgesamt: „There is no single, definitive 'stream of consciousness', because there is no central Headquarters, no Cartesian Theatre where 'it all comes together' for the perusal of a Central Meaner. Instead of such a single stream (however wide), there are multiple channels in which specialist circuits try, in parallel pandemoniums, to do their various things, creating Multiple Drafts as they go“ (Ebd., S. 253 f.).

Aus Brooks und Mandiks Einwand 4. zieht der Philosoph und Kognitionsforscher Paul Churchland den gegenteiligen Schluss, nämlich dass Personen mit „[...] sufficient neuroscientific education can introspect his or her brain states as brain states“ (zit. nach: Mandik, 2006, S. 66). Churchland vertritt seine „Introspection Thesis“ im Rahmen eines eliminativen Materialismus, der unser laienhaftes psychologisches Vokabular („folk psychology") für überflüssig und irreführend hält. Eine elaborierte zukünftige Kognitions- und Neurowissenschaft muss nicht mehr auf dubiose mentale Entitäten rekurrieren, sondern spricht stattdessen von neuronalen Zuständen. Möchten wir an uns vertrauten Begriffen wie z.B. „Introspektion" festhalten, dann referieren diese nicht mehr auf Psychisches sondern notwendigerweise auf Physisches. Churchlands eliminativer Materialismus bzw. Naturalismus ist von verschiedenen Seiten nachhaltig kritisiert worden (z.B: Keil, 1993), was im Rahmen dieser Arbeit jedoch nicht vertieft werden kann.

Mit dem zunehmenden Einfluss der Kognitions- und Neurowissenschaften kam es zu einer Kehrtwende; die Methode der Introspektion wurde wieder „salonfähig", insbesondere im Bereich der Emotionsforschung, des „Mental Imagery" und der sogenannten „Consciousness Studies", die alle essentiell auf „subjective reports of experience", also verbale „introspektive" Berichte von Probanden, angewiesen sind. Dies hat die paradoxe Konsequenz, „that neuroscience, the most scientific of approaches to human nature to date, has been forced to fall back onto a technique rejected as unscientific over 100 years ago!" (Brook & Mandik, 2004, S. 390)

In vielen empirischen Studien gibt es aber auch die Tendenz, „subjective reports of experience" bewusst zu umgehen und durch objektivere Methoden zu ersetzen wie z.B. (semantisches) Priming oder gleich auf bildgebende Verfahren auszuweichen. Damit wird zwar der „subjektive Faktor" Introspektion vermieden, aber in Kauf genommen, dass neurowissenschaftliche Befunde nicht auf eindeutige Weise mit entsprechenden Mentalzuständen korreliert und insofern interpretationsbedürftig sind (vgl. Ruchsow, Hermle & Kober, 2010). Insofern scheinen neurowissenschaftliche Studien häufig zwischen der Skylla unzuverlässiger introspektiver Probandenberichte und der Charybdis objektiver aber uneindeutiger Messergebnisse wählen zu müssen.

Wie gezeigt, geht der internalistische Fundamentalismus davon aus, dass unsere Mentalzustände wesentlich privat und unmittelbar zugänglich sind, zwei Annahmen, die in den nächsten beiden Abschnitten kritisch untersucht werden sollen.

2.6. Privatheit

Wittgensteins Überlegungen zur Privatheit bzw. zu den Möglichkeiten einer Privatsprache in den Paragraphen 243 bis 315 der „Philosophischen Untersuchungen" (PU) lassen sich als kritische Auseinandersetzung mit dem Cartesianismus lesen. Unter einer Privatsprache versteht Wittgenstein folgendes: „Die Wörter dieser Sprache sollen sich auf das beziehen, wovon nur der Sprechende wissen kann; auf seine unmittelbaren, privaten Empfindungen. Ein Anderer kann diese Sprache also nicht verstehen." (Wittgenstein, 1953/1984, § 243 = PU 243)

Die Grundannahme einer derartigen privaten Sprache lässt sich folgendermaßen zusammenfassen.:

P1 „Sensations are private occurences" (Schroeder, 2001, S. 196). Meine Zahnschmerzen sind aus diesem Grund anderen Personen nicht unmittelbar zugänglich. Ebenso wenig kann ich mir sicher sein, ob eine andere Person ähnliche Zahnschmerzen wie ich empfinden kann.

2.6.1. „Das Rad gehört nicht zur Maschine“ (PU 271)

Aus (P1) ergibt sich eine skeptische Konsequenz, die Wittgenstein in PU 272 formuliert: „Das Wesentliche am privaten Erlebnis ist eigentlich nicht, dass Jeder sein eigenes Exemplar besitzt, sondern dass keiner weiß, ob der Andere auch dies hat, oder etwas anderes. Es wäre also die Annahme möglich - obwohl nicht verifizierbar - ein Teil der Menschheit habe eine Rotempfindung, ein anderer Teil eine andere.“ Für Wittgenstein haben private psychische Ereignisse keinerlei Funktion, vergleichbar einem überflüssigen Zahnrad in einer Maschine: „Hier möchte ich sagen: das Rad gehört nicht zur Maschine, das man drehen kann, ohne dass Anderes sich mitbewegt“ (PU 271).

Für Wittgenstein sind private mentale Ereignisse nicht nur überflüssig, sondern im Rahmen einer öffentlichen Sprache nicht kommunizierbar. Mentalzustände sind wie ein Käfer in einer Schachtel, zu der nur der Besitzer der Schachtel Zugang hat. Der Käfer ist also wesentlich „privat“. Wittgenstein analysiert diese Situation folgendermaßen: „Niemand kann je in die Schachtel des Anderen schaun; und jeder sagt, er wisse nur vom Anblick seines Käfers, was ein Käfer ist. - Da könnte es ja sein, dass Jeder ein anderes Ding in seiner Schachtel hätte. Ja, man könnte sich vorstellen, dass sich ein solches Ding fortwährend veränderte. [...] die Schachtel könnte auch leer sein“ (PU 293). Sind Schmerzen, Käfer, etc aber wesentlich privat, dann ergibt sich als Konsequenz: „Wenn man die Grammatik des Ausdrucks der Empfindung nach dem Muster von ’Gegenstand und Bezeichnung’ konstruiert, dann fällt der Gegenstand als irrelevant aus der Betrachtung heraus“ (PU 293).

2.7. Unmittelbarkeit

Eine ausführliche Kritik an der Vorstellung unmittelbaren nicht-inferentiellen Wissens findet sich bereits im 1. Kapitel von Hegels „Philosophie des Geistes“ (Hegel, 1807/1973, S. 82 ff.). In der analytischen Philosophie verlief die Rezeptionsgeschichte Hegels sehr wechselhaft, um nicht zu sagen: dialektisch. Nach einer kurzen hegelianischen Phase der „Gründungsväter“ der analytischen Philosophie, Moore und Russell, verstanden sich diese als dezidierte Anti-Hegelianer. Dieser Anti-Hegelianismus im Selbstverständnis der analytischen Philosophie ging so weit, dass die oft gestellte Frage, warum sich die analytische Philosophie eigentlich „analytisch“ nenne, folgendermaßen beantwortet werden sollte: „’analytisch’ bedeutet ursprünglich genau ’anti-hegelisch’“ (Welsch, 2011, S. 71).

Seit etwa Mitte der 1950er Jahre zeichnet sich jedoch eine Wiederkehr Hegels im Bereich der neueren analytischen Philosophie ab. Hier ist (neben John McDowell und Robert Brandom) insbesondere der amerikanische Philosoph Wilfrid Sellars zu nennen, der seine Kritik an der Möglichkeit unmittelbaren Wissens unter dem Stichwort „Mythos des Gegebenen“ („myth of the given“) auch als „Méditations Hegeliènnes“ verstanden wissen wollte (Sellars, 1956/1997, S. 45).

Nach Sellars lässt sich die Idee, dass „truth bearers“ durch „truth makers“ verifiziert (bzw. falsifiziert) werden, nicht aufrecht erhalten: „Having a sense-impression is, by itself, an example neither of knowledge nor of conscious experience“ (Sellars, 1956/1997, S. 4), da es sich bei Sinnesdaten nicht um (propositionales) und damit wahrheitsfähiges Wissen handelt. In anderen Worten: „[...] one might think one is acquainted with certain sorts of objects (sense data), determinate properties (this particular shade of yellow), generic universals (being yellow, being colored), and, crucially, facts (my being in pain now, something's being yellow). None of the items on this list are the kinds of things that can be true or false [...]. The object that is yellow, the yellowness of the object, that fact that the object is yellow are all neither true nor false“ (Fumerton, 2009, Zugriff: 22.01.2012). Der Mythos des Gegebenen („Myth of the Given“) besteht nach Sellars in der Idee „that observation [...] is constituted by certain self-authenticating nonverbal episodes, the authority of which is transmitted to verbal and quasi-verbal performances [...]“ (Sellars 1956/1997, S. 77). Die Vorstellung einer Fundierung unseres (propositionalen) Wissens durch mentale Episoden lässt sich aber nicht halten: „For empirical knowledge, like its sophisticated extension, science, is rational, not because it has a foundation but because it is a self-correcting enterprise which can put any claim in jeopardy, though not all at once“ (Sellars 1956/1997, S. 79). Bei dem Versuch, Wahrnehmungsberichte, also epistemisches bzw. propositionales Wissen auf nicht-epistemisches bzw. nicht-propositionales Wissen zu reduzieren, handelt es sich nach Sellars vielmehr um einen naturalistischen Fehlschluss: „Now the idea that epistemic facts can be analyzed without remainder - even 'in principle' - into non-epistemic facts whether phenomenal or behavioral, public or private [...] is, I believe, a radical mistake - a mistake of a piece with the so-called 'naturalistic fallacy' in ethics“ (Sellars 1956/1997, S. 19).

Aber nicht nur Descartes' Introspektionsbegriff, sondern auch der diesem zugrunde liegende Substanzbegriff war sehr umstritten und wurde von empiristischen Philosophen wie z.B. John Locke abgelehnt.

3. Locke

3.1. Kritik am Substanzbegriff

Ähnlich wie Descartes wollte auch Locke einen radikalen Neuanfang in der Philosophie machen. Er betrachtete sich als Hilfsarbeiter („Under-Labourer“), der das Ziel hat, „[...] clearing Ground a little, and removing some of the Rubbish that lies in the way to Knowledge [...]“. Durch Leidenschaften, Erziehung, Gewohnheiten und Vorurteile wird unser Wissen systematisch verzerrt und verfälscht. Insofern ist auch eine radikale Sprachkritik erforderlich, denn „Vague and insignificant Forms of Speech and Abuse of Language have so long passed for Mysteries of Science; And hard or misapply'd Words, with little or no meaning, have, by Prescription such a Right to be mistaken for deep Learning and height of Speculation, that it will not be easy to persuade either those who speak or those who hear that they are but the Covers of Ignorance and hindrance of true Knowledge“ (Locke, 1694/1979, S. 10). Das Ziel dieser Demontage ist die Fundierung unseres Wissens auf der Grundlage der Erfahrung, die nach Locke die einzige Quelle sicherer menschlicher Erkenntnis ist: „Let us then suppose the Mind to be, as we say, white Paper void of all Characters, without any Ideas. [...] Whence has it all the materials of Reason and Knowledge? To this I answer, in one word, From Experience [...]" (Locke 1694/1979, S. 104). Insofern ist für Locke auch die Frage, ob es eine cartesianische Seelensubstanz gibt zu verneinen, da der Begriff „Substanz" kein Gegenstand möglicher Erfahrung ist.

