



Hemispheric specialization and creative thinking: A meta-analytic review of lateralization of creativity

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ABSTRACT

In the last two decades research on the neurophysiological processes of creativity has found contradicting results. Whereas most research suggests right hemisphere dominance in creative thinking, left-hemisphere dominance has also been reported. The present research is a meta-analytic review of the literature to establish how creative thinking relates to relative hemispheric dominance. The analysis was performed on the basis of a non-parametric vote-counting approach and effect-size calculations of Cramer's phi suggest relative dominance of the right hemisphere during creative thinking. Moderator analyses revealed no difference in predominant right-hemispheric activation for verbal vs. figural tasks, holistic vs. analytical tasks, and context-dependent vs. context-independent tasks. Suggestions for further investigations with the meta-analytic and neuroscience methodologies to answer the questions of left hemispheric activation and further moderation of the effects are discussed.

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1. Introduction

It is often said metaphorically that creativity is the ability to think outside the box. Sternberg and Lubart (1999) conceptually defined creativity as the ability to abstract from the conventional way of thinking, to create a new concept by combining two or more ideas that do not appear to be compatible, and to abstract from the context and see beyond the mere representation (for a similar definition, see also Amabile, 1983). In an attempt to operationalize creativity, a number of techniques have been devised assessing the outcome of a creativity task: for example, Lines Test (Spingbett, Dark, & Clarke, 1957), Sounds and Images (Khatena & Torrance, 1973), Thinking Creatively About the Future (Torrance, 1975), Similes Test (Schaefer, 1971), Photoanalogies Test (Templeton, 1964; Templeton, 1973), Possible Jobs Test (Gershon & Guilford, 1963), What Kind of Person Are You? (Khatena & Torrance, 1976), Something About Myself (Khatena & Torrance, 1976), Your Style of Learning and Thinking (Torrance, Reynolds, Ball, & Riegel, 1978). These different measures tap onto different processes (e.g. memory for the Lines Test) that led to a creative outcome. The measures could rely on different underlying processes for analysis of the material and the tasks. This research focused on measurements of the holistic process and its outcome as evidence for creative thought process.

Methodologically, these tests and their use result in correlational evidence between creativity and other variables such as per-

sonality (e.g. Dollinger, Dollinger, & Centeno, 2005), memory (e.g. Butler, Scherer, & Reiter-Palmon, 2003) and cognition (e.g. Campos & Gonzalez, 1994). These findings, however, do not manage to explain why creativity is related to those particular constructs.

In the past few years, in pursuit for an answer to this question, correlation methods have been complemented by investigation of brain processes with neuroscience methodology. Such investigations have shed more light to the connection between creativity and cognitive processes based on identical underlying neural circuits. It has been found, for example, that high creativity is correlated with high information seeking and strong personal identity (Dollinger et al., 2005). (Platek, Keenan, Gallup, and Mohamed (2004); see also, Feinberg & Keenan, 2005 for a clinical observation) furthered the findings by Dollinger et al. investigating experimentally self-conceptualization. They suggested that the right hemisphere of the brain is, relative to the left, more important for the processing of information about the self.

The relationship between the hemispheres and creativity becomes a corner stone for the understanding of the creative processes. Simple measure such as the Edinburg Handedness inventory (Oldfield, 1971) are correlated with the scores from one of the creativity tests or with a performance on a creativity task and the established correlation is suggestive of the predicted relationship. Methods of measuring hemispheric dominance vary in complexity and sophistication as well as in spatial and temporal resolution: for example, Edinburgh Handedness Inventory (Oldfield, 1971), Lateral Saccades (e.g. Harnad, 1972; O'Haire and Marcia, 1980; Owens & Limber, 1983; Smith, 1980), Line Bisection Task

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(e.g. Bradshaw, Nettleton, Nathan, & Wilson, 1985; Friedman & Förster, 2005; Milner, Brenchmann, & Pagliarini, 1992; Morton, 2003; Scarisbrick, Tweedy, & Kuslansky, 1987), Electroencephalography (EEG; e.g. Bowden & Jung-Beeman, 2003; Jausovec, 1997; Jausovec & Jausovec, 2000; Martindale, Hines, Mitchell, & Covello, 1984), Positron Emission Tomography (PET; e.g. Bekhtereva et al., 2000), Functional Magnetic Resonance Imaging (fMRI; e.g. Howard-Jones, Blakemore, Samuel, Summers, & Claxton, 2005; Jung-Beeman et al., 2004; Seger, Desmond, Glover, & Gabrieli, 2000). These methods are arguably very diverse in terms of the measured underlying processes and their timely unfolding.

Despite the variety of spatial and temporal resolutions of these methods, researchers of the lateral dominance have, with fair certainty, come to the conclusion that the right hemisphere and its regions are specialized for creative tasking (e.g. Bhattacharya & Petsche, 2005; Bowden & Jung-Beeman, 2003; Falcone & Loder, 1984; Friedman & Förster, 2005; Jung-Beeman et al., 2004, etc.). However, contradictory evidence has also been presented (e.g. Martindale et al. 1984, study 3; Razumnikova & Bryzhalov, 2006; Singh, 1990, etc.). It would be unrealistic to assume that only the right hemisphere is involved in this kind of information processing and it is essential to keep in mind that there is tremendous interplay between the hemispheres including inhibitory and excitatory effects (see Chiarello & Maxfield, 1996). None of the methodologies, however, can directly and reliably measure such effects.

