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# Motivation, Affect, and Hemispheric Asymmetry: Power Versus Affiliation

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In 4 experiments, the authors examined to what extent information related to different social needs (i.e., power vs. affiliation) is associated with hemispheric laterality. Response latencies to a lateralized dot-probe task following lateralized pictures or verbal labels that were associated with positive or negative episodes related to power, affiliation, or achievement revealed clear-cut laterality effects. These effects were a function of need content rather than of valence: Power-related stimuli were associated with right visual field (left hemisphere) superiority, whereas affiliation-related stimuli were associated with left visual field (right hemisphere) superiority. Additional results demonstrated that in contrast to power, affiliation primes were associated with better discrimination between coherent word triads (e.g., *goat, pass,* and *green,* all related to *mountain*) and noncoherent triads, a remote associate task known to activate areas of the right hemisphere.

*Keywords:* need for power, need for affiliation, hemispheric lateralization, valence

The relationship between the study of cognition and motivation can be compared with the relationship between a car's technical functioning and the needs, goals, and feelings of its driver. Cognitive psychology examines the mechanisms underlying information processing, whereas motivational psychology typically explores the needs and goals for which cognitive mechanisms can be used and the feelings aroused in response to the degree of goal attainment or need fulfillment (McClelland, 1985). This division of labor between cognitive and motivational psychology tends to neglect interactions among cognitive and motivational processes. In recent years, there has been an increasing interest in cognition–motivation interactions. Whether a goal can be reached or a need can be satisfied should depend on the appropriateness of the cognitive operations used.

There is evidence that the two hemispheres of the brain are associated with different cognitive styles (Beeman & Bowden, 2000; Beeman et al., 1994; Levy & Trevarthen, 1976; Rotenberg, 2004). Thus, hypotheses concerning links between needs (e.g., the needs for power and affiliation) and cognitive styles (e.g., analytical vs. holistic styles) can be tested by examining the relationship between needs and hemispheric lateralization. The four studies reported in this article investigate hemispheric asymmetries concerning motivation.

## Motivational Lateralization Hypothesis

Specifically, we test the hypothesis that there is a basic link between affiliation or intimacy and right hemispheric processing and a link between power and left hemispheric processing. The rationale underlying this hypothesis is based on the idea that instrumental planning and linear thinking (presumably associated with the left hemisphere) may be more typical of power motivation, whereas (right hemispheric) holistic and intuitive processing may be more conducive to affiliation-related motivation involving affective sharing in close relationships.

Some functional hemispheric differences reported in the literature are in accordance with our assumption concerning lateralization of instrumental planning versus holistic processing. Although either hemisphere can be subdivided into many different functional networks (Kolb & Wishaw, 2003), a common feature of left hemispheric systems seems to be direct (monosemantic) processing combined with a linear mode of processing supporting instrumental means–end representations for planning of intended behavior (Levy & Trevarthen, 1976; Rotenberg, 2004; Tucker & Williamson, 1984), whereas right hemispheric systems have been related to a coarse and holistic mode of processing within extended parallel networks that integrate even remote semantic associations (Beeman & Bowden, 2000; Beeman et al., 1994; Rotenberg, 2004; Springer & Deutsch, 1997). For example, in the classical study by Levy and Trevarthen (1976), split-brain patients matched drawings (e.g., a cake) to objects according to their instrumental relatedness (e.g., fork and knife that can be used as instruments for eating the cake) when the stimulus was presented in the right visual field (RVF; reaching the left hemisphere [LH] first), whereas the same objects (e.g., the cake) were matched with an object according to global similarity (e.g., a round hat whose shape was similar to the cake) when the stimulus was shown in the left visual field (LVF; processed first by the right hemisphere [RH]).

We note that there may be more than one way of parsing the functions of the two hemispheres. In other previous research, hemispheric specialization has been related to approach versus avoidance motivation (Davidson, 2003; Harmon-Jones, 2003) or conceptual versus emotional processing (Gainotti, 2005). These views have yielded important insights into the emotional and motivational significance of the two hemispheres of the brain. The lateralization hypothesis tested here, however, focuses on another potential specialization of either hemisphere that may work over

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and above approach versus avoidance motivation or conceptual versus emotional processing.

The relationship between power motivation and instrumental planning is highlighted in the classical definition of Veroff (1957): "Power motivation will be considered that disposition directing behavior toward satisfactions contingent upon the control of means influencing another person(s)" (p. 1). In the same line, in Winter's (1994) scoring key, power imagery is scored in a narrative for any indication of having an impact, control, or influence. On one hand, means–end structure seems to be at the core of power concerns: The actor does something that is supposed to be a means to the end of having an impact on others. On the other hand, typical examples of affiliation imagery do not necessarily involve means–end instrumentality: "Two college friends are glad to see each other" or "a sense of common humanity has united us" (Winter, 1994, p. 12).

Consistent with the idea that means–end structure is critical for power motivation is the proposal of Keltner, Gruenfeld, and Anderson (2003) that persons with high levels of power (assumed to relate to approach behavior) tend to perceive others as a means to satisfying one's personal goals and desires, which is not the case for persons with low levels of power (assumed to relate to inhibition behavior; see "Proposition 5," Keltner et al., 2003, pp. 271–273). Alternatively, Schore (2001) summarized studies on RH involvement in empathy (which can be regarded as a correlate of the need for affiliation). According to Anderson and Keltner (2002), the main function of empathy is to strengthen social bonds. Empathy helps (a) to coordinate the actions of individuals in a rapid, automatic fashion (e.g., in mother–infant interactions); (b) to take each other's perspective, so that an individual is more likely to accurately perceive other's perceptions, intentions, and motivations, increasing the predictability of her or his behavior; and (c) to signal solidarity, providing the basis of interpersonal communication. Presumably, these three functions of empathy facilitate affiliative interactions.

Neurobiological research has shown a relationship between empathy and right hemispheric processing: Recognizing emotional expressions in other persons (assuming that we recognize another individual's state by simulating how the individual would feel when displaying a certain emotion) has been related to somatosensory regions of the RH (Adolphs, Damasio, Tranel, Cooper, & Damasio, 2000). A second example is that patients with damage to the ventromedial prefrontal cortex of the RH show deficits in affective measures of empathy and in "cognitive" measures of empathy, such as theory of mind, compared with patients with posterior lesions and healthy controls (Shamay-Tsoory, Tomer, Berger, & Aharon-Peretz, 2003). Consistent with the above research, Spinella (2002) reported a relationship between right nostril smell identification (which spreads ipsilaterally to the RH) and a self-report measure of empathy. Notably, this relationship was not found for left nostril smell identification.

## Lateralization of Attention as an Indicator of Hemispheric Lateralization

The motivational lateralization hypothesis does not exclude the possibility that a primary link between either hemisphere and a particular motive can be overridden by secondary factors acquired through context-dependent learning. From a methodological point of view, a useful assumption holds that compared with primary factors, secondary factors should intervene during later stages of processing. Accordingly, the chance to observe a basic link can be increased by tapping rather early stages of processing. For this reason, we decided to use a method capturing a rather primitive cognitive process that can be measured at very early (even preattentional) stages of processing: We used a modified version of the dot-probe task (MacLeod, Mathews, & Tata, 1986) to infer right versus left hemispheric activation from latency gains in the detection of simple dots presented in the LVF versus RVF after exposure to pictures or words related to affiliation versus power. Cognitive research on spatial attention has demonstrated that simple forms of orientation are performed at very early stages of processing (Klein, 2004; Posner, 1980; Posner & Rothbart, 1992). Moreover, neuroimaging studies have shown a clear-cut relationship between attentional orientation toward the LVF and right hemispheric activation and attentional focus on the RVF and left hemispheric activation (Hilgetag, Theoret, & Pascual-Leone, 2001; Hopfinger, Buonocore, & Mangun, 2000). For example, focusing attention on the LVF results in shorter detection latencies for elements in the LVF compared with the RVF that are accompanied by increased activation of the contralateral (i.e., the right) hemisphere. Capitalizing on this contralateral relationship between visual field and hemispheric lateralization, we expect a RVF (LH) advantage in response to power-related stimuli and a LVF (RH) advantage in response to affiliation-related stimuli.

The modified dot-probe task entails another methodological challenge. To the extent that an optimal test of the motivational lateralization hypothesis requires rather brief stimulus exposure and short response latencies, the problem arises as to how one can ensure proper arousal of motives. Specifically, one cannot take for granted that motives, with their high-level ("narrative") cognitive elaboration, are aroused by brief presentations of isolated verbal or pictorial stimuli (McClelland, Koestner, & Weinberger, 1989; Schultheiss, 2001). Our second methodological challenge, then, was to ensure the cognitive elaboration of motive-related (preconceptual) cognition despite the first methodological requirement of brief stimulus presentation. To solve this problem, we decided to have participants learn associations between narratives that elaborated the motive content with pictorial or verbal stimuli, respectively.