Durch die Ablehnung des Substanzbegriffs ergab sich jedoch eine neue Konstellation hinsichtlich der Identität von Personen. Für Descartes war das Problem der diachronen Identität von eher untergeordneter Bedeutung, da sein Substanzbegriff die Unsterblichkeit der Seele (= Persistenz der Person) garantierte. Die Erklärung der synchronen Identität war jedoch weitaus problematischer, da sie sich dem Problem der Interaktion von res extensa und res cogitans stellen, bzw. den Begriff der substantiellen Einheit inhaltlich füllen musste. Für Locke ergab sich eine inverse Problematik: die synchrone Identität ist leichter zu denken, während sich die transtemporale Einheit der Person (und damit die Unsterblichkeit der Seele) ohne Substanzbegriff nur schwer verstehen lässt.

3.2. Diachrone personale Identität

Locke definiert Person folgendermaßen: „[...] we must consider what Person stands for; which, I think, is a thinking intelligent Being, that has reason and reflection, and can consider itself as itself, the same thinking thing, in different times and places; which it does only by that consciousness which is inseparable from thinking, and, as it seems to me, essential to it" (Locke 1694/1979, S. 335). „Consciousness" liefert auch das gesuchte (naturalistische bzw. neurowissenschaftliche) Kriterium diachroner Identität: „For, since consciousness always accompanies thinking, and 'tis that which makes every one to be, what he calls self, and thereby distinguishes himself from all other thinking things, in this alone consists personal Identity, i.e. the sameness of a rational Being: And as far as this consciousness can be extended backwards to any past Action or Thought, so far reaches the Identity of that Person" (Locke 1694/1979, S. 335). In der Nachfolge Lockes wurde „consciousness" meist mit „memory" bzw. „Erinnerung" übersetzt und das Kriterium diachroner Identität dementsprechend als Erinnerungskriterium bezeichnet. Für Locke ist wichtig, dass man sich nicht nur allgemein an eine bestimmte Wahrnehmungssituation erinnert, sondern dass die damalige Wahrnehmung sozusagen „im selben Bewusstsein" wie die jetzige erfolgt: „For as far as any intelligent Being can repeat the Idea of any past Action with the same consciousness it has of any present Action; so far it is the same personal self" (Locke 1694/1979, S. 336).

Locke war der erste, der den Begriff der Person im Gegensatz zur Scholastik und zum Cartesianismus allein durch den des Bewusstseins bestimmte (Thiel, 1997, S. 163; Gillitzer, 2001, S. 111). Die diachrone Einheit der Person konstituiert sich im Selbstbewusstsein und ist damit epistemisch ausschließlich in der Ersten-Person-Perspektive zugänglich. Quante nennt dies die „These der erstpersönlichen Natur personaler Einheit" (kurz: Erstpersönlichkeitsthese; Quante, 2007, S. 57).

Darüber hinaus vertritt Locke eine „Unabhängigkeitsthese“, die besagt, dass personale Einheit „unabhängig von der Identität einer selbstbewusstseinstranszendenten Substanz“ ist (Quante, 2007, S. 58 f.).. In Lockes Worten: „For it being the same consciousness that makes a Man be himself to himself, personal Identity depends on that only, whether it be annexed only to one individual Substance, or can be continued in a succession of several Substances. [...] The same consciousness uniting those distant Actions into the same Person, whatever Substances contributed to their Production“(Locke 1694/1979, S. 336).

Drittens ist Locke der Meinung, dass personale Einheit ein komplexes Phänomen ist und sich (z.B. durch das Erinnerungskriterium) auf informative Weise weiter analysieren lässt. Quante nennt dies „die These der internen Komplexität personaler Einheit - kurz: die Komplexitätsthese“ (Quante, 2007, S. 58).

4. Reid und Butler

Lockes Lösungsansatz wurde insbesondere von Reid und Butler kritisiert. Reid zeigt anhand des „Brave Officer Paradox“, dass Lockes Erinnerungskriterium nicht stichhaltig ist: „Suppose a brave officer to have been flogged when a boy at school for robbing an orchard, to have taken a standard from the enemy in his first campaign, and to have been made a general in advanced life; suppose, also, which must be admitted to be possible, that, when made a general, he was conscious of his taking a standard, but had absolutely lost the consciousness of his flogging“ (Reid, 1785/1975, S. 114). Reids Kritik lässt sich pointiert folgendermaßen zusammenfassen: „Identity is transitive; memory continuity is not“ (Olson, 2010, Zugriff: 22.01.2012).

Dieser Transitivitätseinwand lässt sich jedoch dadurch entkräften, dass man Lockes Erinnerungsrelation im Sinne einer psychologischen Verbundenheit („connectedness“) ersetzt durch die schwächere Relation der psychologischen Kontinuität („continuity“), für die gilt: „Zwischen dem Bewusstseinszustand einer Person zum Zeitpunkt t_0 und dem Bewusstseinszustand einer Person zum Zeitpunkt t_1 besteht genau dann psychologische Kontinuität, wenn es zwischen diesen beiden Bewusstseinszuständen ein stetiges Band von Bewusstseinszuständen gibt, die untereinander in der Relation der psychologischen Verbundenheit stehen. Gibt es ein solches Band, dann handelt es sich bei den beiden Bewusstseinszuständen zu t_0 und t_1 um die Bewusstseinszustände ein und derselben Person“ (Quante, 2007, S. 47).

Butler wies darauf hin, dass Erinnerungen stets eine Person implizieren, die die Erinnerungen hat. Das Erinnerungskriterium setzt also personale Identität voraus und kann diese niemals konstituieren: „And one should really think it self-evident, that consciousess of personal identity presupposes, and therefore cannot constitute, personal identity, any more than knowledge, in any other case , can constitute truth, which it presupposes“ (Butler, 1736/1975, S. 100).

Butlers Zirkularitätseinwand lässt sich durch die Annahme sogenannter „q-memories“ entkräften, ein Vorschlag, der auf Sydney Shoemaker zurückgeht. Nach Shoemaker sind q-memories durch einen fehlenden impliziten Subjektbezug gekennzeichnet, so dass sie nicht-zirkulär personale Identität konstituieren können: „One way of characterizing the difference between quasi-remembering and remembering is by saying that the former is subject to a weaker previous awareness condition than the latter. Whereas someone's claim to remember a past event implies that he himself was aware of the event at the time of its occurrence, the claim to quasi-remember a past event implies only that someone or other was aware of it“ (Shoemaker, 1970/2003, S. 24). Jedoch muss sich auch ein Verteidiger von Lockes Erinnerungskriterium, der q-memories als basal ansetzt, fragen lassen, „auf welcher Grundlage er von der Menge der Quasi-Erinnerungen zu der Menge der Erinnerungen kommen möchte“ (Quante, 2007, S. 90).

5. Das physische Kontinuitätskriterium

Quante und Olson plädieren aufgrund der geschilderten Schwierigkeiten des Erinnerungskriterium für ein anderes naturalistisches Kriterium diachroner Identität, das physisches Kontinuitätskriterium. Nach Quante lässt sich Butlers Zirkularitätseinwand effektiv durch die Annahme aus dem Weg räumen, „dass der Träger der mentalen Episoden nicht die Person, sondern ein [...] menschlicher Organismus ist“ (Quante, 2007, S. 90). Zu diesem Schluss kommt auch Olson, der für einen „somatic approach“ bzw. „animalism“ plädiert: „There appears to be a thinking animal located where you are. It also appears that you are the thinking thing - the only one - located there“. Olsons Überlegung ist auch durch die absurde Konsequenz des Erinnerungskriteriums motiviert, dass alle Unterbrechungen des Bewusstseinsstroms z.B. durch Schlaf, Narkosen, Ohnmachten, etc. dazu führen „that I have never existed at any time when I was completely unconscious“ (Olson, 2010, Zugriff: 22.01.2012).

Auch der New Yorker Philosoph Thomas Nagel definiert personale Identität anhand des physischen Identitätskriteriums. Die Minimalanforderung an ein physikalisches Korrelat personaler Identität besteht darin, „bearer of mental states and the cause of their continuity“ zu sein (Nagel, 1986, S. 40). Hypothetisch nimmt Nagel an, dass am ehesten das intakte Gehirn diesen Anforderungen Genüge tut. Ein alternativer Kandidat ist der menschliche Körper, der eng mit den Hirnfunktionen verknüpft ist, jedoch „[...] the brain is the only part of me whose destruction I could not possibly survive. The brain, but not the rest of the animal, is essential to the self“. Zusammenfassend kann (mit milder Übertreibung) gesagt werden: „ [...] I am my brain [...]“ (Nagel, 1986, S. 40). Das Gehirn ist die notwendige und hinreichende Bedingung personaler Identität (Northoff, 2001, S. 131-132), da es die biologische Grundlage aller mentalen Vorgänge wie Erinnerungen aber auch des „Bewusstseinsstroms“ ist und somit ein Fortbestehen der Person nach (Teil-)verlust des Gehirns unmöglich erscheint.

6. Parfit

Mit Hilfe eines Gedankenexperiments weist Parfit nach, dass Nagels Slogan „I am my brain“ nicht ausreicht, um numerische Identität zu garantieren: „Suppose next that I need surgery. All of my brain cells have a defect which, in time, would be fatal. But a surgeon can replace all these cells. He can insert new cells that are exact replicas of the existing cells except that they have no defect“ (Parfit, 1984, S. 474). Parfit unterscheidet zwei Operationsprozeduren: In der ersten („Case One“) werden alle Nervenzellen meines Gehirns in einer Serie von 100 Operationen schrittweise entfernt und durch neue ersetzt. Bei der anderen Operationsart („Case Two“) wird in einem Schritt mein ganzes Gehirn ausgetauscht. Bei der ersten Operation ist die Kontinuität meiner Person gegeben, bei der zweiten jedoch nicht: „ There is a real difference between these cases. In Case One, each of the new parts of my brain is for a time joined to the rest of my brain. This enables each new part to become part of my brain. When the first new part is inserted, and joined to the rest of my brain, it wins the title to be as much part of my brain as the old parts. When the second new part is inserted, it too becomes a part of my brain. This is true of every new part, because there is a time when this part is joined to what then counts as the rest of my brain.

In Case Two, things are different. There are no times when each part is joined to the rest of my brain. Because of this, the new parts do not count as parts of my brain. My brain ceases to exist“ (Parfit, 1984, S. 474 f.). Die erste Art der Operation werde ich (als Person) überleben, die zweite jedoch nicht, obwohl das Endergebnis in beiden Fällen dasselbe ist. Folglich ist der Slogan „I am my brain“ nicht hinreichend, um numerische Identität zu gewährleisten.

Zusammenfassend bleibt festzuhalten, dass weder Descartes’ noch Lockes Ansatz eine tragfähige Lösung des Problems der personalen Identität darstellt. Descartes’ Substanzbegriff lässt sich im Rahmen des zeitgenössischen naturalistischen Paradigmas nicht halten. Die Aufgabe des Substanzbegriffs führt in der Folgezeit zu einer Verlagerung der Diskussion von der synchronen zur diachronen Identität. Aber auch die (naturalistischen) Kriterien der Erinnerung und der physischen Kontinuität, die im Zusammenhang der diachronen Identität formuliert wurden, sind mit einer Vielzahl von Schwierigkeiten belastet.

Im folgenden sollen Überlegungen des kanadischen Philosophen Charles Taylor zur narrativen Identität vorgestellt werden, der sich nicht nur an der analytischen Philosophie, sondern insbesondere auch an kontinentaleuropäischen Traditionslinien orientiert.