Literature reviews have concluded the relative dominance of the right hemisphere in the processes associated with creativity (e.g. Fiore & Schooler, 1998; Katz, 1985; Rubenzer, 1979). For example, Fiore and Schooler (1998) review the literature of creative thinking in the context of problem solving and insight. They suggest that the right hemisphere is better at exploring for new possibilities while the left hemisphere is more likely to result in negative or positive transfer (the application of a previously learnt concept or pattern to a new problem). A further conclusion is that the right hemisphere is better at semantically connecting verbal phrases rather than exploring their direct meaning. The review, however, also points out several findings that suggest the superiority of the left hemisphere. This contradictory information is addressed in the current paper. We applied a systematic meta-analytic approach to the findings – obtained with a variety of neurophysiological methods – that associate creative outcomes with either a predominant left or right-hemispheric activation,

Furthermore, building on the primary literature, a list of moderators was compiled. The three moderators are thinking styles required to fulfill the task (abstract or concrete), context-dependency of the task (context-dependent or context-independent), and the modality of the task (lexical or figurative):

First, it has been shown that global/abstract thinking style is associated with creative thinking and local/concrete thinking with analytical approach (Friedman & Förster, 2000; Friedman & Förster, 2001, 2005). On a perceptual level, people can process information globally (focusing on the whole gestalt) or locally (focusing on the details of a gestalt). A similar distinction applies for higher mental processes (Friedman, Fishbach, Förster, & Werth, 2003; see also Förster, Friendman, Özelsel, & Denzler, 2006; Förster & Higgins, 2005; Förster, Liberman, & Kuschel, 2008); people can think about the same event (e.g. rearranging plant) in abstract terms (i.e., broad categories such as “room decoration”) or in more concrete terms (i.e., narrow categories such as “shuffling the plants”). In a series of studies, Friedman and Förster investigate the effect of approach and avoidance cues on hemispheric activation, creativity and analytic problem solving. On one hand, their data suggests a relationship between approach motivation and global thinking style on one hand and avoidance motivation and local thinking style. In addition, they found that greater relative right (diminished relative left) hemispheric activation is related to both approach motivation

and better performance on creativity tasks. Thus, we would hypothesize that abstract processing style will be more characteristic of tasks that result in relative right hemispheric dominance as compared to concrete processing style.

Second, in the same series of studies, they found that approach motivation is further related to holistic thinking style, seeing the bigger picture and the context. An example of a detail-oriented task, in which the context is better ignored, is the Embedded Figures Test (Horn, 1962). The greater the person’s ability to ignore the context (context-independent processing) is, the better her performance on this task is. Thus, one can hypothesize that context-independent thinking will be less characteristic of creative outcomes than context-dependent. Little direct evidence exists for these assumptions, however, and we would be cautious with such hypotheses.

The third and last moderator was the modality of the task. There is evidence for left specialization for lexical processing (e.g. Keller, Carpenter, & Just, 2001; Luh & Wagner, 1997; Cousin, Peyrin, & Baci, 2006; but see also Beeman & Chiarello, 1998). A large number of the creativity tasks are in fact lexical in nature. It is, thus, very likely that: (1) if there were bilateral activation or no relative hemispheric dominance, it could be due to the left hemisphere being activated to process the information (and not necessarily to contribute creatively to the task solution); and (2) if there were relative left hemispheric dominance, it could be that the task requires so much verbal processing that the right-hemisphere activation is overshadowed by the lexical complexity. Thus, we would hypothesize that the studies that show relative left hemispheric activation, verbal tasks will be a significant predictor.

This meta-analytic review aims at extending the conclusions drawn from literature reviews into providing a systematic evaluation of the entire available retrievable literature investigating brain specialization and creativity. In addition, several factors that could account for differences in brain activity with respect to the tasks were taken into consideration as moderators. The analysis looks into the size of the effects of the observed pattern of dominance and the results are summarized with suggestions for a possible further systematization.

2. Methods

2.1. Study selection

The literature search involved a systematic online search of the following three databases: PsycInfo (1887–March, 2008); MEDLINE (1966–March, 2008); and Web of Science (1945–March, 2008). The performed search was for the terms “creative\$” and “hemispher\$” (the “\$” sign indicates that any derivative of a word that contains what is before the sign, would be included in the search) with mapping of the terms in the title, abstract, heading word, table of contents, and key concepts. This allowed for a broad selection and was guided by the topic of hemispheric dominance in the context of creativity.¹ Thus, the collected articles had as a dependent variable (DV) either creativity or hemispheric activation and as an independent variable (IV) either hemispheric activation or creativity, respectively. Only primary empirical investigations published in English were included in the search. All studies involving clinical population were excluded. The entire retrieval process resulted in 52 independent studies with 5601 participants in total (mean = 74; $N_{\min} = 5$; $N_{\max} = 289$).

Study coding. The coding was performed by two of the authors independently. Any discrepancies in the judgments were discussed

¹ Search with the term “laterals\$” yielded a smaller number of studies all of which were in fact found in the “hemispher\$”-term search.

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