Our motivational lateralization hypothesis refers to the effects of power stimuli on left hemispheric processing and of affiliation stimuli on right hemispheric processing. Compared with power and affiliation, we believe that the achievement motive more heavily depends on integration of instrumental and holistic processing, which suggests less clear-cut lateralization. Because we expected no consistent lateralization to be associated with the achievement motive, achievement-related stimuli may serve as a control condition to test specific hypotheses concerning laterality of power versus affiliation motives: Using motivationally neutral stimuli would not be an ideal control because it confounds the effects of qualitative differences between affiliation and power (to be tested here) with features in which all motives differ from motivationally neutral stimuli.

## Experiment 1

### Method

#### Participants

Twenty college students (17 women and 3 men) were recruited through flyers and were given course credit or paid 7.50 Euros for their participation. Their mean age was 24 years (range = 19 to 41 years). All participants were right handed as assessed by a German adaptation of the 10-item Edinburgh Inventory of Handedness (Oldfield, 1971). Their mean laterality quotient was 82.3 (range = 46.7 to 100).

#### Materials and Procedure

We used a modified version of the dot-probe task (MacLeod et al., 1986), with pictures presented simultaneously on the left and right sides of the screen, recording choice reactions (Bradley, Mogg, Falla, & Hamilton, 1998; see also Brosch, Sander, & Scherer, 2007, for an almost identical version of the present dot-probe task) and not simple reactions. The experiment was carried out individually, and the participant was seated 65 cm away from the monitor. The participant was asked to maintain this distance throughout the experimental session (no chin rest was used). All pictures were of about the same size, 4 cm (3° 30′ of visual angle) and were shown in black within white frames 5.5 cm wide (4° 50′ of visual angle). In addition, at the beginning of each trial we presented on the computer screen three pairs of parallel brackets of decreasing size in a quick sequence (150 ms, 100 ms, and 75 ms for each pair, respectively) producing the illusion of movement, which induces the ocular reflex of looking at the center of the screen (Stelmach & Herdman, 1991). The last pair of brackets was replaced by a blue fixation stimulus, an asterisk, at the center of the screen for 500 ms. Immediately after, the screen showed for 750 ms two pictorial stimuli at the RVF and LVF, followed by the imperative stimulus, a plus sign (1 cm wide; 0° 52′ of visual angle), which appeared 4 cm (3° 30′ of visual angle) away from fixation, at the previous central location of one of the two stimuli (i.e., either the one shown in the RVF or the one shown in the LVF, in a counterbalanced design). The participant's task was to press the (left or right) assigned key as soon as the imperative stimulus was presented, which happened immediately after the two prime stimuli disappeared from the screen.

The pictures used in this and in Experiment 3 form part of the current version of the Operant Multimotive Test (OMT; Kuhl & Scheffer, 2002), described later in this section. The stimuli relevant to this research are presented in Figure 1. The pictures (and verbal labels) related to positive affect tend to spontaneously elicit positive responses in the corresponding motive (e.g., encouragement, support; free, alert; and love, tenderness), whereas those related to negative affect tend to spontaneously elicit negative responses in the corresponding motive (e.g., humiliated, punished; helpless, fearful; and alone, sad).

We paired a picture with a motive content (e.g., power) at a given location (e.g., left) with equal likelihood with a stimulus of a different content (affiliation or achievement; see Figure 1). We used all motive and location combinations, but kept the valence of the pair of pictures presented at a given trial constant (i.e., both positive or both negative). We instructed participants to pay attention to both sides of the screen because the imperative stimulus could appear on a random basis behind the picture presented to the left or right side of the screen. There were a total of 72 trials in each baseline and postmeasure phase of the experiment, resulting from the combination of 3 Need-Related Picture Pairs (affiliation vs. power, affiliation vs. achievement, or power vs. achievement) × 2 Individual Picture Positions (left or right) × 2 Affect Levels (positive or negative) × 2 Dot-Target Positions (left or right) × 3 Stimulus Repetitions.

| | Power | Achievement | Affiliation |
|---|---|---|---|
| **Positive affect** |  *Giving good advice.* A teacher gives his student some good advice. He encourages him to find his own way through life and become the person he is meant to be. |  *Merged in the challenging activity.* He is a free climber on vacation in the mountains. The only important thing is to climb. He feels awake, free, immersed in the demanding activity. |  *Sharing feelings.* They are happy to be together again. They are in love. While they look at each other, they express their tender feelings. They understand each other and enjoy their deep mutual trust. |
| **Negative affect** |  *Feeling humiliated.* The student is punished by his teacher. He listens to his reprimanding lecture. The student feels insecure and powerless because he can do nothing against the teacher's decision. |  *Helplessness.* The person sitting down was not able to solve a difficult problem. He must admit his failure. He feels helpless and afraid. |  *Feeling lonely.* His girl friend has finished the relationship. She left him because of another guy. There is no sense in trying to make her come back. He feels very lonely, lost, weak, and abandoned by her. |

*Figure 1.* Short narratives elaborating the motivational meaning of the pictures (Experiment 1) or verbal labels (Experiment 2) for power-, achievement-, and affiliation-related stimuli associated with positive or negative affect. The verbal labels and narratives used were in German.

*Association of items with motive contents.* We presented all stimuli for a baseline measure of attentional preferences, following a random sequence (i.e., at the beginning of the session, before associating the stimuli with particular need contents). Before the baseline phase, the participant carried out 16 practice trials with neutral stimuli (geometrical figures) to get acquainted with the procedure. After the baseline phase was completed, there was a learning phase in which the participant associated each of the pictures with a short story (a vignette) elaborating the affiliation-, achievement-, or power-related content of the stimulus (see Figure 1).[1] The participant read each story carefully and was instructed to memorize its relationship with the picture. The learning phase was terminated when the participant was able to connect each cue with its story on two consecutive test trials without making any mistakes: Each test sheet listed the pictures on the left side and the vignettes on the right side, and the participant was to draw a line connecting each picture with the appropriate vignette.

During the subsequent experimental phase, the same procedure as in the baseline followed: The participant was required to respond to the imperative stimulus (i.e., the probe) by pressing a key on the ipsilateral or contralateral side of the keyboard as quickly as possible. Response side was counterbalanced across participants, who were assigned to one of these two conditions on a random basis.

In addition to the main computer task, participants filled out some tests at the end of the session to assess individual differences in implicit and explicit motives (OMT and Motive Enactment Test [MET], described next), in addition to other tests that are not relevant to our lateralization hypothesis. After answering some questions concerning the nature of the investigation, participants were debriefed and thanked for their participation.

*OMT (Kuhl, 2001, Chapter 12; Kuhl & Scheffer, 2002).* This test measures implicit motives (cf. McClelland et al., 1989). The version used in this study consists of 12 pictures showing line drawings of one or more persons that could be interpreted as affiliation, achievement, or power related. These pictures are completely different and are much more detailed than the pictures used in the dot-probe task (Figure 1), which also form part of the current version of the OMT. For each picture, the participant is to spontaneously invent a story involving one person depicted and briefly answer the following questions (using key words rather than fully verbalizing the full story): (a) What is important for the person in this situation and what does she or he do, (b) how does the person feel, (c) why does this person feel that way, and (d) how does the story end? Participants' answers are scored independently by trained raters according to motive content and affect level. Consistent with previous research (Baumann, Kaschel, & Kuhl, 2005; Baumann & Scheffer, 2006; Kazén & Kuhl, 2005, Study 3), we calculated implicit motive scores by the sum of the answers given that correspond to the approach component of the given motive (e.g., "hope of relationship" for affiliation). We also measured the avoidance component of the motive (e.g., "rejection" for affiliation) and used it for correlational analyses (see footnote 2). The validity of the OMT to predict spontaneous behavior related to the corresponding motive has been demonstrated in several studies (Baumann, Kaschel, & Kuhl, 2005; Baumann & Scheffer, 2006; Kazén & Kuhl, 2005, Study 3; scoring instructions and validation information for the version used here are described in Kuhl, 2001, chapter 12, and in the English OMT manual, Kuhl & Scheffer, 2002). OMT scoring was carried out by two well-trained assistants who had reached sufficient reliability across several studies (interrater reliabilities were .80 and .78 for the first and second experiments, respectively).