7. Taylor

7.1. Selbstinterpretation

Taylors Überlegungen zur personalen Identität knüpfen in vielen Punkten an Wittgenstein an, mit dem er sich sehr intensiv auseinandergesetzt hat (z.B. Taylor, 1972; 1988a; 1995; 2010). Taylor ist jedoch nicht nur einem analytischen Ansatz verpflichtet, sondern steht u.a. in den Traditionslinien von Hermeneutik, Anthropologie und Deutschem Idealismus (hier insbesondere Hegel). Von Axel Honneth wurde er als ein Parteigänger der Hermeneutik im Felde der analytischen Wissenschaftstheorie bezeichnet (in: Taylor, 1988b, S. 296).

Für Taylor sind Personen wesentlich „self-interpreting animals“ (Taylor, 1985a, S. 45 ff.) und „dialogical selves“ (Taylor, 1995, S. 230). Sie sind also durch ihre Fähigkeit zur Selbstinterpretation und zum sprachlich-dialogischen Austausch mit anderen Menschen gekennzeichnet. Ähnlich wie für Wittgenstein ist für Taylor Sprache ein intrinsisch soziales Phänomen:

„The matter talked about is no longer just for me or for you, but for us“ (Taylor, 1985a, S. 260). Insofern verfehlen wir völlig das Wesentliche, „if we remain with the monological model of the subject, and think of all states of awareness, knowledge, belief, attending to, as ultimately explicable as states of individuals“ (Taylor, 1985a, S. 265).

7.2. Sprache

Ausgehend von dieser sozialen und dialogischen Dimension der Sprache kritisiert Taylor die zeitgenössischen Sprachauffassungen als naturalistisch, worunter er Theorien versteht, die von einem Beobachter über einen beobachteten Gegenstand entwickelt werden, an dem er nicht beteiligt ist.

Taylor stellt dieser naturalistischen eine romantisch-expressivistische Sprachauffassung gegenüber, die er auch als Herder-Humboldt-Hamann-Theorie bzw. als „triple-H theory“ bezeichnet (Taylor, 1985a, S. 256). Die Expressivität von Sprache verdeutlicht auch deren dialogischen Charakter, indem sie eine bestimmte Art der Beziehung zu einem Gegenüber ausdrückt. Sprechen heißt dann „to put it ’out there’, to have it out before us, to be ’up front’ about it“ (Taylor, 1985a, S. 264). Sprache erzeugt etwas, „what one might call a public space, or a common vantage point from which we survey the world together“ (Taylor, 1985a, S. 259). Etwas ausdrücken bedeutet „to place it in public space, and thus to bring us together qua participants in a common act of focussing“ (Taylor, 1985a, S. 260).

7.3. Hermeneutik

Wie Gadamer ist auch Taylor der Auffassung, dass Menschen immer schon in eine bestimmte Sprachgemeinschaft, bestimmte Traditionen und ein bestimmtes Verständnis der Welt hineingeboren sind, das die Basis ihres Verstehens bildet („Geworfenheit“ im Sinne Heideggers). Intersubjektivität geht der Subjektivität voraus, „we are aware of the world through a ’we’ before we are through an ’I’“ (Taylor, 1985b, S. 40). Insofern befindet sich jeder in einem hermeneutischen Zirkel, weil die Interpretationen unserer Umwelt selbst schon Resultat vorgängiger Interpretationen sind (Breuer, 2000, S. 23). Verstehen hat immer den Doppelcharakter der Teilnahme an einem Sinngeschehen, das dem Subjekt vorausgeht und sein Begreifen ermöglicht und einem Sichverstehen (Angehrn, 2004, S. 774): Wie ich die Welt auffasse, ist davon abhängig, wie ich den Sinn meines Daseins interpretiere, wie umgekehrt mein Selbstverständnis nicht losgelöst von meiner Sicht auf die Dinge zustande kommt bzw. in Honneths Worten: „Soziales Handeln ist ohne Bezugnahme auf das situationsgebundene Selbstverständnis der handelnden Subjekte gar nicht angemessen aufzufassen; der Erklärung einer Handlung muss daher ein hermeneutisches Verstehen der jeder unmittelbaren Beobachtung entzogenen Perspektive des Handelnden unbedingt vorhergehen“ (in: Taylor, 1988b, S. 299).“

Taylor unterscheidet dementsprechend zwei Interpretationsebenen: Auf einer präreflexiven Ebene ist Personen ein Selbst- und Weltverständnis vorgegeben, das primär und zum größten Teil implizit und nicht artikuliert ist (vgl. Rosa, 1998, S. 200). Dem reflexiven Bewusstsein wird diese gesamte erste (präreflexive) Interpretationsebene dann zum Gegenstand einer zweiten Interpretationsebene, in der jene auf ihre Bedeutungen und ihren Sinn befragt und sprachlich artikuliert wird.

7.4. Moralische Topographien

Ein „selbstinterpretierendes Tier" zu sein heißt für Taylor u.a. auch, sich der Frage zu stellen „Who I desire to be?" (Rosa, 1998, S. 98) und sich durch ihre Beantwortung in einem moralischen Raum zu verorten. Unsere Identität als Personen wird aus seiner Sicht entscheidend durch fundamentale Wertungen mitbestimmt, so dass sich ein unauflöslicher Zusammenhang von Personalität und der Konzeption des Guten ergibt.

Taylor unterscheidet (mit zunehmender Wertigkeit) zwischen „Lebensgütern" („Life Goods"), „Hypergütern" („Hypergoods") und „konstitutiven Gütern" („Constitutive Goods"). Konstitutive Güter sind Moralquellen, d. h. „it is a something the love of which empowers us to do and be good" (Taylor, 1989, S. 93). Dabei leistet das konstitutive Gut mehr als nur die Bestimmung des Inhalts der Moraltheorie. „Love of it is what empowers us to be good. And hence also loving it is part of what it is to be a good human being.". Moraltheorie gebietet also nicht nur, in bestimmter Weise zu handeln und bestimmte moralische Eigenschaften an den Tag zu legen, sondern schreibt auch vor, zu lieben, was gut ist: „To love the constitutive good [...] is to be strongly motivated in just that way which is defined as part of doing the good [...]. That is why being good involves loving something and not just doing something" (Taylor, 1989, S. 533 f., Anm. 2).

Lebensgüter sind demgegenüber Ziele, Prinzipien und Ideale, die Menschen in ihrem Leben zu verwirklichen suchen, während Hypergüter Leitwerte darstellen, die Kohärenz und eine einheitliche Orientierung in unser Leben zu bringen vermögen

7.5. Narrative Identität

Nach Taylor müssen wir das eigene Leben im Sinne einer narrativen Darstellung begreifen. Es genügt nicht, dass ein Individuum über eine identitätsstiftende moralische Landkarte verfügt bzw. sich im moralischen Raum orientiert. Die Ausbildung und der Erhalt personaler Identität verlangt vielmehr, dass es in der Lage ist, „sich auf dieser Landkarte zu positionieren, d. h. seinen jeweiligen aktuellen Ort im Hinblick auf die verzeichneten Güter (und Übel) zu bestimmen sowie einen Sinn für die Bewegungsrichtung des eigenen Lebens und Handelns vor dem Hintergrund dieser Güter zu entwickeln" (Rosa, 1998, S. 166). Personale Identität hat eine unhintergehbare zeitliche Struktur, der die narrative Darstellung der eigenen Lebensgeschichte am ehesten gerecht wird. Personsein erschöpft sich nicht in der Bestimmung dessen, was jemand ist, sondern umfasst auch immer, was jemand geworden ist (oder hätte werden können) bzw. was er in Zukunft werden wird. Der Mensch ist ein Geschichten erzählendes Wesen: „It has often been remarked that making sense of one's life as a story is also, like orientation to the good, not an optional extra; that our lives exist also in this space of questions, which only a coherent narrative can answer. In order to have a sense of who we are, we have to have a notion of how we have become, and of where we are going" (Taylor, 1989, S. 47).

Kritisch anzumerken bleibt, dass Narrationen ebenfalls ein intaktes (autobiographisches) Gedächtnis voraussetzen und sich damit letztendlich als eine Variante des Erinnerungskriteriums entpuppen. Sie können somit kaum die Identität der Person garantieren, sondern haben diese vielmehr zur Voraussetzung. Taylors großes Verdienst besteht jedoch darin, auf die soziale Dimension personaler Identität hingewiesen zu haben. Sein Ansatz müsste durch Überlegungen des Sozialkonstruktivismus ergänzt werden (z.B. Smith, 2010; Bakhurst, 2011), was jedoch den Rahmen dieser Arbeit sprengen würde.

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Abstracts of the 20th German EEG/EP Mapping Meeting, Giessen, October 14-16, 2011

The influence of expertise on neural processes when anticipating action effects in tennis N. Balser (1), S. Pilgramm (1,2), M. Bischoff (1,2), B. Lorey (1,2), K. Zentgraf (3), R. Stark, A (2). M. Williams (4) & J. Munzert (1) *(1) Institut für Sportwissenschaft, Justus-Liebig-Universität Gießen, D-35394 Gießen, Germany; (2) Bender Institute of Neuroimaging, Justus-Liebig-Universität Gießen, D-35394 Gießen, Germany; (3) Institut für Sportwissenschaft, Universität Bern, CH-3012 Bern, Switzerland; (4) Faculty of Health Sciences, University of Sydney, AUS-NSW 2141 Sydney, Australia*

It has recently been proposed that the action observation network (AON) (Zentgraf et al., 2011) plays an important role in the anticipation of action effects. The cerebellum could be particularly crucial for predicting action consequences because of its role in the control of executed movements (Miall, 2003) and its inclusion in the AON (Cross et al., 2009). To investigate whether expertise in sport influences the activation of this network during an anticipation task, 16 expert tennis players and 16 novices observed videos of tennis strokes. While lying in an fMRI scanner, participants observed videos showing an opponent's forehand strokes that were occluded at the moment of ball-racket contact. The participants' task was to anticipate the direction of the observed strokes without having any information about the ball flight. This anticipation task was contrasted with observing a player bouncing a ball with no need to anticipate. Results showed a significantly better anticipation performance in expert tennis players compared to novices, $t(30) = 4.19$, $p < .001$. The functional imaging data showed enhanced activation in the main areas of the AON when contrasting the anticipation and nonanticipation tasks. More precisely, the premotor cortex, the inferior frontal gyrus, and the superior parietal lobe showed greater activation when anticipation of stroke direction was contrasted with mere observation. Compared with novices, experts showed greater activation in the cerebellum during the anticipation condition. An additional covariate tennis experiencerevealed that the cerebellar activation in the experts was higher for players who had longer tennis experience. Our findings support the theory that the AON is used to anticipate the effects of observed actions (Zentgraf et al., 2011). The stronger activation in the cerebellum suggests that experts rely on internal models when predicting the consequences of an action.

Inhibitory control assessed through simultaneous EEG-fMRI imaging: a pilot study Sarah Baumeister (1), Sarah Hohmann (1), Isabella Wolf (1), Michael Plichta (2), Stefanie Rechtsteiner (1), Maria Zangl (5), Matthias Ruf (3), Christine Niemeyer (4), Peter Kirsch (4), Herta Flor (5), Andreas Meyer-Lindenberg (2), Martin Holtmann (1,6), Vasil Kolev (1,7), Juliana Yordanova (1,7), Tobias Banaschewski (1), Daniel Brandeis (1,8) *(1) Department of Child and Adolescent Psychiatry and Psychotherapy, CIMH Mannheim; (2) Department of Psychiatry and Psychotherapy, CIMH Mannheim; (3) Department Neuroimaging,* *CIMH Mannheim; (4) Department of Clinical Psychology, CIMH Mannheim; (5) Department of Cognitive and Clinical Neuroscience, CIMH Mannheim; (6) Child and Adolescent Psychiatry, Ruhr-University Bochum, Germany; (7) Institute of Neurobiology, Bulgarian Academy of Sciences, Sofia, Bulgaria; (8) Department of Child and Adolescent Psychiatry, University of Zürich*

Inhibitory control shows individual and genetic variation and is impaired in Attention Deficit Hyperactivity Disorder (ADHD). Neurofeedback is an emerging nonpharmacological treatment for ADHD (Holtmann et al., 2009), but how changes in the inhibitory pathway contribute to the treatment outcome is still unclear. Advanced imaging with combined EEG (electroencephalography) and fMRI (functional magnetic resonance imaging) should optimally characterize individual variation and treatment-induced changes of inhibitory control.

