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Impact of Interhemispheric Integration on Creativity

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Abstract

Present study sought to investigate the impact of Interhemispheric integration on creativity. There is scarcity of research investigating the relation between Interhemispheric integration and creativity. Literature has shown that much of the work is based on neurological studies. There is scarcity of empirical literature on Interhemispheric integration and its impact on creativity. Objective of the present study is to determine the impact of Interhemispheric integration on creativity. Study suggested that Interhemispheric integration positively predicts creativity. Young adults with age range of 19 to 25 were focused. Data was collected from 250 individuals from different departments of Quaid-iAzam University. Design of the study was experimental. Interhemispheric integration experiment was used [1]. 2×4 factorial design was used. Experiment consisted of two conditions (Spatial and Symbolic) having four levels of stimulus presentation (left, right, center and split). Creativity was measured through Biographical inventory of creative behaviors [2]. Results did not support the hypothesis of the study. No relationship was found between Interhemispheric integration and creativity. Present study concluded that interaction and integration of both hemispheres does not affect creativity of individuals.

Introduction

In present era of life creativity has gained much importance in almost every field and in everyday life. Essential activity of human information processing is creativity [3]. Creativity has been studied through different perspectives such as social, psychological, developmental, cognitive and historical. Whereas the neuroscience of creativity is in its developing phase. Among all the human abilities, the most complex is creativity. Despite the decades of experimental research, some questions regarding the nature of creativity are still understudied. For instance, what type of operations is involved in creative thinking? Whether these operations are interdependent or not? How creativity is instigated in brain? These questions were essential for the understanding of cognitive neuroscience of creativity [4-8].

In the neuroscience of creativity, the most prevailing research approach described the neurological foundations and then linked the neurological correlates of the creativity task to other cognitive processes [8-12]. Two creativity tasks and two control tasks were administered in a study and areas of brain i.e., anterior inferior frontal cortex, temporal poles, and lateral frontal polar cortex were reported, which correlated with creativity tasks [13].

Creativity

The study of creativity within psychology gained importance after the work of Guilford (1950), before that creativity has been neglected as a research topic. An ability to produce original, unique, flexible and useful ideas which are not inhibited by traditional mental habits refers to creativity. The generation of effective novelty is suggested as being the most commonly used definition of creativity [14,15] indicated the fact that only novelty is not enough for creativity rather usefulness and adaptability are the most essential components of any creative idea. Originality is not sufficient for creativity, even though it is a significant and necessary component of creativity (Runco, 2004). In a constantly changing and challenging environment, flexibility of thought is also important. When flexibility is coupled with originality, creative individuals respond effectively and efficiently to challenging environment [16]. As such, creativity lie beneath problem solving, it enables the production of original, suitable and effective solutions to the challenges that come across.

Suggested that creativity is adaptive in the sense that more creative individuals enjoy greater physical and psychological health. According to creativity can be seen as signal of genetic viability as it is associated with general intelligence which is further linked to overall genetic quality. Problem solving, adaptability and self-expression is enhanced by creativity which is an essential component of human functioning [17-20].

Horan (2009) defined creativity as the capacity to generate novel and useful ideas. It is a way of accepting originality. Unique connections are made between desperate ideas through creativity [21].

Creativity is an ability in which innovative ideas have significance which takes the help of new methods and situations to present a proper solution for any problem. Creative work includes any new discovery, thought or presenting old notions in a new manner. Creativity is a mixture of several abilities or traits. Although the term creative is often reserved for those who are known for their creative output, some make the case that daily life involves thinking things and doing things that, at least in some small way, have never been thought or done before, and thus that everyone is somewhat creative [22,23]. Creativity research has traditionally been intrigued with exceptionally creative people and their achievement [24], but more recently, much attention has been devoted to more wide-spread forms of creativity as manifested in everyday creativity [25]. Everyday creativity can be defined as creative activities taking place in one's leisure time which involves creative activities of personal significance rather than publicly recognized accomplishments Everyday creativity corresponds to the concept of little-c creativity, which is to be distinguished from Pro-c and Big-c creativity that reflect professional and genius levels of creativity [26-30].