*MET (see Kuhl & Henseler, 2003).* The MET is a self-report inventory measuring affiliation, achievement, and power. Responses are given on a 4-point Likert scale: "This statement applies to me: not at all (0), somewhat (1), much (2), or completely (3)." The three scales measuring motive dominance were applied, each with four items. An example item from the Affiliation Dominance scale is "I enjoy talking with nice people about all sorts of topics" (Cronbach's $\alpha = .73$). An example item from the Power Dominance scale is "Other people often prefer me to be the leader" (Cronbach's $\alpha = .63$). An example item from the Achievement Dominance scale is "I often choose to engage in activities in which I can test my skills" (Cronbach's $\alpha = .70$).

## *Results and Discussion*

In the dot-probe task, response latencies are measured as an indication of visual attention to the stimuli preceding the dot (Bradley et al., 1998). Because attentional resources devoted to RVFs versus LVFs are associated with activation of contralateral hemispheres (Hilgetag et al., 2001; Mangun, Buonocore, Girelli, & Jha, 1998), our motivational–lateralization hypothesis predicts lower latencies for probes in the RVF (LH) when preceded by power stimuli and lower latencies for probes in the LVF (RH) when preceded by affiliation-related stimuli within the same visual field.

To test the above hypothesis, we performed a series of analyses of variance (ANOVAs) on response latencies (there were practically no errors in this task, and exploratory analyses revealed no effects of experimental conditions on error rates in any experiment). We excluded latencies faster than 100 ms or slower than 1,500 ms from the analyses and applied this criterion to the first three experiments (outliers were very rare: They occurred less than 3% of the time in each experiment).

We calculated the reliability of the variables used for the analyses within each need, separately for the baseline and postmeasure phases. Specifically, averaging within stimulus repetitions, we used the four variables associated with each need (i.e., positive and negative crossed with left and right target positions) to estimate reliability. Cronbach's alphas were .93, .88, and .93 and .87, .83, and .90 for power, achievement, and affiliation in the baseline and

[1] To verify the extent to which each vignette was spontaneously associated with the motive and valence we postulated (see Figure 1), we carried out a study with an independent group of 24 voluntary judges (17 men and 7 women) and asked them to rate each vignette ("Story"; presented together with its corresponding picture, but without the verbal label) on the extent to which it addressed a topic related to power–influence–leadership, achievement, and affiliation–relationship using 6-point Likert scales, ranging from 1 (*not at all*) to 6 (*very strongly*). They also rated each vignette as to how strongly it was characterized by positive or by negative feelings, using the same Likert scale. Results were fully consistent with our expectations. For each vignette, judges gave a significantly higher motive score to our postulated motive compared with each of the other two motives ($p < .05$; Bonferroni tests). The same was true for the stimulus valence, positive versus negative ($p < .001$; $t$ tests).

second measurement phases, respectively. We additionally calculated the reliability within target visual field position. Averaging within stimulus repetitions, we used six variables (i.e., positive and negative crossed with power, achievement, and affiliation stimuli) to estimate the reliability. Cronbach's alphas were .87 and .83 and .88 and .86 for the left and right target positions in the baseline and second measurement phases, respectively.

Preliminary analyses including the between-participant factor of ipsilateral versus contralateral response modes did not show any latency effects. We then carried out a four-way ANOVA on response latencies including the within-participant variables of Time (baseline or postmeasurement), Need (affiliation, achievement, or power) × Affect (positive or negative) × Target Visual Field (left or right). There was a significant main effect of time, $F(1, 19) = 12.77$, $p < .005$, $\eta_p^2 = .40$. As may be expected due to practice with a novel task, mean latencies during baseline (424 ms) were longer than on the second measure (398 ms). There was a significant Need × Target Visual Field interaction, $F(2, 38) = 6.21$, $p < .005$, $\eta_p^2 = .25$, which was qualified by the significant interaction between time, need, and target visual field, $F(2, 38) = 4.91$, $p < .025$, $\eta_p^2 = .21$.

Data on this interaction are shown in Table 1, listed separately for the baseline and the second measurement phase. During the baseline, there were no differences due to need or visual field. On the second measurement, consistent with our main prediction, latencies for power-related pictures presented to the RVF (LH) were shorter than those presented to the LVF (RH), 383 ms versus 408 ms, $t(19) = -2.13$, $p < .05$, $d = -0.49$, whereas latencies for affiliation-related pictures presented to the LVF (RH) were shorter than those presented to the RVF (LH), 382 ms versus 416 ms, $t(19) = -2.94$, $p < .005$, $d = -0.67$. However, there were no differences for achievement items (395 ms vs. 383 ms). Additional post hoc comparisons between power and affiliation latencies within the LVF and within the RVF, which are more indirectly related to our main hypothesis, are reported in the analysis with pooled data from the experiments using the dot-probe task ($N = 64$; see Analysis of Experiments 1, 2, and 3 section).

Table 1
*Mean Latencies (and Standard Deviations) to the Dot-Probe Task During the Baseline and the Second Measurement Phase of Experiment 1 as a Function of Visual Field and Need Content of the Pictures*

| Phase | LVF-RH | RVF-LH |
|---|---|---|
| Baseline | | |
| Power | 421 (81.4) | 421 (86.4) |
| Achievement | 426 (72.9) | 432 (86.5) |
| Affiliation | 422 (85.7) | 426 (90.4) |
| 2nd measurement | | |
| Power | $408_a$ (64.9) | **383**$_b$ (62.1) |
| Achievement | 395 (48.4) | 383 (60.1) |
| Affiliation | **382**$_c$ (53.5) | $416_d$ (70.4) |

*Note.* On the second measurement, means for power and affiliation that do not share a subscript within a row differ significantly from each other, "ab" $p < .05$; "cd" $p < .005$. There were no significant differences on the baseline, according to post hoc Bonferroni tests. Boldface indicates the two conditions with the postulated advantage in hemispheric processing (power, RVF-LH, and affiliation, LVF-RH). LVF = left visual field; RVF = right visual field; RH = right hemisphere; LH = left hemisphere.

The main factor of affect was not significant, $F(1, 19) = 1.41$, $p > .20$, $\eta_p^2 = .07$. However, there was an Affect × Target Visual Field interaction, $F(1, 19) = 8.10$, $p < .01$, $\eta_p^2 = .30$, which was qualified by a significant Time × Affect × Target Visual Field interaction, $F(1, 19) = 9.14$, $p < .01$, $\eta_p^2 = .37$. Data related to this last interaction are shown in Table 2. During the baseline phase, positive pictures were responded to faster than negative pictures if presented to the LVF (RH), $t(19) = -2.32$, $p < .05$, $d = -0.53$, whereas negative pictures were responded to faster than positive ones if presented to the RVF (LH), $t(19) = -2.93$, $p < .01$, $d = -0.62$. During the second measurement phase, however, these differences disappeared (see Table 2). There were no other significant higher order interactions in the ANOVA. The four-way interaction was nonsignificant, $F(2, 38) = 1.76$, $p > .18$, $\eta_p^2 = .08$.

The main results, shown in Table 1, support our prediction that affiliation-related items are more efficiently processed if presented to the LVF (RH) and power-related items are more efficiently processed if presented to the RVF (LH). The control achievement items appeared to be preferentially processed by the LH, but this effect was not as strong as the one obtained for power-related items. Notice that during the baseline phase, there were no significant need-related effects. This implies that the need-related asymmetry obtained during the experimental phase is attributable to the semantic elaboration of the stimuli used.

Affect had an effect on response latencies related to each hemisphere only during the baseline phase, and this occurred independently of the need content of the items: There was a LVF (RH) attentional bias for positive pictures and a RVF (LH) attentional bias for negative pictures (see Table 2). These results are consistent with studies reporting positive and negative mood effects (Baumann & Kuhl, 2002; Bolte, Goschke, & Kuhl, 2003; Isen, 2002) for tasks for which right or left lateralization, respectively, has been demonstrated (Beeman & Bowden, 2000; Beeman et al., 1994). However, after learning the motivational meaning of each picture on a narrative level (i.e., during the training before the second measurement), the need content wiped out the effects of affective content on the response latencies, that is, differences due to item affectivity disappeared (cf. Table 1 vs. Table 2).

To investigate whether our laterality findings for the affiliation and power needs are robust across changes in stimulus format, we carried out a second experiment using verbal labels as stimuli instead of pictures.

## Experiment 2

### Method

#### Participants

A new group of 20 undergraduate students (15 women and 5 men) participated in exchange for course credit. Their mean age was 26 years (range = 20 to 47 years). All participants were right handed according to the Edinburgh Inventory of Handedness (Oldfield, 1971). Their mean laterality quotient was 80.8 (range = 50 to 100).