In this pilot study we explored the feasibility of simultaneous recording of 64 channel EEG and 3T (Siemens TIM Trio) fMRI to probe conflict processing and inhibitory control using a Flanker/NoGo task (Meyer-Lindenberg et al., 2006). The task requires a left or right button press, corresponding to the central arrow, when flankers are either other arrows or boxes. The button press has to be inhibited when flankers are „XX".

The fMRI analysis (N=23) revealed robust NoGo vs. Neutral effects, with increased activation to NoGo stimuli in an inhibitory network involving bilateral insula and the ACC ($p<.05$, FWE corrected). After gradient, ballistocardiogram and ICA corrections, the corresponding EEG analysis (N=17) revealed a significant ($p<.01$ at Cz, compared to neutral flankers) NoGo positivity lasting from about 460 to 660ms. Furthermore, we found a significantly ($p<.05$ at Cz) enhanced N2 in the NoGo compared to the Neutral condition.

Simultaneous EEG-fMRI during a Flanker/NoGo task showed landmark effects of inhibitory control in both imaging modalities with a simple 7 min paradigm suitable for adults as well as ADHD children. In an ongoing study we now examine whether inhibitory control is impaired in ADHD compared to control groups, and improves after neurofeedback training.

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Manipulierte audiovisuelle Pointlight Displays beeinflussen die Nutzung interner Modelle zur Prädiktion M. Bischoff (1,2), B. Lorey (1,2), S. Pilgramm (1,2), K. Zentgraf (3,2), R. Stark (2), D. Vaitl (2) & J. Munzert (1,2) *(1) Institut für Sportwissenschaft, Justus-Liebig-Universität Giessen, D-35394, Deutschland; (2) Bender Institute of Neuroimaging, Justus-Liebig-Universität Giessen, D-35394, Deutschland; (3) Institut für Sportwissenschaft, Universität Bern, CH-3012, Schweiz* Um Handlungen und Handlungseffekte zu verstehen, werden im Hirn des Beobachters interne Modelle der Bewegung mit der wahrgenommenen Bewegung verglichen. Solche Handlungsrepräsentationen liegen in verschiedenen Sinnesmodalitäten vor, die Verarbeitung interner Modelle sollte also durch Manipulation multisensorischer Wahrnehmung beeinflussbar sein. Wird bei der visuellen Handlungswahrnehmung zusätzliche auditive Information verwendet und wie wirkt sich widersprüchliche auditive Information aus?

Ein Tischtennis-Spieler, der seinen Gegenspieler während dessen Schlagausführung beobachtet, nutzt auch den Zeitpunkt des Schläger-Ball-Kontakts zur Einschätzung des Schlages. Wird die visuelle Bewegungsinformation reduziert in Form von Pointlight Displays (PLD) und werden Ball sowie Schläger dabei ausgeblendet, dann zeigt der Ton den Schläger-Ball-Kontakt an und vervollständigt im Vergleich zu einer äquivalenten aber tonlosen Bewegung das interne Modell.

Sechsundzwanzig Beobachter wurden mit funktioneller MRT untersucht, während sie PLDs eines gegnerischen Tischtennis-Spielers bezüglich der Richtung des resultierenden Ballflugs einschätzten (die Alternative war „Cross oder Longline“). In den Videos waren nur die Marker für beide Schultern, den rechten Ellenbogen und das rechte Handgelenk des Spielers zu sehen, sowie zwei statische Markierungen der gegenüberliegenden Plattenkante. Der Schläger-Ball-Kontakt konnte allein durch ein entsprechendes Tonsignal markiert werden. Dieser Ton wurde entweder gar nicht präsentiert, zum Bewegungsbeginn – also offensichtlich zu früh, 120ms vor dem eigentlichen Zeitpunkt – unmerklich zu früh – oder zum Zeitpunkt des Schläger-Ball-Kontakts.

Die Probanden zeigten eine erhöhte Performanz, wenn der Ton zeitlich kongruent gesetzt war. Region-of-Interest Analysen der fMRT-Daten ergaben als sensitiv für die Kongruenz multisensorische Integrationsareale im temporo-okzipitalen Gyrus temporalis medius und im anterioren intraparietalen Sulcus. Die Rekrutierung interner Modelle im ventralen prämotorischen Kortex und Gyrus frontalis inferior (BA44) zeigte bei kongruenter audiovisueller Stimulation höhere Aktivierung als bei der unmerklich inkongruenten. Interne Modelle sind also multisensorisch repräsentiert und als funktionelle Grundlage der Prädiktion zugänglich für multisensorische Kongruenzeffekte.

Functional and clinical abnormalities in patientes with panic disorder and their treatment options S. Deppermann (1), S. Sickinger (1), N. Vennewald (2), A.J. Fallgatter (1), P. Zwanzger (2) & A.-C. Ehlis (1) *(1) MÃ¼nster, (2) TÃ¼bingen*

Repetitive transcranial magnetic stimulation (rTMS) has already been suggested as an alternative treatment method in a variety of psychological disorders such as major depression. Another frequent disabling disease is panic disorder (PD). PD is characterized by the sudden onset of unexpected panic attacks often resulting in the avoidance of a multitude of situations (agoraphobia). The neurobiological correlate of these symptoms is believed to be a dysfunction of the fear network including hyperactivity of the amygdala and decreased activity of the prefrontal cortex. Accordingly, a model of inadequate top-down governance in anxiety disorders has been established. Whereas functional magnetic resonance imaging (fMRI) data could show that cognitive behavioral therapy (CBT) is capable of normalizing both exaggerated amygdala activity and prefrontal hypofunction, the effects of rTMS as an additional therapeutic tool have not been investigated much so far. Even though CBT is an effective treatment method it has the disadvantage of a delayed onset of its effect and is not always sufficient so that additional psychopharmacological medication might be needed. Therefore the aim of this study was to investigate the application of sham controlled prefrontal rTMS during CBT in order to enhance the impact of the therapy. To quantify and hence being able to evaluate the effects of rTMS in terms of helping to normalize the prefrontal hypoactivity the neuroimaging method functional near infrared spectroscopy (fNIRS) was chosen. One major advantage of this method over fMRI is its compliance with especially PD patients. During the NIRS recording patients performed an emotional (emotional stroop/Westphal paradigm) as well as a cognitive task (verbal fluency). The results are not only groundbreaking regarding the future of the treatment of PD but also demonstrate the benefits of fNIRS as an imaging method to assess higher cortical structures when other methods such as fMRI are less convenient.

Frontal Midline Theta in Simple Reaction Time Tasks: Comparing Predictable and Unpredictable Stimulus Onset M. Doppelmayr & E. Weber *FB Psychologie, Universität Salzburg, Hellbrunnerstr 34, 5020 Salzburg, Österreich*

In several types of sport, fast reaction times are of upmost importance. To gain a better understanding of the cognitive processes that occur in the prestimulusinterval of reactions (as for example the start of a 100m sprint), we investigated changes of the EEG frontal midline theta (Fmθ), which is known to be related to working memory, action regulation, and sustained attention.

EEG and simple reaction times of 18 voluntary participants have been recorded during three different RT- tasks. In all tasks participants were instructed to react (push a button) as fast as possible whenever a circle was presented on a monitor. The interstimulusinterval (ISI) of the presentation has been set either to 3 seconds, to 6 seconds or varying between 3 and 6 seconds (in 125 msec steps).

As expected the results indicated the fastest RT for the 3 sec ISI presentation, followed by the 6 sec ISI. The varying ISI yielded the slowest RT. EEG data indicated significant differences in the timecourse of Fmθ activity at frontocentral and central locations. While for the 6 second ISI as well as for the varying ISI Fmθremained on a relatively stable level during the last second preceding the task, in the 3 sec ISI condition a specific preparation patternëmerged. In this task Fmθ increased significantly from a very low level to a level exceeding the Fmθ activity of the other task conditions. Taken together these data indicate that the predictability of a stimulus leads to varying preparatory attentional processes that can be detected by Fmθ.

The neuronal basis of the development of humans into speaking and cultural beings Duncker, H.-R. *Institut für Anatomie und Zellbiologie der Universität Gießen* During the phylogenetic development of humankind, both the structures and functions of the human body were subjected to evolutionarily-driven biological modifications. The body has enlarged, has developed new proportions with respect to its extremities, and has dramatically increased functional capabilities. Each successive Homo species exhibits an enlarged cerebrum, which has developed as a consequence of new tertiary association areas, which make up 50

By migration out of the tropical rain forest, their ancestral living area, into the enlarging East African savannahs, developing humans could no longer make use of their inherited feeding manners and behaviour. As such, they were forced to invent all necessary activities for their nourishment and defence, including their social communication in the extended savannahs. The inventions of single individuals were adopted by most members of the community, including the successful handing down of these new abilities to descendants. Through these developments, social communities drove the formation of cultural communities, with common use of, and communication about, these abilities and activities, which are collected into, and thereby enlarged, their historical development.

All these new capabilities and communication abilities could not be integrated into the genetic codes of the developing humans, but could be stored as memory in the newly-developed tertiary association areas of the cerebrum. For handing down of these capabilities to descendants, developing humans depended on the imitation of these activities and actions, by observing the activities of their parents and other community members. These imitations, which are used occasionally by higher apes, were intensively used by developing humans to hand down abilities to descendants. However, the results of the first imitations by minors had to be intensively socially controlled by parents and other community members, and the developing minors had to repeat and rehearse the imitated actions until they mastered the necessary level of precision. These activities were then neuronally fixed for automatic future application. Apart from these activities, a gesticulatory communication developed, perhaps out of gestural pointing at or towards important objects or events. The gesticulatory communication incorporated primarily the language characteristic of including the functional meaning of these objects or events for the communicating humans, which are represented together with the objects or events in the cerebral memory of the persons.

This gesticulatory communication has developed – very slowly and in a stepwise fashion – in combination with linguistic sounds. Only with the appearance of modern humans, with their ability to produce all vowels, has a full capacity for spoken communication developed. By the long phylogeny of mammals in the subterranean or nocturnal habitat, their auditory systems became the most important sensory system for social and emotional interaction. In the language communication of modern humans, a direct coupling of the brains of interlocutors occurs: The speaker's production of cortical excitations for pronouncing words and sentences induces in the brain of the listener comparable excitations, together with specific associations. These capabilities of acoustic communication depend not only on the mutual understanding of interlocutors, but also one the handing down of complex thoughts to all of the members of the community, and to their minors. All cultural developments of modern humans depend on these abilities, in particular, the development the diversity of different occupations, as well as thinking in highly developed cultural communities.

Recording of laser evoked potentials during preferential stimulation of mechano-insensitive nociceptors unmasked by peripheral nerve block M. Dusch (1*), J. van der Ham (1*), B. Weinkauf (1), J. Benrath (1), M. Schmelz (1), R. Rukwied (1), M. Ringkamp (2), R-D. Treede (3), U. Baumgärtner (3) *(1) Dept. of Anaesthesiology, Medical Faculty*

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In order to investigate preferentially mechano-insensitive (MIA) nociceptors in healthy volunteers, laser radiant heat stimuli were applied to the lateral proximal leg after peripheral nerve block of the lateral femoral cutaneous nerve (LFCN). Laser-evoked potentials (LEP) were recorded in healthy volunteers from partially anesthetized skin areas.

Nerve block of the LFCN was performed in 10 healthy male subjects with Ropivacain 1

In the area of differential sensitivity LEP responses were delayed compared to unaffected skin (225 ±10.4 ms (SEM), vs. 185 ±7.8 ms) and LEP amplitudes were reduced (13.8 ±1.3 µV vs. 25.6 ±1.6 µV). Reaction times of pain responses to the laser stimuli were increased (654 ms vs. 406 ms, p<0.01) and pain magnitude reduced (1/10 vs. 5/10 NRS; p<0.01).

The increase of LEP latency suggests that mechano-insensitive heat-sensitive $A\delta$ nociceptors (MIA type II) have a slower conduction velocity or a higher response latency as compared to mechano-sensitive $A\delta$ nociceptors (type II MSA). Alternatively, recruitment of widely branched slowly conducting and mechano-insensitive branches of $A\delta$ nociceptors can explain our finding. We conclude that recording of LEP during laser stimulation of areas with differentially anesthetized skin is useful to study a mechanically-insensitive, heat-sensitive subpopulation of $A\delta$ nociceptors.

Alternative approaches in estimating regional individuality indices and reliability in complex cognition: FMRI and ERP-data

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Individual differences, but also the reliability of psychophysiological measurements are important upcoming topics in the neurosciences. Usually, experimental approaches are directed to reduce information to describe neural correlates of complex mental processes in a more comprehensible and putatively sufficient way. However, individual aspects potentially due to individual learning history and mental strategy run the risk of being inappropriately neglected. Furthermore, retest-reliability in individual physiological parameters has not been examined in both experimental intra- and inter-session arrangements. The present approach utilizes the STROOP-paradigm as one of the most consistent and reliable experimental procedures in psychological sciences. Based on previously published data, there was an adapted form of the STROOP-task applied in an EEG- and fMRI-study to estimate individual intra- and inter-session reliability of behavioural and physiological data. Behavioural data showed the expected interference effect for incongruent as compared to congruent and baseline conditions reflected in longer response times for the incongruent condition. Different individuality indices on the basis of Cartesian analytical geometric will be introduced and applied on functional neuroimaging data. Reliability- and individuality-estimations of ERP- and fMRI-data will be compared, illustrated, and critically discussed.

Topographic correlates of semantic priming differentiate Alzheimer's and semantic dementia M. Grieder (1), R.M. Crinelli (2), T.

Dierks (1), L.-O. Wahlund (2), T. Koenig (1), M. Wirth (3) *(1) Dept. of Psychiatric Neurophysiology, University Hospital of Psychiatry, University of Bern, Switzerland; (2) Karolinska Institute, Dept. NVS, Division of Clinical Geriatrics, Stockholm, Sweden; (3) Jagustlab, Helen Willis Neuroscience Institute, University of California Berkeley, Berkeley, CA, USA*

With the progressing course of Alzheimer's disease (AD), deficits in declarative memory increasingly restrict the patients' daily activities. Besides episodic memory impairments, semantic memory is affected by this dementia subtype. In contrast, patients suffering from semantic dementia (SD) show isolated semantic memory impairments. With the aim to establish sensitive biological markers for the differentiation of symptom dimensions in dementia subtypes, the present study compared AD and SD patients with healthy controls. In particular, the automatic and controlled semantic word processing was investigated by combining the recording of event related potentials (ERP) with the performance of a semantic priming (SP) task. Concretely, the task required word/non-word (prime and target) lexical decisions on sequentially presented word pairs, consisting of semantically related or unrelated prime-target combinations. Besides the analysis of the target onset reaction times (RT), early automatic and later controlled ERP components were investigated. Both patient groups showed general slowed RTs for all task conditions (related and unrelated word pairs), whereby the SD performed considerable slower than the AD. However, the size of the SP effect was comparable in all participant groups. The ERP results indicate that early automatic components are only slightly altered in AD and SD patients whereas the late controlled components are affected most dominantly in the SD group. Taken together, these results could reflect that the semantic database itself is likely to remain preserved in AD and to a less extent also in SD patients, who suffer from deteriorated retrieval of semantic representations. Taken together, the automatic spread of activation in the semantic network appeared to be preserved in both patient groups, while the late ERP components gave a clear indication of neurophysiological alterations in AD and SD. Together with subsequent studies, these novel findings might improve a profound understanding of the dementia subtypes and their early detection.

EEG recorded during gross-motor behavior and sleep Hoedlmoser, K. (1), Birklbauer, J. (2), Rigler, S. (1), Mueller, E. (2), & Schabus, M. (1) *(1) Laboratory for Sleep and Consciousness Research, Department of Psychology, University of Salzburg, Austria; (2) Department of Sport Science and Kinesiology, University of Salzburg, Austria*

There is now compelling evidence that sleep contributes to the consolidation of procedural types of memory and to motor learning in particular. Concerning offline processing of fine-motor skills during sleep there is already profound knowledge. However, data on gross-motor tasks are still missing. Therefore, the aim of our study was to investigate sleep effects on performance in a real-life gross-motor task: riding an inverse steering bicycle. We tested 20 healthy male subjects (20 - 29 yrs; M=24.3, SD=2.03) by a between-subject design. Each subject either participated in a 2hr midday nap or a restful wake condition. In both conditions participants were previously trained on the gross-motor learning task and tested for performance pre- and post-sleeping/resting. Gross-motor performance was decreased after nap but not after resting wakefulness. Fast sleep spindle density (13-15Hz) was negatively related to the change of performance over nap, whereas slow sleep spindle density (11-13Hz) was generally (baseline and experimental nap) negatively related to initial gross-motor performance. Together these findings suggest that fast sleep spindles during short midday naps interfere with gross-motor consolidation and individual's general gross motor learning ability is reflected in interindividual differences of slow sleep spindle activity. Additionally to our sleep-related hypotheses, we investigated EEG alpha activity during riding the inverse in comparison to a normal steering bicycle in a subsample of our subjects (N=5). These analyses revealed a strong task related alpha synchronization more prominent during inverse compared to normal steering bicycling. As the inverse steering bicycle provides an inversion-evoked cognitive load due to inhibition of highly automated movement patterns (riding a normal steering bicycle), the observed task related power increase in the alpha band with respect to a reference can be considered as a cortical correlate of the inhibition of already well known, automated memory traces.

Recording EEG and fMRI simultaneously during a reward anticipation task: Pilot results for a study with ADHD children Sarah Hohmann (1), Michael Plichta (2), Isabella Wolf (1,3), Stefanie Rechtsteiner (1), Sarah Baumeister (1), Maria Zangl (5), Christine Niemeyer (4), Matthias Ruf (3), Peter Kirsch (4), Herta Flor (5), Andreas Meyer-Lindenberg (2), Tobias Banaschewski (1), Martin Holtmann (1,6), Daniel Brandeis (1,7) *(1) Department of Child and Adolescent Psychiatry and Psychotherapy, Central Institute of Mental Health; (2) Department of Psychiatry and Psychotherapy, CIMH; (3) Department Neuroimaging, CIMH; (4) Department of Clinical Psychology, CIMH; (5) Department of Cognitive and Clinical Neuroscience, CIMH; (6) Department of Child and Adolescent Psychiatry – University of Bochum; (7) Department of Child and Adolescent Psychiatry - University of Zürich*

Recording EEG during an fMRI - session is increasingly used to study cognitive and motivational states in basic and clinical neuroscience. We used this combined measurement technique to learn more about the human reward system. Simultaneous recordings require modifications of the original fMRI reward task to improve signal to noise ratio for EEG. One aim of the present study was thus to find out whether the fMRI core results would prove robust in the modified paradigm, while resolving potential technical problems which may occur when combining both methods in challenging motivational paradigms. Based on previous work of Kirsch et al. (2003) we modified a reward anticipation task for the use with EEG, which is known to reliably activate ventral striatal brain structures. EEG data and fMRI images were simultaneously acquired in a 3T MRI Siemens TIM Trio scanner from 20 healthy participants (20 to 26 years) using an event related design. Money gained of the reward task was paid after the fMRI-Session.

We found a stronger BOLD signal in the ventral striatum during anticipation of reward. The robust activation of the brain reward system in our modified monetary incentive task confirms that neither simultaneous fMRI-EEG, nor the corresponding task modifications diminished sensitivity in detecting ventral striatal BOLD-responses. The analyses revealed meaningful ERPs with significant differences between both conditions (win money/no money) developing during early (<1s) as well as late (>1s) stages of reward anticipation.

Showing that simultaneous combination of both methods produced good data quality concerning electrophysiology and hemodynamic response future work will concentrate on data fusion of both techniques to fully utilize the complementary information brought by EEG to fMRI and vice versa. In future studies with ADHD-children we will apply this task to study effects of neurofeedback-training on the brain reward system regarding neurobiological and neurophysiological alterations.

Acute and chronic response of electroencephalographic activity to exercise during normoxia and normobaric hypoxia: a pilot study Hülsdünker, T. (1), Gutmann, B. (1), Mierau, A. (1), Mierau, J. (1), Hollmann, W. (2), Strüder, H.K.(1) *(1): Institute of Movement and Neurosciences, German Sport University (Cologne, Germany), (2): Institute for Cardiology and Sports Medicine, German Sport University (Cologne, Germany)*

It has been suggested, that exercise training under normobaric hypoxia may be superior to normoxic training for the performance of endurance athletes. So far, most of the previous research has focused on vascular, metabolic and muscular changes associated with exercising under hypoxia without taking into account that changes may also occur in the central nervous system. Therefore, the aim of the current study was to examine the effects of acute exercise before and after training under normoxic versus hypoxic conditions on Electroencephalography (EEG). Three endurance untrained male volunteers performed one-legged cycle training for 30 minutes, three times per week, for four weeks. One leg was trained under normoxic and the other leg under normobaric hypoxic (12.5Before training, upper alpha power increased by after normoxic but decreased by after hypoxic exercise in the parietal region. These changes were attenuated after training in normoxia but even more pronounced after training in hypoxia. Our results suggest that exercise effects on EEG are strongly influenced by hypoxia. Training-induced adaptations to normoxic versus hypoxic exercise may have opposite directions however, with the same meaning (here: increased activity in the parietal cortex).