#### Materials and Procedure

We used the same materials as in Experiment 1, including the vignettes (see Figure 1), with the exception that instead of pre-

Table 2
*Mean Latencies (and Standard Deviations) to the Dot-Probe Task During the Baseline and Second Measurement Phase of Experiment 1 as a Function of Visual Field and Valence of the Pictures (Pooling Data From All Three Motives)*

| Phase | Positive affect | Negative affect |
|---|---|---|
| Baseline | | |
| Left visual field (RH) | $411_a$ (66.1) | $435_b$ (91.9) |
| Right visual field (LH) | $438_b$ (90.2) | $415_a$ (81.8) |
| 2nd measurement | | |
| Left visual field (RH) | 399 (52.0) | 389 (56.3) |
| Right visual field (LH) | 400 (63.3) | 388 (56.9) |

*Note.* For the baseline, means that do not share a subscript within a row differ significantly from each other, $p < .05$. There were no significant differences during the second measurement. RH = right hemisphere; LH = left hemisphere.

senting the stimuli as pictures, we presented them as corresponding pairs of verbal labels enclosed in boxes before they were replaced by the imperative stimulus plus sign. The verbal labels (with the original in German) used were *giving good advice* (*Guten Rat geben*; power positive), *feeling humiliated* (*Gedemütigt werden*; power negative), *merged in the challenging activity* (*In der Tätigkeit aufgehen*; achievement positive), *helplessness* (*Sich hilflos fühlen*; achievement negative), *sharing feelings* (*Gefühle austauschen*; affiliation positive), and *feeling lonely* (*Einsamkeit spüren*; affiliation negative). We chose these verbal labels according to the scoring key of the implicit motive test (OMT) mentioned before. We chose this criterion for constructing verbal labels because the contents of the scoring key have been validated in a similar way as the motive-related contents specified in Winter's (1994) scoring key for Thematic Apperception Test assessment of the three motives involved.

We followed the same procedure as in Experiment 1, with the exception that the associations made with the short stories (vignettes) during the learning phase were made with the verbal labels rather than with pictures (see also Figure 1). The comparison between the baseline (i.e., before exposure to short stories) and main phases was to examine to what extent elaborating the motivational meaning of the verbal labels was necessary to reproduce the effects: If the verbal labels are less ambiguous than the pictures in Experiment 1, we could expect to find need and/or valence effects even before elaboration of stimulus meaning.

We calculated the reliability of the latency variables used for the analyses in the same manner as in the previous experiment. Cronbach's alphas were .76, .79, and .84 and .88, .86, and .74 for power, achievement, and affiliation in the baseline and second measurement phases, respectively. Cronbach's alphas were .89 and .81 and .87 and .91 for the left and right target positions in the baseline and second measurement phases, respectively.

Participants filled out some tests at the end of the session, including the OMT and MET. After answering questions concerning the nature of the investigation, they were debriefed and thanked for their participation.

### *Results and Discussion*

Because we had clear-cut a priori hypotheses based on theoretical considerations outlined in the introductory section and also on the results of Experiment 1, we used one-tailed tests to test our main prediction in this and Experiment 3: Presumably, power-related items are processed faster when presented to the RVF than to the LVF and affiliation-related items are processed faster when presented to the LVF than to the RVF.

We analyzed data in a similar way as in the first experiment. The between-participants factor of ipsilateral versus contralateral response modes did not produce any significant effects in a preliminary analysis, and data were pooled on this factor. We then performed an ANOVA on response latencies including the within-participant factors of Time (baseline or post) × Need (affiliation, achievement, or power) × Affect (positive or negative) × Target Visual Field (left or right). The main effect of time was significant, $F(1, 19) = 18.21$, $p < .001$, $\eta_p^2 = .49$. Mean latencies during baseline (451 ms) were longer than on the second measure (417 ms). The main result, however, was the significant interaction between time, need, and target visual field, $F(2, 38) = 3.69$, $p < .05$, $\eta_p^2 = .16$.

Results are shown in Table 3 separately for the baseline and second measurement phases. The interaction shows a very similar pattern as was found for pictorial stimuli. Post hoc comparisons using Bonferroni tests on the baseline phase yielded no significant effects. On the second measurement, as predicted, latencies for power-related verbal labels presented to the RVF (LH) were shorter than those presented to the LVF (RH), 409 ms versus 432 ms, $t(19) = -3.02$, $p < .001$, $d = -0.69$ (a priori contrast), whereas latencies for affiliation-related labels presented to the LVF (RH) were shorter than those presented to the RVF (LH), 404 ms versus 419 ms, $t(19) = -1.76$, $p < .05$, $d = -0.40$ (a priori contrast). However, there were no significant differences for achievement items (430 ms. vs. 408 ms), $t(19) = 1.82$, $p < .10$, $d = 0.42$, for which we did not have a clear-cut expectation.

The results therefore indicate that the attentional bias effect is reliable not only for pictures but also for verbal stimuli, irrespective of the affective valence of the stimuli.

Table 3
*Mean Latencies (and Standard Deviations) to the Dot-Probe Task During the Baseline and Second Measurement Phases of Experiment 2 as a Function of Visual Field and Need Content of the Verbal Labels*

| Phase | LVF-RH | RVF-LH |
|---|---|---|
| Baseline | | |
| Power | 464 (57.6) | 456 (78.8) |
| Achievement | 445 (56.2) | 463 (61.9) |
| Affiliation | 442 (63.9) | 436 (54.5) |
| 2nd measurement | | |
| Power | $432_a$ (70.1) | **$409_b$** (57.6) |
| Achievement | 430 (66.6) | 408 (47.9) |
| Affiliation | **$404_c$** (50.0) | $419_d$ (67.4) |

*Note.* On the second measurement, means for power and affiliation that do not share a subscript within a row differ significantly from each other, "ab" $p < .05$; "cd" $p < .01$ (a priori comparisons). There were no significant differences on the baseline, according to post hoc Bonferroni tests. Boldface indicates the two conditions with the postulated advantage in hemispheric processing (power, RVF-LH, and affiliation, LVF-RH). LVF = left visual field; RVF = right visual field; RH = right hemisphere; LH = left hemisphere.

The main factor of affect was not significant, $F(1, 19) = 2.14$, $p > .15$, $\eta_p^2 = .10$. Neither were the Affect × Target Visual Field interaction, $F(1, 19) = 0.01$, *ns*, $\eta_p^2 = .00$, nor the Time × Affect × Target Visual Field interaction, $F(1, 19) = 2.41$, $p > .13$, $\eta_p^2 = .11$. For comparison purposes with the significant results related to this last interaction in the first experiment (see Table 2), we list the equivalent means in Table 4. A comparison of the means during the baseline phase, however, indicated that negative verbal labels (441 ms) were responded to faster than positive verbal labels (463 ms) if presented to the RVF (LH), $t(19) = -2.33$, $p < .05$, $d = -0.53$, which replicates a finding of the previous experiment. There were no equivalent differences for the verbal labels presented to the LVF (RH). As in Experiment 1, there were also no differences during the second measurement phase (cf. Table 2). No other higher order interactions in the ANOVA were significant. The four-way interaction was nonsignificant, $F(2, 38) < 1.0$, *ns,* $\eta_p^2 = .05$.

In partial replication of the findings of Experiment 1, the affective contents of the verbal labels presented influenced the latency responses to the probes during the baseline phase. In particular, negative verbal labels had a processing advantage over positive ones if presented to the RVF (Table 2). However, there was no significant effect of valence for items presented to the LVF (RH). The reason for this difference between experiments cannot be attributed to lack of differences in subjective valence because these stimuli do differ significantly in the positive and negative affectivity they elicit (see footnote 1). Because of that, we assume that this difference may be due to the nature of the stimuli we used in each experiment: pictures versus verbal labels.

Notice that there were no significant need-related effects for the baseline phase, as in Experiment 1. This suggests that the need-related hemispheric asymmetry obtained during the experimental phase is attributable to the unambiguous semantic elaboration of the pictorial or verbal stimuli during the learning phase, according to affiliation- or power-related contents (cf. Tables 1 and 3).

## Alternative Interpretation

Consistent with our hypotheses, the results of Experiments 1 and 2 show hemispheric-related attentional biases depending on need content: affiliation stimuli eliciting an attentional bias toward the LVF (RH) and power stimuli eliciting an attentional bias toward the RVF (LH), irrespective of the position (LVF vs. RVF) of the stimulus. The effects were significant only after participants explicitly learned to associate the stimuli with the respective need by reading the vignettes. The absence of need-related effects during baseline can be explained according to the potential ambiguity concerning the motive content that novel pictorial or verbal stimuli may have for a particular individual. After the learning phase, however, this ambiguity in the motivational interpretation of the stimuli is removed, and spontaneous (implicit) attentional biases can take place. According to the concept of motive, removal of ambiguity is mediated by a high-level cognitive–emotional representation of need-related experience (McClelland, 1985). Presumably, it is this high-level process that establishes attentional bias, even at an (early) automatic level of processing, not only toward need-relevant information, but also toward the mode of processing that seems optimal for need-relevant action. To the extent that positive and negative affect are consequences of the satisfaction or frustration of needs, respectively, need-related information should be processed at an earlier stage of processing compared with affect-relevant information. Therefore, the observation that need-related effects prevent affect-related effects from occurring can be explained on the basis of the temporal and functional primacy of need over affect in processing.

According to an alternative interpretation, however, our data may indicate a process related to *person perception* and not to implicit motive processing. It is probably not possible to discard this alternative interpretation on the basis of latency data only. However, we measured the motive dispositions of participants in Experiments 1 and 2 using both an implicit (OMT) and an explicit (MET) motive test. It is assumed that these two types of tests tap qualitatively different motivational processes, and because of that, they do not correlate with each other (McClelland et al., 1989). On one hand, if the attentional bias data reflect a process related to implicit power versus affiliation, as we suggest here, the latency data should correlate significantly with the respective implicit motive measures and not with the corresponding explicit motive measures. On the other hand, if these latency data reflect person perception, they are not expected to be significantly related to the implicit motive measures and could perhaps be related to the explicit motive measures (McClelland et al., 1989; see Schultheiss, 2007, for a current discussion of implicit vs. explicit motive measures). Our hypothesis refers primarily to the approach component of the implicit motive because it is the usual way of measuring it (Baumann, Kaschel, & Kuhl, 2005; Baumann & Scheffer, 2006; Kazén & Kuhl, 2005, Study 3; Kuhl & Scheffer, 2002).

To address the motive versus person perception issue, we first calculated an index of right hemispheric advantage for affiliation stimuli by taking latencies to all affiliation stimuli minus latencies to all power stimuli presented to the LVF (RH). Likewise, to calculate an index of left hemispheric advantage for power stimuli, we took latencies to all power stimuli minus latencies to all affiliation stimuli presented to the RVF (LH). We then correlated these indexes with participants' scores on the implicit (OMT) and explicit (MET) motive tests. To increase power, we pooled together data from Experiments 1 and 2 ($N = 40$). Results are shown in Table 5. As we expected, the index of right hemispheric advantage for affiliation correlates significantly with implicit affiliation

Table 4
*Mean Latencies (and Standard Deviations) to the Dot-Probe Task During the Baseline and Second Measurement Phases of Experiment 2 as a Function of Visual Field and Valence of the Verbal Labels (Pooling Data From All Three Motives)*

| Phase | Positive affect | Negative affect |
|---|---|---|
| Baseline | | |
| Left visual field (RH) | 454 (62.9) | 448 (50.9) |
| Right visual field (LH) | $463_b$ (56.6) | $441_a$ (60.9) |
| 2nd measurement | | |
| Left visual field (RH) | 425 (60.7) | 419 (60.4) |
| Right visual field (LH) | 409 (54.2) | 416 (61.3) |

*Note.* For the baseline, means that do not share a subscript within a row differ significantly from each other, $p < .05$. There were no significant differences during the second measurement. RH = right hemisphere; LH = left hemisphere.

Table 5
*Correlations Between the Latency Indexes of Right Hemispheric Advantage (RHA) for Affiliation Stimuli and of Left Hemispheric Advantage (LHA) for Power Stimuli and the Scores on Implicit and Explicit Affiliation and Power Motive Tests for Pooled Data From Experiments 1 and 2*

| | Implicit measure (OMT) | | Explicit measure (MET) | |
|---|---|---|---|---|
| Latency index | Power | Affiliation | Power | Affiliation |
| Power—LHA | $-.49^{**}$ | $-.09$ | .05 | .21 |
| Affiliation—RHA | $-.25$ | $-.32^{*}$ | $-.08$ | $-.01$ |

*Note.* $N = 40$. The approach component of the implicit motive measures was used for these correlations. Results from a combined (approach plus avoidance) measure of implicit motivation are reported in footnote 2. Negative correlations indicate better performance. OMT = Operant Multimotive Test; MET = Motive Enactment Test.
$^{*}p < .05$. $^{**}p < .001$.

($p < .05$) and not with explicit affiliation or any of the power measures. The index of left hemispheric advantage for power correlates significantly with implicit power ($p < .001$) and not with explicit power or any of the affiliation measures. Note that negative correlations indicate faster latencies. The same pattern of predicted correlations was observed considering each experiment separately (stronger for the verbal item condition compared with the visual item condition). These data are therefore consistent with our interpretation that the attentional bias data obtained with this modified dot-probe paradigm go beyond person perception and are more adequately accounted for by implicit motive processing. Finally, the correlations described in Table 5 cannot be attributed to a transfer from the experimental stimuli to the OMT picture because they were obtained for both pictorial and verbal cues.

The correlation between explicit affiliation and power was $r(39) = .44$, $p < .01$, whereas that between implicit affiliation and power was $r(39) = .24$, *ns.* That is, in each case the two motives show significant correlations at the explicit level only. Supporting the assumption of independence between the two types of motive measures we used, the correlation between implicit and explicit affiliation was $r(39) = .03$, *ns,* and that between implicit and explicit power was $r(39) = -.04$, *ns* (see McClelland et al., 1989). All other combinations of the above implicit and explicit measures produced likewise nonsignificant results (all correlations had $p > .15$).[2]

## Experiment 3

The results of Experiments 1 and 2 show a consistent pattern across changes in stimulus materials. There are, however, two limitations of these studies. One methodological shortcoming is that need-related stimuli were presented for 750 ms. We used such an exposure time to allow participants to clearly read the titles of the vignettes in the second experiment and wanted to have comparable exposure times in both experiments. It could be argued, however, that participants had enough time to move their eyes to both sides of the screen during stimulus exposure time, which would impair the control of lateralized stimulus presentation. In this case, our method would not unambiguously indicate hemispheric lateralization. In this third experiment, we controlled for that possibility by showing the same pictorial stimuli as in Experiment 1 but for fewer than 100 ms, which is too fast a time to allow for ocular saccades. A second limitation to the generalizability of the previous results is that participants had only a short time to get acquainted with the stimulus materials and associate them with the power or affiliation areas (i.e., only during the experimental session). Will these results be replicated with participants acquainted with the stimulus materials for a period of several weeks? To answer this question, in this experiment we recruited only psychology students who were already familiar with the different meanings of the pictorial stimuli used because they had to thoroughly learn these materials for an examination in the lecture of Julius Kuhl.

### *Method*

#### *Participants*

An additional group of 24 psychology undergraduates (8 women and 16 men) participated in exchange for course credit. Their mean age was 24.7 years (range = 20 to 31 years). All participants were right handed according to the Edinburgh Inventory of Handedness (Oldfield, 1971). Their mean laterality quotient was 82.3 (range = 60 to 100). The experiment was carried out in the final week of the semester. According to postexperimental questioning, all participants were well acquainted with the particular need-related meanings of the materials presented (power, achievement, or affiliation) but were naive concerning the experimental hypotheses.

#### *Materials and Procedure*

The same pictorial materials were used as in Experiment 1. The procedure was also similar to that of Experiment 1, with the following differences. The pictorial stimulus presentation time was 88 ms rather than 750 ms to prevent saccadic eye movements before they were replaced by the imperative stimulus plus sign. Because participants were already acquainted with the materials, there was no need to train them to associate the materials with specific need areas, and the dot-probe data were obtained only once, at the beginning of the session. After carrying out the experimental task, participants filled out a series of question-

[2] In light of the finding that lateralization effects were stable across positive and negative valence of motive-related stimuli, one might expect a similar generalization of laterality effects across approach and avoidance components of motives. It should be noted, however, that combining approach and avoidance components is psychometrically not advisable because of violations of homogeneity of pooled approach and avoidance components from implicit motive measures: Psychometric analyses based on Rasch's measurement model revealed a significant departure of combined approach and avoidance components from the one-dimensional model (Kuhl, 1978; see also Tuerlinckx, De Boeck, & Lens, 2002, for a similar study). Despite this problem, we examined whether the correlations could be replicated after pooling approach and avoidance components of the OMT for each motive. The significant correlation for the implicit power measure (Table 5) was replicated, and the correlation for the implicit affiliation measure showed a nonsignificant negative correlation.

naires,[3] answered a series of postexperimental questions, and were debriefed and thanked for their participation.