Do lateralized readiness potentials help to elucidate extraversion-related differences in the magnitude of the psychological refractory period (PRP) effect? Rebekka Indermühle, Stefan Troche, and Thomas Rammsayer *Department of Psychology, University of Bern, Bern, Switzerland*

Psychological refractory period (PRP) refers to a major bottleneck of information processing that becomes evident when participants are required to respond to two signals (S1 and S2) presented in rapid succession. Typically, the response to S2 becomes increasingly delayed with decreasing stimulus onset asynchrony (SOA) between S1 and S2. The major goal of the present study was to answer the question of whether extraversion-related individual differences can be identified at this stage of premotor information processing. For

this purpose, 63 introverts and 63 extraverts performed a PRP task and stimulus-locked (S-LRP) and response-locked (LRP-R) lateralized readiness potential latencies were determined. To quantify the PRP effect at the behavioral level, regression analyses were performed separately for each participant with SOA as independent variable and response time to S2 as dependent variable. Thus, the resulting regression coefficient b represents an estimate of the magnitude of the individual PRP effect. While at the behavioral level, a reliably more pronounced PRP effect could be confirmed for introverts compared to extraverts, extraversion-related individual differences could be revealed neither for S-LRP nor for LRP-R latencies. Our findings suggest that experimentally induced overload of the information processing system by means of a PRP task appears to differentially affect introverts and extraverts. LRP analyses, however, did not prove to be sensitive for the identification of these behavioral differences at the electrophysiological level.
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Enhancement of delta- and theta EEG power during perception of visual ambiguous stimuli. Ksenia Khalaidovski, Christina Schmiedt-Fehr, Canan Basar-Eroglu & Birgit Mathes. *Institute of Psychology and Cognition Research, University of Bremen, Grazer Str.4, D-28359 Bremen, Germany*
Ambiguous patterns make up a well-known class of visual phenomena in which one invariant stimulus pattern is perceived in two different, mutually exclusive ways. When subjects indicate a perceptual reversal by pressing a button a reversal-related slow positive wave, which is prominent in the delta-band (0.5-3 Hz), can be detected [1]. This delta component, by its functional and topographical similarity to the P300, was interpreted as reflecting the conscious recognition of the perceptual change. However, focused attention needed during perceptual reversals should also reflect in an enhanced theta (4-7 Hz) response. This EEG study aimed to investigate the reversal-related delta and theta activity using the stroboscopic alternative motion (SAM) paradigm, a multistable stimulus that during constant viewing induces internally generated changes in the perceived direction of motion of flashed dots. Reaction times from an unambiguous control condition were used to estimate the stimulus onset after which the percept has presumably changed. Reversal-related delta as well as theta EEG power was enhanced when compared to a time period during which the percept was stable. As expected, the theta response exhibited a frontal maximum. Further, the topography of the theta response observed following exogenously triggered perceptual reversals differed from internally generated perceptual changes. These results suggest that the state of enhanced attention may be reflected by reversal-related activity in the delta and theta band. These emphasize the influence of top-down regulated processes upon multistable perception [2]. [1] C. Basar-Eroglu et al. (1993), Int J Neurosci 73, 139-51 [2] B. Mathes et al. (2006), Neurosci Lett 402, 145-49

EEG-Analysis with Matrix-Wavelets A. Klein *Physiologisches Institut, Aulweg 129, 35392 Gießen*
Scalar wavelet analysis of EEG-recordings poses a considerable problem due to the

amount of data produced. In particular, the resulting wavelet transforms are not obviously related to each other, and it would be very desirable if known or suspected relationships between channels could be modelled within the transform itself, not necessitating any additional steps. This requirement is met by the Matrix-Wavelet-Transform which operates on vector-valued instead of scalar-valued signals using matrix-valued wavelet functions, and which guarantees that any information contained in the original signal is still available for analysis in the computed transform.

The possibilities of this novel method, for example the analysis of centroids of activity, dimensionality of the signal, and time-frequency centroids, are presented and compared with results that were obtained with more traditional methods.

Neuronal correlates of focused attention in pistol shooting sports Christoph Kreinbucher, Andrea Geipel, Denise Beckmann-Waldenmayer & Jürgen Beckmann *Institute of Sport Psychology, Technische Universität München*

In shooting sports the last few seconds of the shot preparation are crucial for a successful shot outcome. It is not yet clear if certain frequencies in different regions of the brain are mandatory for achieving peak performance. Therefore, neuronal correlates of focused attention in sport pistol shooting ought to be researched further. Moreover, the investigation should reveal whether an increase in focused attention can be achieved through the implementation of sport specific attentional training and if there are also changes related to the cortical activity.

The participants included thirteen male and seven female right handed youth athletes (M = 16.79, SD = 2.68) from the German shooting federation (DSB). While the experimental group (N = 11) received attentional training based on scientifically substantiated research and augmented by hypnotherapeutic elements, participants in the control group (N = 9) engaged in progressive muscle relaxation. Both cohorts received six 90 minute training sessions. A 64-channel EEG was used before and after the trainings were conducted to evaluate the efficacy of the attention training measures. In each of them a competition was designed in which the pistol shooters were required to shoot 60 shots on a target in 90 minutes. The shot release was determined with the help of an optical sensor fixed directly on the weapon. The sensor's analyzing software enabled the differentiation between good and bad shots based on an assessment of several shooting relevant criteria during the aiming process. In addition to also assessing the participant's overall shot outcome, an assessment of the athlete's distractibility from the shooting tasks was conducted by evaluating the athlete's perception of subliminal stimuli. Self-report questionnaires were also used to evaluate the participant's level of attention.

Results from baseline measures of the brain waves revealed that an increase of theta activity in frontal areas is only present in bad shots. Thus, there is evidently an optimal level of the theta frequency range. In good shots, there is a higher alpha activity in parietal regions two seconds before shot release than in bad shots. These findings indicate an inhibition of verbal and analytical processes while trying to become highly focused before pulling the trigger. Further calculations are needed to assess the degree to which a change in brain activity occurs through the implementation of the attention training and how this correlates with behavioral states.

Change detection enhances the P3 and fronto-parietal delta response during delay-dependent working memory B. Mathes (1,2), J. Schmiedt (1), C. Schmiedt-Fehr (1,2), C. Pantelis (3) & C. Basar-Eroglu (1,2) *(1) University of Bremen, Institute of Psychology and Cognition Research, Bremen, Germany, (2) Centre for Cognitive Science, Germany (3) Melbourne Neuropsychiatry Centre, University of Melbourne, Melbourne, Australia*
Both, recognition of previously encoded stimuli and change detection enhance the P3. The current study contrasted these opposite influences on the P3 using a delayed matching-to-sample task, which included requirements of commonly used working memory as well as change detection tasks. Mean P3 amplitude and delta activity was analysed from participants who classified probe stimuli as either being identical or modified. The P3 amplitudes were larger for modified than for identical probes, with both eliciting a larger P3 than during encoding. Enhanced single-trial amplitude and trial-by-trial consistency of delta activity contributed to the larger P3 for the modified probe. Fronto-parietal phase coherence of delta activity was also more enhanced for modified than for identical probes. The results indicate that the P3 reflects an adaptable process of attentional resource allocation to optimize memory-guided decision-making.

Brain oscillatory changes after acute exercise in pre-school children during eyes-closed versus eyes-open resting conditions Mierau, A. (1), Hülsdünker, T. (1), Mierau, J. (1), Hense, A. (2), Hense, J. (2), Strüder, H.K. (1) *(1) Institute of Movement and Neurosciences, German Sport University (Cologne, Germany); (2) Children's Sport School NRW (Cologne, Germany)*

The effects of acute exercise on brain cortical activity have been reported in some previous studies however, only for adults. To the best of our knowledge, there have been no studies which investigate such effects in pre-school children although this age-group is characterized by a particularly high plasticity of the central nervous system. 8 male, pre-school children participated in the study (5.6±0.5 yrs; 122.4±4.2 cm; 22.1±2.7 kg). In a balanced cross over design participants either completed an exercise session (EXE) of 45 min or a control condition (CON) where they were allowed to paint and/or to talk to their parents. The exercise session consisted in three out of five different movement games (10 min each) that were introduced in a counterbalanced order and a soccer match (15 min) at the end of the session. Heart rate (HR) was recorded continuously before, during and after exercise as a measure of physical demand. 15-20 min before (PRE) and after (POST) one minute resting EEG recordings were completed with the eyes closed and the eyes open in a counterbalanced order between subjects. EEG data was Fourier transformed to provide estimates for absolute power in eight frequency bands (delta to gamma) based on the individual peak alpha frequency and analyzed in four regions across the scalp. Average HR during the exercise session was 150.2±15.8 beats/min. Lower-1 alpha power was reduced for CON compared to

EXE ($p<0.05$) in the eyes open condition. Furthermore, beta1 and beta2 power were significantly lower in the frontal cortex for EXE compared to CON ($p<0.001$). The results of the present study show that acute exercise can induce significant changes in brain cortical activity of 5-year old children. These changes are characterized by decreased frontal activity accompanied by a reduction of global cortical arousal however, only when visual input is present.

Statistical methods for the identification of significant directed interactions between EEG signals T. Milde, K. Schwab, L. Leistritz & H. Witte *Institut für Medizinische Statistik, Informatik und Dokumentation*

The Granger Causality Index (GCI) and Partial Directed Coherence (PDC) are two of the most common methods for the identification of directed interactions between EEG signals. To identify statistically significant interactions it is necessary to know the probability distributions of these interaction measures under the null-hypothesis of absent interactions. As desired distributions are mostly unknown nonparametric statistical methodologies must be used to identify significant interactions. Fundamentals of GCI- and PDC-analysis are presented using multivariate AR-models. Statistical analysis of resulting values via bootstrapping in the multi-trial case and via surrogate data is presented. The focus is on the comparison between different groups and tasks. It can be shown that topographic representations of significant directed interactions allow conclusions on interacting brain regions. Benefits of these techniques are demonstrated for applications in pain research and in clinical child psychology.

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Bimodal processing of audio-visual stimuli during face-to-face communication Horst M. Müller, Verena Winter, Hendrik Wesselmeier *SFB 673 „Alignment in Communication“ and EC 277 „Cognitive Interaction Technology“ (CITEC), University of Bielefeld, 33501 Bielefeld, Germany*

While speaking in a face-to-face dialogue, lip reading supports the language comprehension process substantially. Besides this bimodal binding process during natural language comprehension, perception of voice and lip movement of the interlocutor is not synchronic. In a conversation, for instance standing two metres apart from each other, an approx. 6 ms delay of the voice exists. Due to this fact, auditory sensation after visual sensation is a common circumstance, but auditory sensation before visual sensation should be unusual to us. However, in comparison to hearing only, an audio-visual signal should have the most ecological validity. In this study, we investigated 1) how varying the temporal synchrony of the auditory signal to the visual signal evokes different ERP wave forms and 2) how bimodal audio-visual processing will influence the amplitude of the N1/P2 component. Therefore, 25 subjects perceived audio-visual sequences of up to four seconds in length. The auditory signal laged for 0 ms, 40 ms, 80 ms, 200 ms, 360 ms and preceded 40 ms, 80 ms, 120 ms and 280 ms in relation to the visual signal while recording the EEG. In addition, the bimodal effects were measured against a physical deviance of the stimuli as an additional control condition. In a behavioral task the naturalness of the stimuli was rated by a questionnaire and compared to ERPs. The auditory after visual sensation caused flattened N1/P2 amplitudes while the odd situation with auditory before visual sensation caused N1/P2 amplitudes similar to natural synchronic stimuli. The results correlate with the findings from the behavioral experiment where subjects had to judge when an audio-visually presented stimulus was out of sync. These findings were discussed in the framework of the lip-moving requirements of speaking humanoid robots, which could increase the robustness of the machine to human communication.

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The Applicability of the Somatotopic Principle to Action Execution, Imagery, and Observation T. Naumann (1), B. Lorey (1,2), S. Pilgramm (1,2), C. Petermann (4), M. Bischoff (1,2), K. Zentgraf (3,2), R. Stark (2), D. Vaitl (2) & J. Munzert (1) *(1) Institute for Sports Science, Justus Liebig University Giessen, D-35394, Germany; (2) Bender Institute of Neuroimaging, Justus Liebig University Giessen, D-35394, Germany; (3) Institute for Sports Science, University of Bern, CH-3012, Switzerland; (4) Department of Sports Medicine, Justus Liebig University Giessen, D-35394, Germany*

Jeannerod's (2001) mental simulation theory hypothesizes overlapping cerebral activation during the imagery, observation, and execution of human movements. Several fMRI studies have shown somatotopic activation patterns for the imagery (Ehrsson et al., 2003) and observation (Wheaton et al., 2004) of movements with different effectors that are roughly similar to the patterns found for their execution. Against this background, the goal of the first study was to compare the degree of overlap between both simulation states and execution in one design. During fMRI measurement, participants had to imagine, observe, and execute alternate, unilateral extension/flexion movements with the right hand, right foot, or both effectors simultaneously. The fMRI results showed similarities between execution and imagery in both the activation pattern and the dissociation of effectors in the contralateral motor cortex (M1, PMC & SMA). Although these areas were activated significantly during observation, this condition showed more of an overlap of both effectors. A somatotopic dissociation was found only in the right (ipsilateral) hemisphere (BA44). To investigate the relevance of somatotopy and movement characteristics for the degree of overlap, the second study extended the design to include two additional movements. This time, participants had to imagine or observe three different unilateral movements executed with either the right hand or the right foot. The first movement was the rhythmic extension/flexion movement already described, the second was an accuracy-demanding pointing task, and in the third task, subjects had to generate static force by pushing a bellows. Results showed distinct activation sites in the contralateral motor cortex for different movements during action observation. No clear somatotopic organization could be found for either hand or foot movements. It is concluded that there might be a task-specific form of organization in action observation (Graziano, 2006), whereas an effector-specific dissociation of different types of movements is found for imagery.

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Mismatch Negativity in Patients with Major Depression Christine Norra (1), Sebastian Waniek (2) *(1) Dept. of Psychiatry, Psychotherapy, Preventive Medicine, Ruhr University Bochum, (2) Dept. of Psychiatry and Psychotherapy, University Hospital Münster, Germany*

Mismatch negativity (MMN) is an auditory evoked potential that has consistently detected neural pre-attentive information processing deficits of rare unexpected deviants mainly in schizophrenia. Neurochemically the glutamatergic neurotransmitter system has been identified as crucial for the origin of deficits in MMN. There is also some evidence for monoaminergic modulation of MMN. Still, with regard to patients with depressive disorders there are only a few small and rather heterogeneous studies of MMN, so far. The aim of the study was first a comparison of MMN between patients with major depression and a healthy control group, and second, a longitudinal examination of differential monoaminergic medication effects on MMN.

Auditory MMN was recorded using multichannel EEG in 17 unmedicated inpatients with an acute depressive episode and age-matched healthy controls. Patients received a follow-up MMN after four weeks of randomized antidepressant treatment with selective serotonergic or noradrenergic re-uptake inhibitors. In parallel, depressed symptoms were documented on a weekly basis.

MMN amplitudes of scalp derived potentials were impaired, with different alterations in the latencies pointing to deficits of MMN generation in depressed patients as opposed to healthy controls. Brain source analysis significantly located the largest MMN impairment in patients left frontally with increased latency. However, despite full psychopathological response patients showed no significant change of MMN after antidepressive pharmacotherapy, irrespective of the selective nature of the monoaminergic drug.

Our findings point to deficits of the auditory information processing in MMN in patients with depressive disorder, too. However, the absence of any normalization of the MMN in the post-acute phase regardless of the pharmacological profile of monoaminergic antidepressants might rather refer to the trait character of underlying pathophysiological mechanisms in depression. Further longitudinal studies are warranted to investigate the potential serotonergic modulation of MMN and its clinical impact.

Personal Identity from the Viewpoint of Neuroscience and (Analytical) Philosophy M. Ruchsow *Christophsbad, Faurndauer Str. 6-28, 73035 Göppingen*

During the last years the controversy about diachronic personal identity was dominated by naturalistic approaches, proposing a (modified) memory criterion (e.g. Locke), a physical criterion of bodily continuity (e.g. Williams, Nagel), or a combination of both (e.g. Brand, Northoff). Contrary to this, Wittgenstein's non-naturalistic approach shows that the meaning of a word is its use in language (Philosophical Investigations [PI] § 43). With reference to (diachronic) personal identity Wittgenstein succinctly remarks that „there is a great variety of criteria for personal 'identity'" (PI 404) which can be characterized by family resemblance (PI 66). A detailed elaboration of Wittgenstein's basic idea can be found in the work of the Canadian philosopher Charles Taylor who advocates that personal identity nowadays is influenced by three traditions: 1.) a disengaged atomistic individualism originating mainly from the philosophy of Enlightenment, 2.) a romantic expressivism as alternative to Enlightenment philosophy, and 3.) a traditional theistic position. Taylor refuses disengaged atomism. In his view persons obtain identity by identification with their social institutions / social roles, which alludes to Hegel's concept of ethical life (Sittlichkeit) and I. Berlin's concept of positive freedom. The present paper argues for a view of personality in the tradition of hermeneutics and (post)analytical philosophy and refuses naturalistic and neuroscientific solutions to the problem of diachronic personal identity.

Wavelets - what works and what doesn't? T. Sauer *Lehrstuhl für Numerische Mathematik, Heinrich-Buff-Ring 44, 35392 Gießen, Germany*

Wavelets are an extremely powerful tool to process phenomena that are local in time and frequency. Such effects appear frequently especially in the context of EEG signals. Due to this reason, wavelet methods, discrete ones as well as continuous ones, can be found in more and more toolboxes for biosignal processing. In practice, however, it happens quite often that a transform is applied to a class of signals for which it is neither intended nor suitable. This can lead to very strange results and the reasons for that are of principal nature, not even due to incorrect or poor implementations. In this talk I will mention and explain some of these phenomena (which, by the way, can even appear in a similar way for the Fourier transform); since they cannot be avoided in general, it is a good idea to be at least aware of their existence.

Cortical current density oscillations in the motor cortex are correlated with muscular activity during (sub-)maximal bike exercise Stefan Schneider (1), David Rouffet (2), Francois Billaut (2), Heiko K. Strüder (1) *(1) German Sport University Cologne, Institute of Movement and Neurosciences, Germany; (2) Victoria University Melbourne, School of Sport and Exercise Science, Australia*

Despite modern imaging techniques, assessing and localizing changes in brain activity during whole body moderate and intensive exercise is still challenging and has not been shown so far. Using an active EEG system in combinations with source localization algorithms, in this study we aimed to asses, display and localize changes in brain cortical activity at different intensities of bike exercise. Two experienced bikers (one male / one female) served as subjects in this study. EEG activity was recorded on 32 sites across the motor cortex (m1). Simultaneously muscle activity was recorded using EMG. Muscular as well as brain activity were time locked to the pedaling cycle. Averaging 100 cycles at different Watt loads up tp 7W/kg body weight, revealed a high correlation between oscillations in muscular activity and cortical current density (CCD) in the lower limbs motor cortex area (MNI 0/-40/60). Results demonstrate that it is possible to assess and localize brain cortical activity even during maximal exercise intensity using highly sophisticated but also easy to use and simple techniques like EEG in combination with source localization algorithms. Furthermore results confirmed the assumption that increasing exercise intensity is accompanied by an increase in cortical current density in M1, whereas activity patterns remain comparatively stable across different exercise intensities.

Multimodal imaging of complex language processing - A combined NIRS-EEG study

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Modern neuroimaging methods allow for a distinct visualization of the localization, function and intercommunication of the language network. The deliberate, combined application of different imaging methods, in particular, can benefit a holistic investigation of dynamic processes, on the one hand, and brain regions and networks, on the other, that are crucially involved in language processing. The present study focuses on simultaneous recordings of electroencephalography (EEG) and near-infrared spectroscopy (NIRS) to investigate both temporal as well as topographical aspects of brain activation patterns associated with the processing of complex language, such as metaphorical speech or coherent discourse. A group of 20 right-handed, healthy subjects performed two subsequent tasks while EEG and NIRS data were recorded simultaneously: First, participants had to judge the meaningfulness of metaphoric, literal or nonsense phrases. In the second paradigm short stories were presented in form of sentences with either definite articles (leading to more coherent discourse) or indefinite articles (leading to less coherent discourse) as well as a sequence of meaningless letter combinations as a control condition. Neurophysiological data revealed condition related differences in brain activation patterns for both tasks. More precisely, a combined consideration of electrophysiological and vascular data gave insight to the complex neurocognitive processes underlying pragmatic language comprehension. Our results demonstrate the utility of combined EEG and NIRS measurements to investigate neural substrates of higher-level cognitive processes such as figural language processing and discourse comprehension.

Are effects of sleep deprivation treatment in patients with major depression predictable by event-correlated potentials?

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As opposed to psychopharmacotherapy the antidepressive effect of sleep deprivation is immediate and clinically striking. However, the search for neurobiological predictors like aminergic-cholinergic dysbalance of REM sleep, alterations of circadian rhythms, effects of vigilance or microsleep has not yet been successfully terminated. The loudness dependence of auditory evoked potentials (LDAEP) has been found a potentially valid psychobiological marker for the serotonergic system. Therefore, the influence of sleep deprivation treatment on LDAEP in depressive patients was examined in a controlled study.

In 27 inpatients with a moderate to severe episode of major depression taking their individual antidepressive medication a multichannel-EEG was recorded on two consecutive mornings. Auditory evoked potentials with different intensities (60-100 dB) were recorded, and LDAEP of N1 and P2 amplitudes was determined. 14 patients took part in supervised sleep deprivation while 13 patients served as controls by sleeping as usual. In addition, mood (BDI, HAM-D) and sleepiness (SSS) was psychometrically assessed.

Self- and investigator-rated assessments showed significant improvement of depressive mood in depressive patients after SD compared to controls. AEP amplitudes and latencies were not different between the groups, and LDAEP remained intra-individually stable. Still, there was a clear tendency (p<0.069) of a stronger LDAEP at baseline in responders to SD compared to non-responders.

Altogether this pilot study showed effects of sleep deprivation in AEP analyses of subgroups with stronger LDAEP, i.e., lower serotonergic activity, in depressive patients who were responders to SD. The results are in line with previous studies showing that a stronger LDAEP seems to be associated with a favourable treatment response to serotonergic antidepressants, e.g., SSRI. In order to find the optimum indication for SD among depressive patients further studies of LDAEP in SD are warranted in larger patient samples.

Scalp Topography Evoked by Reading Color Words W. Skrandies *Institute of Physiology, Justus Liebig University, Giessen*

Brain imaging studies show that non-compatible Stroop stimuli activate the anterior cingulum of the human brain, and commonly late ERP effects are described. In an electrophysiological study we analyzed the processing of compatible and non-compatible color words (Stroop condition) and simple color words (Color condition). Two groups of 22 healthy adults each participated in two different experiments. In the Stroop condition compatible and incompatible color words were presented on a monitor while in the Color condition simple color words appeared. EEG was recorded from 30 channels between the inion and 5In the Stroop condition effects of stimulus compatibility were seen with components between 120 und 170 ms where compatible stimuli yielded significantly larger responses. In the Color condition global field power was significantly smaller than in the Stroop condition. Components occurring at 170 and at 200 ms showed significant differences in their scalp topography. There were no topographical differences at latencies smaller than 130 ms. Our results illustrate that the compatibility of Stroop stimuli is reflected early in field strength and topography at about 120 ms latency. In addition, components occurring after 170 ms activated different neurons in Stroop and Color condition. This suggests specific top-down processing at the level of the visual cortex.

Topographical Correlates of Human Semantic Learning W. Skrandies (1) & H. Shinoda (2) *(1) Institute of Physiology, Justus Liebig University, Giessen, Germany; (2) Faculty of Psychology, Rissho University, Tokyo, Japan*

We studied human semantic learning of Kanji symbols in 18 healthy German adults. Forty Kanji characters were presented visually in random order before and after a learning session of 20 minutes duration. In the learning period subjects acquired the meaning of 20 of the stimuli while the other stimuli served as unlearned control condition. Learning performance was tested at the end of the experiment. Event-related potentials were recorded from 30 electrodes between the inion and Fz, and were averaged offline for each condition separately. All subjects learned stimulus meaning with a recall rate of more than 90Our findings show that learning of the semantic meaning of Kanji characters occurs rapidly within 20 minutes. Learning is directly related to neurophysiological changes at early processing stages. Thus learning is reflected by systematic changes in scalp topography of electrical brain activity of primary visual areas.