We calculated the reliability of the latency variables used for the analyses following the procedure described in Experiment 1's *Method* section. Cronbach's alphas were .73, .89, and .84 for power, achievement, and affiliation, respectively, and .87 and .91 for the left and right target positions, respectively.

### *Results and Discussion*

We analyzed latency data similarly as before, with the exception that there was no factor of time. The between-participant factor of ipsilateral versus contralateral response modes did not show any effects in a preliminary analysis, and data were pooled on this factor. We calculated a three-way repeated-measure ANOVA including Need (affiliation, achievement, or power) × Affect (positive or negative) × Target Visual Field (left or right). The pattern of results is similar to the one we found in the previous experiments. The only significant finding was our predicted Need × Target Visual Field interaction, $F(2, 46) = 3.29$, $p < .05$, $\eta_p^2 = .13$. Latencies for power-related pictures presented to the RVF (LH) were shorter than those presented to the LVF (RH), 392 ms versus 419 ms, $t(23) = -1.72$, $p < .05$, $d = -0.72$ (a priori contrast). The latencies for affiliation-related pictures presented to the LVF (RH) were not significantly different from those presented to the RVF (LH), 409 ms versus 418 ms, $t(23) = -0.88$, *ns,* $d = -0.37$ (a priori contrast). There were also no significant differences for achievement items (413 vs. 401 ms), $t(23) = 0.84$, *ns,* $d = 0.35$.

Considering the overall interaction pattern shown in Table 6, the results seem to indicate that the attentional bias effect is reliable not only for pictures shown for a longer period of time (750 ms), but also for pictures shown below the eye saccade movement threshold (88 ms), independently of their affective valence. Moreover, these results were obtained with participants having week-long familiarity with the connection between the pictorial stimuli presented and the corresponding power versus affiliation narrative elaboration.

The three-way interaction in the ANOVA was nonsignificant ($F < 1$). The main factor of affect was not significant, $F(1, 23) = 2.86$, $p > .10$, $\eta_p^2 = .11$, and neither was the Affect × Target Visual Field interaction, $F(1, 23) = 1.22$, $p > .28$, $\eta_p^2 = .05$. The mean latency for positive and negative items presented to the LVF (RH) was 411 ms and 407 ms, respectively. The mean latency for positive and negative items presented to the RVF (LH) was 415 and 392 ms, respectively. Notice that although these last RVF (LH) data are nonsignificant (using a Bonferroni test), they are nonetheless consistent with the baseline results of Tables 2 and 4 and indicate a RH advantage of negative compared with positive items, which does not fit well with the proposal that negative affect is preferentially processed by the RH (cf. Davidson, 2000).

Table 6
*Mean Latencies (and Standard Deviations) to the Dot-Probe Task During the Baseline Phase of Experiment 3 as a Function of Visual Field and Need Content of the Pictures*

| Baseline | LVF-RH | RVF-LH |
|---|---|---|
| Power | $419_a$ (92.0) | **$392_b$** (79.6) |
| Achievement | 413 (118.0) | 401 (78.3) |
| Affiliation | **$409_a$** (78.6) | $418_a$ (87.5) |

*Note*. The means for power and affiliation that do not share a subscript within a row differ significantly from each other, $p < .05$ (a priori comparison). Pictures were presented for 88 ms. Boldface indicates the two conditions with the postulated advantage in hemispheric processing (power, RVF-LH, and affiliation, LVF-RH). LVF = left visual field; RVF = right visual field; RH = right hemisphere; LH = left hemisphere.

## Analysis of Experiments 1, 2, and 3

In each experiment, our predicted Need × Target Visual Field interaction was significant, and all but one of the predicted individual contrasts were significant. To increase power and to find out whether the motivational lateralization hypothesis can be confirmed not only across stimulus format but also across stimulus presentation changes, we pooled data from the first three experiments ($N = 64$), specifically from the second measurement phase of the first two experiments and from the experimental phase of the third. If we find significant results pooling data from these three experiments, which differed in the stimulus format (pictorial or verbal) and exposure time (88 ms or 750 ms) of the items, this would support our assumption that the same underlying process is at work in producing the laterality effects we find with power- and affiliation-related stimuli, over and above those methodological differences across experiments.

The mixed ANOVA on response latencies to the probes included the between-participants factor of experiment (first, second, or third) and the within-participant factors of need (affiliation, achievement, or power), affect (positive or negative), and target visual field (left or right). The factor of experiment was not significant as a main effect or in any interaction (all $p$s > .20). The main effect of affect was almost significant, $F(1, 61) = 3.73$, $p = .059$, $\eta_p^2 = .06$. Mean latencies for positive items (411 ms) were longer than for negative items (403 ms). The only other significant result was the Need × Target Visual Field interaction, $F(2, 126) = 12.81$, $p < .001$, $\eta_p^2 = .17$. Results are illustrated in Figure 2. As predicted by our main hypothesis, latencies for power-related items presented to the RVF (LH) were shorter than those presented to the LVF (RH), 394 ms versus 419 ms, $t(63) = -3.33$, $p < .001$, $d = -0.42$ (a priori contrast), whereas latencies for affiliation-related items presented to the LVF (RH) were shorter than those presented to the RVF (LH), 399 ms versus 418 ms, $t(63) = -3.09$, $p = .005$, $d = -0.39$ (a priori contrast). There was also a significant difference for achievement items, 412 ms versus 397 ms, $t(63) = 2.18$, $p < .05$, $d = 0.36$.

We carried out additional post hoc comparisons contrasting power- and affiliation-related items within each visual field in this analysis. Although the evidence is only indirectly related to our a priori hypothesis, the results are compatible with our motivational lateralization hypothesis. There was a RVF (LH) advantage of power over affiliation stimuli (394 ms vs. 418 ms), $t(63) = -4.46$, $p < .001$, $d = -0.56$, and a LVF (RH) advantage of affiliation

[3] Unfortunately, we did not apply the OMT test on Experiment 3. Because of that, it is not possible to carry out equivalent correlations between the indexes of right hemispheric advantage for affiliation and left hemispheric advantage for power stimuli and implicit motives as those reported in Table 5.

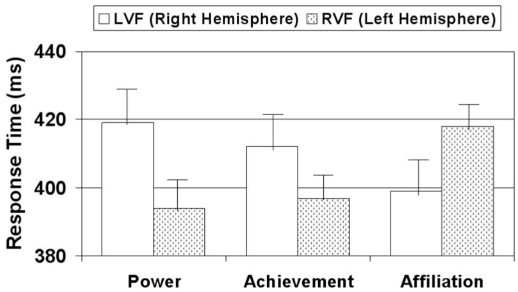


*Figure 2.* Response times (milliseconds) for detecting probes in the LVF versus RVF (as an index of contralateral hemispheric lateralization) as a function of need-related items presented before the probe. Data from the first three experiments are pooled, including pictures and verbal labels ($N$ = 64; second measurement of Experiments 1 and 2 and experimental phase of Experiment 3). The bars indicate 1 standard error from the respective mean. For each motive, the comparison between RVF (LH) and LVF (RH) was significant: power, $p < .001$; achievement, $p < .05$; and affiliation, $p < .005$. LVF = left visual field; RVF = right visual field; LH = left hemisphere; RH = right hemisphere.

over power stimuli (399 ms vs. 419 ms), $t(63) = -2.85$, $p < .01$, $d = -0.36$.

Consistent with our motivational lateralization hypothesis, a pattern of results that confirmed our predicted contrasts emerged after pooling together data of the previous three experiments. One limitation of these experiments, however, is that in all of them we used only one task, the lateralized version of the dot probe. We carried out a further experiment to explore the generalization of our findings to a different task and to test an implication of our hypothesis, namely, that presentation of affiliation- but not of power-related stimuli facilitates performance in a task involving right hemispheric functions. The task we used was modeled after the Remote Associates Test of Mednick (1962) and relates to high-level intuition (Bowers, Regehr, Balthazard, & Parker, 1990), requiring that participants intuitively rate word triads as coherent or incoherent. An example of a coherent word triad would be *goat, pass,* and *green* because all of these words are associated with a fourth word (not presented), *mountain.* An example of an incoherent triad would be *spoon, lion,* and *ticket,* because these words are not easily related to a fourth word. The main dependent variable is correct performance on coherent word triads, that is, those words that were correctly classified as coherent by the participant without him or her having retrieved the linking fourth word. Performance on this task is facilitated when participants are in a positive mood compared with a negative mood, presumably because positive mood potentiates spread of activation to weak or remote associates in memory (Bolte et al., 2003; see also Isen, Daubman, & Nowicki, 1987). More relevant to our lateralization hypothesis, the solution of these "compound remote associate" problems (cf. Bowden & Jung-Beeman, 2003) involves RHA, according to behavioral (Bowden & Jung-Beeman, 1998) and functional MRI and electroencephalograph data (Bowden, Jung-Beeman, Fleck, & Kounios, 2005). If affiliation and power stimuli activate right and left hemispheric functions, respectively, as our motivational lateralization hypothesis asserts, and if this lateralization effect extends to a broader time window than the one assessed with the dot-probe task, we should expect better performance in the word triad task after primes related to affiliation compared with primes related to power themes.