Phase Locking Mechanisms in the Alpha Range During Retention of a Motor or Visuospatial Working Memory Trace E. Weber (1), B. Griesmayr (1), & P. Sauseng (2) *(1) Department of Physiological Psychology, University of Salzburg, A-5020, Salzburg, Austria*

The neuronal correlates of retaining a motor memory trace are examined in 30 healthy participants. Studies using transcranial magnetic stimulation (Hummel et al, 2002, Sauseng et al., 2009) showed decreased cortical excitability while alpha amplitude was high. Thus, alpha activity is assumed to be important for response inhibition. Concerning interregional connectivity, Serrien et al. (2005) found increased connectivity between the sensorimotor cortex and prefrontal cortex shortly after presentation of NoGo stimuli. In the presented experiment, a finger sequence had to be encoded and reproduced after a retention interval of three seconds. In a control condition, the finger sequence only had to be recognized (but not reproduced) after the retention interval. In this study, power changes and phase coupling indices have been investigated in the alpha range (8-12 Hz) for the reproduction and recognition conditions as well as for a resting condition. No significant differences in alpha power (8-12 Hz) between the retention intervals of recognition or reproduction and a resting condition have been observed. However, in contrast to a resting condition, phase decoupling of a distributed network in the Alpha range (8-10 Hz) could be found for both conditions. Further phase coupling analysis showed significant coupling mechanisms in the upper Alpha (10-12Hz) in the reproduction condition between left dorsolateral premotor cortex, right primary motor cortex and right central and centroparietal regions in the last second of the retention period. While Alpha power did not play a major role retaining a motor memory trace, phase coupling analysis uncovered memory-relevant network couplings. This coupling mechanism may be interpreted as a motor memory trace which is relevant for the recall of the respective motor response in particular shortly before the execution of the initially inhibited motor response. Supported by the FWF Project P 22084

Reliability of ERP-data in the STROOP interference task Juliana Wiechert *Department of Neuropsychology and Behavioral Neurobiology, Universität Bremen*

The STROOP-paradigm is one of the most consistent experimental approaches in psychological sciences. However, retest-reliability in individual physiological parameters has not been examined in both experimental intra- and inter-session arrangements. Based on previously published data, an adapted form of the STROOP-task was applied in an EEG-study to estimate individual intra- and inter-session reliability of behavioural and electrophysiological data. Preliminary behavioural data showed both consistent split-half as well as re-test reliability in 15 healthy young female study participants. There was an expected interference effect in the incongruent condition reflected in longer response times compared to both congruent and baseline conditions, and a facilitation effect in the congruent condition reflected in shorter response times compared to the baseline condition. Electrophysiological data suggest larger intra- as compared to inter-session-reliability. Topographical ERP-effects appeared to be less reliable at processing relevant electrode sites across sessions as compared to electrode positions not presenting any condition differences. Behavioural data will critically be discussed in relation to the respective electrophysiological findings in an extended sample of individuals.

Model-based strategies for time-variant analysis of oscillatory EEG/MEG activity H. Witte, Th. Lehmann, M. Wacker, L. Leistritz
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It is shown that model-based analysis strategies can be beneficially used for exploring phase coupling characteristics (linear and non-linear) and cross-frequency couplings of and between EEG oscillations. As model coupled non-linear oscillators (e.g. of the Duffing type) were applied to identify the dependencies between time-variant phase-locking, n:m synchronization, and quadratic phase coupling patterns as well as their relations to so-called cross-frequency couplings (amplitude-amplitude, amplitude-frequency and frequency-frequency couplings). In a first step the parameters of the coupled differential equations (oscillators) are estimated by using the measured EEG data. In a second step the differential equations are solved which results in a corresponding modeled EEG realization. The comparative time-variant analysis between measured and simulated data reveals the effects which can be explained by the model. Such strategies were successfully applied for analysis of EEG burst patterns in sedated patients (encephalographic burst suppression pattern) and in healthy neonates (burst-interburst patterns during quiet sleep) and can be adapted on other oscillatory EEG/MEG activities.

Neural correlates of switching the attentional focus during finger movements
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For more than a decade, sports-related research has been concerned with the effects of various attentional strategies on motor performance. Thereby comparing an attentional focus on moving body parts (internal focus) with a focus directed on extracorporeal movement effects (external focus), the latter seems superior in producing a benefit in performance outcome. However, the search for differences in the underlying mechanisms of an internal and

an external attentional focus during motor execution has just started. This study investigated the effects of switching from a trained to an unfamiliar attentional focus on BOLD signal change by applying functional magnetic resonance imaging (fMRI). While performing an overlearned finger tapping sequence (80 correct sequence executions prior to scanner session), participants (M = 24.7 years; SD = 2.9; gender matched) were instructed to either attend to the keys of the response box (external focus) or to their fingers (internal focus). For the last half of all trials during scanner session, an unexpected change in attentional focus (from external to internal and vice versa) was verbally instructed. The instructed attentional switch led to increased responses in the inferior frontal gyrus and the inferior and superior parietal lobule, assumed to depict attentional reallocation. Moreover, changing from a trained external to a novel internal focus was associated with higher activation in the left primary somatosensory cortex and the right posterior cerebellum. When switching from a trained internal to an unfamiliar external focus, increased activation was found in the left premotor cortex, the left secondary somatosensory cortex, bilateral anterior and posterior cerebellum, the vermis and the basal ganglia. We suggest that the motor-related areas recruited when switching to an external focus of attention are reflecting a beneficial alteration in motor processing by enhancement of sensorimotor integration.

M. Doppelmayr – Neurobiologie der Psychotherapie (Buchbesprechung)

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In der zweiten Auflage des Buches Neurobiologie der Psychotherapie verfolgt Prof. Dr. G. Schiepek von der Paracelsus Medizinischen Universität Salzburg ein ausgesprochen schwieriges und umfangreiches Unterfangen. In diesem ca. 700 seitigen Sammelwerk werden so gut wie alle neurobiologisch orientierten Aspekte der Psychotherapie aufgegriffen und zumeist detailliert diskutiert. Knapp 100 Autorinnen und Autoren haben zu diesem Werk beigetragen, unter Ihnen Persönlichkeiten wie T. Banaschewski, N. Birbaumer, H. Flor, H. Haken, U. Halsband, T. Kircher, W. Leeb, H. Markowitsch, W. Miltner, V. Müller, W. Singer oder P. Tass, um nur einige zu nennen.

Nach einem einleitenden umfassenden Überblick werden die unterschiedlichen Betrachtungsweisen in acht Themenschwerpunkten aufgearbeitet. Die Themen erstrecken sich hierbei auf die Gebiete Messmethoden; Molekulare Neurobiologie von Gehirn, Immun- und Endokrinsystem; Das Gehirn als komplexes System; Psychische Funktionen; Neurobiologie sozialer Prozesse; Psychische Störungen; Konsequenzen für Therapien; Wissenschaftstheoretische und ethische Fragen. Diese Übersicht zeigt zugleich den umfassenden und multidisziplinären Ansatz, der keinen der in diesem Feld notwendigen oder relevanten Wissenschaftssektoren ausspart.

Für den Großteil der Leserinnen und Leser werden vermutlich diejenigen Kapitel, die einen ganz klaren Bezug zu psychischen Funktionen, sozialen Prozessen oder psychischen Störungen haben, die Wichtigsten sein. Dieser Bereich umfasst etwas mehr als die Hälfte des Buches und schließt eine Vielzahl an Themengebieten und Störungsbilder ein. Die einzelnen Kapitel präsentieren sehr pointiert den aktuellen Stand der Forschung und sind fast ausnahmslos sehr gut und verständlich geschrieben und mit entsprechenden Tabellen oder Graphiken aufbereitet. Die hohe Relevanz der neurobiologischen Grundlagen und Erklärungsmodelle für den Bereich der Psychotherapie wird hier klar demonstriert und abgebildet. In vielen der Kapitel wird auch ganz spezifisch auf die jeweils ableitbaren praktischen Konsequenzen der vorgelegten Befunde hingewiesen. Abhängig vom jeweiligen Autor werden naturgemäß die Grundlagen und Befunde in sehr unterschiedlicher Tiefe und aus unterschiedlichen Blickwinkeln präsentiert. In seiner Gesamtheit ist dieser Teil aber ausgesprochen gut elaboriert, aktuell und zumeist hervorragend aufbereitet.

Neben dem eben beschrieben Teil gibt es noch viele weitere Kapitel, die vornehmlich Methoden oder reine Grundlagen präsentieren. Wenngleich auch diese gut aufbereitet sind, aktuelle Verfahren und neue Entwicklungen aufzeigen, so erscheinen mir diese vom Umfang her etwas unpassend. Für Fachleute bieten diese kaum Neues und für Personen die sich nicht konkret damit beschäftigen erscheint es zu detailliert. Außerdem ist etwas unglücklich, wenn z.B.: im Kapitel zur Elektroenzephalographie spezielle Befunde zu Alzheimer Demenz, Depression oder Schizophrenie besprochen werden, die man in dieser Form in den spezifischen Kapiteln zu den Störungen so nicht mehr findet und somit übersieht, wenn man die Methodenkapitel nicht durcharbeitet.

Zusammenfassend lässt sich sagen, dass dieses Buch eine von erstklassigen Autoren verfasste, gut gewählte, ausgewogene und inhaltlich sehr breite Palette an Wissen bietet. Die Kapitel sind Großteils unabhängig und bauen nicht direkt aufeinander auf, was es ermöglicht beliebige Bereiche selektiv durchzuarbeiten. Die Methoden und Grundlagen nehmen aus meiner Sicht einen etwas zu breiten Raum ein, der besser für eine vertiefte Aufarbeitung klassischer Störungsbilder genutzt werden hätte könnte. So sind etwa dem klassischen Themenbereich "Depression" gerade sieben Seiten gewidmet, während Bereiche wie "Systhemtheorie und Dynamic Causal Modelling" mehr als 30 Seiten umfasst. Generell aber ist dieses Buch eine hervorragende Arbeit, die sowohl TherapeutInnen, neurobiologisch orientierten Fachkräften als auch sehr interessierte Laien faszinieren wird und mit der G. Schiepek eine hilfreiche Brücke zwischen Neurobiologie und Psychotherapie schlägt.

Neurobiologie der Psychotherapie, Günter Schiepek; 2. Auflage; Schattauer Verlag, Stuttgart (2011), ISBN 978-3-7945-2674-1, 704 Seiten, 224 Abbildungen, 32 Tabellen, EUR 119.-

Announcements — Ankündigungen

- **ISBET Meeting**

  The annual meeting of the *International Society for Brain Electromagnetic Topography (ISBET)* will take place in Bristol, Tennessee, USA, as a **Joint Meeting of ECNS - ISNIP - ISBET - EPIC** from September 12-16, 2012.

  Information and Registration at: `http://www.ecnsweb.com/2012-conference.htm`

- **21. Deutsches EEG/EP Mapping Meeting / 21th German EEG/EP Mapping Meeting**

  Conference language is German; English contributions will be accepted.

  - 12. bis 14. Oktober 2012; Schloss Rauischholzhausen
  - Schwerpunkte / Themen
    - M. Falkenstein (Dortmund) ”Altern, Kognition und Elektrophysiologie”
    - Dr. M. Plichta (Mannheim) Symposium über ”NIRS - Grundlagen und Anwendungen in der Neurophysiologie des Menschen”
  - Anmeldeschluss ist der 15. Juli 2012.
  - Information und Anmeldung unter: `http://www.med.uni-giessen.de/physio/`