## Experiment 4

### Method

#### Participants

A new group of 34 undergraduate students (30 women and 4 men) participated voluntarily or in exchange for course credit.[4] Their mean age was 27.4 years (range = 18 to 50 years). According to the Edinburgh Inventory of Handedness (Oldfield, 1971) 2 participants were left handed (−33 and −90) and 32 were right handed. The mean laterality quotient for right-handed participants was 88 (range = 40 to 100).

#### Materials and Procedure

We used as primes both the positive and the negative power- and affiliation-related stimuli used in Experiments 1 (pictures) and 2 (verbal labels), including their corresponding vignettes (see Figure 1). The achievement-related primes were not used. We assigned participants on a random basis to the picture labels or the verbal labels prime condition (half of them to each condition).

We used 48 word triads from the study of Bowers et al. (1990), which they adapted from Mednick's (1962) Remote Associates Test. Half of them were coherent (e.g., *goat, pass,* and *green* → *mountain*) and the other half incoherent (e.g., *spoon, lion,* and *ticket*). All word triads appeared vertically in the middle of the screen (see Baumann & Kuhl, 2002). Participants' viewing distance to the computer monitor was about 60 cm. Physical features of the motive primes were the same as in Experiments 1 and 2. The word triads were in average 4.5-cm wide (4° 17′ of visual angle) × 6-cm high (5° 42′ of visual angle).

Participants were tested individually. The cover story was modeled after Baumann and Kuhl (2002). The experimenter told the participant that the study dealt with intuitive intelligence and that we wanted to find out more about this ability. In the first part of the experiment, the participant learned to associate the pictures (or verbal labels) with their corresponding vignettes (see Figure 1), presented on the computer screen. During the second phase, participants were introduced to the coherence judgment task. On each trial, we presented a motive prime before showing one of the word triads. Each trial started with a fixation stimulus (an asterisk) shown for 500 ms at the center of the screen, which was followed by the presentation of the motive prime presented at the center of the screen for 1,000 ms, then by the to-be-responded word triad, also shown in the middle of the screen. The participant's task was to respond with the left hand by pressing a key (*S*) on the keyboard if the three words presented were coherent or a right key (*L*) if the three words were incoherent. If the participant did not respond within 3 s, the word triad was replaced by a blank screen. There was a variable intertrial interval of 500 ms to 2 s. We told participants that the picture (or verbal label) presented on each trial should be used as a warning signal to prepare for the target word

[4] We thank Thomas Künne and Heiko Frankenberg for their assistance in preparing and conducting this experiment.

triads. The instructions emphasized that participants should decide on a completely intuitive manner whether the three words "belonged together" (*zusammengehoeren*) or not. It was further mentioned that their impression that the three words belonged together could sometimes be rather vague and uncertain and that even in those cases they should rely on their intuition and on their spontaneous feelings to make their responses.

### *Results and Discussion*

We followed the same procedure to analyze the data as in Baumann and Kuhl (2002, pp. 1216–1217). A coherent triad was taken as solved if participants classified it correctly as "coherent." More specifically, we calculated hit (H) rates as the proportion of coherent triads that were correctly classified as coherent and false alarm (FA) rates as the proportion of incoherent triads that were falsely classified as coherent.

#### *Discrimination and Response Bias Indexes*

We calculated a nonparametric index of discrimination $A'$, which is independent of responses biases. This index correlates highly with $d'$. It can be used when the number of observations per cell is small and hit rates equal 1.0 or false alarm rates equal 0.0 on occasion (Snodgrass & Corwin, 1988). $A'$ is calculated using the following formulas, where $H$ is the hit rate and $FA$ is the false alarm rate: (a) If $H > FA$, $A' = 0.5 + (H - FA) * (1 + H - FA) / 4H * (1 - FA)$; (b) if $H = FA$, $A' = 0.5$; and (c) if $H < FA$, $A' = 0.5 - (FA - H) * (1 + FA - H) / 4FA * (1 - H)$. Chance performance yields an $A'$ of 0.5, whereas perfect discrimination performance is reflected in an $A'$ value of 1.0. To find out whether response tendencies played a role in the results, we calculated $C$ as index of response bias (Snodgrass & Corwin, 1988), by means of the formula $C = -0.5 *$ (standardized $H$ + standardized $FA$). Positive $C$ values indicate a conservative bias, a $C$ value of zero indicates no bias, and negative $C$ values indicate a liberal bias.

To increase the comparability of the data with the dot-probe results of the previous experiments, we analyzed and report the $A'$, $C$, and latency data separately for each prime condition, pictures versus verbal items. The results of the combined analyses, including the additional between-participants factor of prime condition, however, yielded equivalent results as the analyses of each prime condition, to be reported next.

We analyzed the $A'$ discrimination data for the picture and verbal labels conditions with repeated-measure ANOVAs including the factors of need (affiliation or power) and affect (positive or negative). Consistent with our main hypothesis for the picture prime condition, the main effect of need was significant, $F(1, 16) = 7.41$, $p < .025$, $\eta_p^2 = .32$. Affiliation primes ($A' = .78$) produced better discrimination rates in this intuitive task than did power primes ($A' = .73$). The main effect of affect was not significant. The Need × Affect interaction was also not significant, $F(1, 16) < 1$, *ns,* $\eta_p^2 = .04$. The analogous ANOVA for the verbal prime condition produced equivalent results. The main effect of need was highly significant, $F(1, 16) = 11.48$, $p < .005$, $\eta_p^2 = .42$. Affiliation primes ($A' = .86$) produced better discrimination rates than did power primes ($A' = .75$). The main effect of affect was not significant. The Need × Affect interaction was also not significant, $F(1, 16) < 1$, *ns,* $\eta_p^2 = .00$. For illustration purposes, we present the main discrimination data in Figure 3.

We analyzed the response bias data using similar repeated-measure ANOVAs as above. For the picture prime condition, the only significant result was the main effect of affect, $F(1, 16) = 6.95$, $p < .025$, $\eta_p^2 = .30$. Negative primes ($C = .38$) produced higher values than positive primes ($C = -.04$). The analogous ANOVA for the verbal prime condition yielded equivalent results; the only significant result was the main effect of affect, $F(1, 16) = 6.95$, $p < .025$, $\eta_p^2 = .30$. Negative primes ($C = .35$) produced higher values than positive primes ($C = -.10$). The significant result in each prime condition indicates that participants had a more strict response criterion for intuitive judgments after presentation of negative primes compared with positive primes (pooling data across needs).

Finally, we analyzed response latencies to the word triads using analogous repeated measures ANOVAs. For the verbal prime condition, the main effect of need was not significant ($F < 1$), whereas the main effect of affect reached significance, $F(1, 16) = 4.52$, $p < .05$, $\eta_p^2 = .22$. Positive primes (1,542 ms) were associated with faster responses to the word triads than negative primes (1,623 ms). This result was qualified by a significant Need × Affect interaction, $F(1, 16) = 6.34$, $p < .025$, $\eta_p^2 = .28$. The interaction indicated that whereas participants responded about equally as fast to positive (1,581 ms) and negative (1,593 ms) primes in the power domain, $t(16) = -0.24$, *ns,* $d = -0.06$, they were much faster to respond to the word triads after positive (1,502 ms) compared with negative (1,653 ms) primes in the affiliation domain, $t(16) = -3.47$, $p < .005$, $d = -0.87$. For the picture prime condition, there were no significant effects (all $ps > .15$), but the pattern of response latencies was similar to the pattern we found in the verbal prime condition.

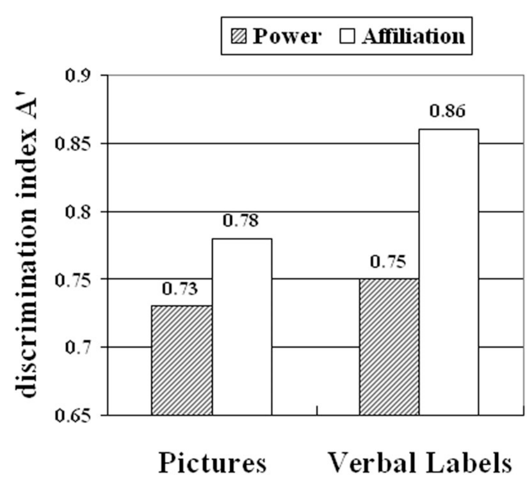


*Figure 3.* Mean discrimination index $A'$ of word triads, as a function of need and prime condition for Experiment 4. Higher values on the ordinate indicate better discrimination in carrying out intuitive judgments about coherent versus incoherent word triads, independent of response bias (chance performance corresponds to $A' = 0.5$, whereas perfect discrimination corresponds to $A' = 1.0$). Only the main effect of need was significant ($p < .025$ for the picture prime condition, and $p < .005$ for the verbal prime condition).

The results of the picture and verbal primes conditions on the above analyses were very similar to each other. To test that formally, we carried out additional analyses on our indexes of discrimination ($A'$), response bias ($C$), and response latencies including prime condition as between-participant factor ($N = 34$) and found that prime condition was not significant in any of the three mixed ANOVAs as a main effect (all $ps > .30$) or in any interaction (all $ps > .15$). In other words, the format of the primes (pictures or verbal labels) did not significantly influence our main dependent variables, $A'$ and $C$ (cf. Figure 3). The response times were also similar in each prime condition, which is indicated by the absence of an effect of this variable in the corresponding mixed ANOVA. The overall pattern of results thus confirms our assumption with a different task than the dot probe that it is the need content (power vs. affiliation) and not the pictorial or verbal format of the stimulus that produces the laterality effects we report in this article.

To summarize, results show that presentation of affiliation compared with power primes improves discrimination ($A'$) between coherent and incoherent word triads. The only significant result with the response bias index $C$ indicates a more strict response criterion after presentation of negative primes. The latency data indicate about equally fast responses after positive or negative power primes, whereas there are significantly faster responses after positive compared with negative affiliation primes.

The results of Experiment 4 are therefore consistent with our motivational lateralization hypothesis and extend its generalizability beyond the attentional dot-probe task that we used in the first three experiments to include a task related to creativity (Mednick, 1962) and insight problems (cf. Bowden et al., 2005, p. 324). More important, because there exist electroencephalograph and functional MRI data showing that this task activates anterior and temporal areas of the right hemisphere (Bowden & Jung-Beeman, 2003; Bowden et al., 2005), the present results converge to show that affiliation but not power-related information activates right hemispheric functions under our laboratory conditions.

## General Discussion

The present findings are consistent with our motivational lateralization hypothesis, which implies that power motivation is supported by the LH and affiliation by the RH (see Tables 1, 2, and 6 and Figures 2 and 3). According to the rationale underlying this expectation, the pursuit of power-related goals is facilitated by instrumental and monosemantic processing, whereas affiliation is facilitated by holistic, polysemantic processing of the RH (Beeman et al., 1994; Rotenberg, 2004).

On one hand, the association between affiliation and global, polysemantic processing is plausible because affiliative interactions typically do not reduce the appraisal of a person to a single (i.e., monosemantic) aspect (as though one were interested in only the one aspect of the interaction partner that happens to be instrumental for one's own purposes). Close relationships can even be disturbed when one of the interaction partners displays explicit means–end intentionality (e.g., uses the other person to accomplish a goal). Consistent with this view are a great number of studies on dyadic affective communication, developmental neuroscience, psychophysiology of stress, and psychopathogenesis linking secure attachment to right hemispheric functions from early infancy (see Schore, 2001). Attachment words, especially those dealing with positive interpersonal relationships, are more efficiently processed if presented to the RH (Mohr, Rowe, & Crawford, 2007). Also consistent are neuropsychological findings showing that empathy (and theory of mind, which can be considered as a form of cognitive empathy) is disrupted after lesions to the ventromedial prefrontal cortex of the RH (Shamay-Tsoory et al., 2003).

On the other hand, instrumental utilization of other individuals is not atypical for power motivation, for example, to achieve attention, approval, or status or to use individuals to accomplish other power-related goals (see Drake & Seligman, 1989; Keltner et al., 2003, pp. 271–273; McClelland, 1985; Veroff, 1957). However, it should be noted that instrumental aspects may not generalize to all types of power. Other forms of power motivation may not be as instrumentalizing or manipulative (e.g., the power motivation manifested by Mother Teresa). The motivational lateralization hypothesis asserts, however, that at an early stage of processing, the various forms of power motivation may have in common an activation of a linear processing mode that facilitates focusing on one particular objective or goal related to the personal or interpersonal domains.

Our conclusion based on the motivational lateralization hypothesis that power motivation is associated with left hemispheric and affiliation with right hemispheric lateralization is also consistent with classical split-brain findings. For example, Levy and Trevarthen (1976) reported that split-brain patients linked left hemispheric processing with the perception of function (instrumental means–end relationships) and right hemispheric processing with the perception of appearance (apparent visual similarity) in pairs of presented objects. This conclusion is also consistent with more recent research showing an advantage of left hemispheric processing in detecting direct (e.g., means–end) relationships and a right hemispheric advantage in detecting multidimensional (polysemantic) similarities (Beeman et al., 1994; Rotenberg, 2004).

The fourth experiment showed that the effects of need on hemispheric processing can be extended to a task related to high-level intuition, the compound remote associate task (cf. Bowden & Jung-Beeman, 2003). As we predicted, compared with power primes, affiliation primes facilitated discrimination of intuitive judgments on word triads that were remotely associated (see Figure 3). This task has been shown to activate right hemispheric areas (Bowden et al., 2005). Interestingly, a similar facilitation of remote associates and other indexes of creativity was obtained in other research after induction of positive affect (Isen, 2002; Isen et al., 1987). Our findings from Experiment 4 suggest that need-related laterality effects may persevere even for extended time periods despite their origin at early (automatic) stages of processing. The automatic nature of need-related lateralization is also confirmed by the fact that laterality effects in the first three experiments were not impaired by inconsistent stimulus–response mapping (which should produce increased response times if controlled processes were involved).

Although our results seem to provide a consistent picture, there is an apparent discrepancy between our position and a proposal advanced by Buck (1999) in his broad theory of emotion. He suggested that prosocial affects are related to left hemispheric processing, whereas selfish affects are related to right hemispheric processing (see pp. 317–318). The prosocial biological affects include relaxation, courtship, pair bonding, lust mating, and attachment; the selfish affects include arousal, pain, approach–reward, withdrawal, and aggression. For Buck, "The essence of the difference between selfish and prosocial affects is that the former support self-preservation and the latter support the preservation of the species" (p. 323). As we have indicated, there is strong neuropsychological evidence that approach–reward and aggression are related to frontal activity of the LH (Harmon-Jones, 2003; Harmon-Jones & Sigelman, 2001; Sutton & Davidson, 1997) and that empathy (a prosocial emotion, one may think) is related to right ventromedial frontal hemispheric functions (Shamay-Tsoory et al., 2003), which does not fit well into the distinction made by Buck. A systematic criticism of Buck's prosocial–selfish distinction was given by Gray (2002), who arrived at the conclusion that the approach–withdrawal distinction is more consistent with the extant literature than is Buck's proposal.

Although our findings show that affiliation-related stimuli are more efficiently processed by the RH and power-related stimuli by the LH, we should not rush to conclude that needs are the only determinants of hemispheric asymmetries. There is ample evidence showing that approach versus avoidance motivation (Harmon-Jones, 2003), empathy (Adolphs et al., 2000), and cognitive task requirements (Hellige, 1991) have an impact on hemispheric asymmetries. Even within the motivational content domain, it would be premature to exclude the possibility that power can sometimes be associated with right hemispheric processing and affiliation with left hemispheric processing.

The compatibility of power motivation with right hemispheric processing should increase when power is combined with functions that are typically associated with right hemispheric specialization. Examples of such functions that have been validated in experimental research are self-confrontational rather than defensive coping with negative life events (Baumann, Kuhl, & Kazén, 2005; Koole & Jostmann, 2004), stimulation of creativity and flexibility (Bowden et al., 2005; Isen, 2002), and empathic personal interaction (Adolphs et al., 2000; Shamay-Tsoory et al., 2003). When power combines with one of those conditions, it is plausible to expect it to be associated with right hemispheric functioning. Exploring the conditions that might facilitate such a cross-over defines a challenge for future research.

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