Verbal creativity is a form of creativity that underlies prose, poetry, irony, puns, humor, etc. Verbal creativity, in particular, is a phenomenon of creativity, in general; other forms of nonverbal creativity include visual creativity (painting) and physical creativity (ballet). Like creativity in general, the processes underlying verbal and nonverbal creativity can be dissociated and interpreted by the creative cognition approach. Verbal creativity relies on semantic associations, the ability to go beyond given words and dominant associations (akin to anchoring and adjusting), inhibition, fluency and speed of processing, and experience. Nonverbal creativity relies on perceptual reference frame adjustment, inhibition, fluency, and experience.

Interhemispheric Integration (IHI)

Inter-hemispheric integration (IHI) is the exchange, coordination, or inhibition of information between the hemispheres. There are two cerebral hemispheres. Left hemisphere and right hemisphere. Each interconnects with the other through the corpus callosum and anterior commissure. IHI refers to what information and how information is communicated between the two hemispheres. IHI is likely not one process, but a set of processes. Inter-hemispheric integration requires different information presented to left and right visual fields to be compared and analysed to make a decision [30-35].

When considering a task which requires the subject to indicate whether two stimuli presented to the same visual field are physically identical (within hemisphere condition), Interhemispheric connection is not required. However, if one of two stimuli is presented to each visual field, respectively (between hemisphere condition), the task requires some collaboration or sharing of information between hemispheres. That is, the comparison of within hemisphere (unilateral) and between hemisphere (bilateral) conditions provides important information on Interhemispheric integration [36].

Integration of differing information across hemispheres can be examined by utilizing Banich's Interhemispheric integration paradigm. In the classic version of the across field advantage visual field task, a different probe letter is displayed in both the left and right visual field and both are presented relatively toward the top of the display. A third letter, the target, is presented in either the left or the right visual field and is presented more central and toward the bottom of the display. Participants decide whether or not the target matches one of the probes. There are two types of match trials with variations on visual field and complexity. For visual field, there are two levels: the target matches a probe in the same visual field (within) or opposite visual field (across). For complexity, there are two levels: the target is the same physical letter as the probe (physical identity; e.g., A-A) or the target is the same name as the probe (name identity; e.g., a-A). Weissman & Banich (2000) have found that there is a within-field advantage for simple tasks, but an across-field advantage for complex tasks. Participants are faster to respond to the simple, physical identity condition when the stimuli are both in the same visual field. Participants respond more quickly in the name identity condition when the matching stimuli are in different visual fields. There appears to be a processing cost for information transfer and integration between the hemispheres. Hence, for simple tasks, it is more efficient to process information in one hemisphere whereas it is more efficient for complex tasks to distribute the processing between hemispheres. The across-field advantage task demonstrates Interhemispheric processing because information from one visual field cannot simply be summated with information from the other visual field – an integration of physically different stimuli must occur.

The organization of the visual system is primarily contralateral such that information from the left visual hemi field is initially processed in the right hemisphere while information from the right visual hemi field is processed in the left hemisphere. Although information from these separate pathways is eventually integrated via the connecting fibers of the corpus callosum, various studies have reported enhanced performance when items are distributed across both hemi fields such that both the right and left hemispheres receive the initial input, compared to when a single hemisphere processes the same amount of information. This effect has been termed the bilateral distribution advantage. In bilateral gain research, participants' performance for lateralized trials (i.e., when a stimulus is presented to a single visual field) is compared to bilateral, redundant, trials (when identical stimuli are simultaneously presented to both visual fields). Generally, it has been shown that participants are faster when information is presented bilaterally [37-45]. An explanation for why bilateral redundant presentation leads to faster performance than lateralized trials is that the hemispheres combine information or activation (Miller, 2004). One plausible way this could occur is through a summation of bilateral associations leading to activation above a given threshold. Additionally, it is plausible that information above the perceptual level is shared between the hemispheres. Found bilateral gain in a lexical decision task for words but not for pronounceable non-words; this suggests that bilateral gain effects are not merely perceptually based, but can be sensitive to semantic content.

Creativity involves cognitive processes ranging from perception to semantic activation to expertise and decision-making which means that many brain areas are associated with creativity. The right hemisphere has been proposed to be the seat of human creativity. Torrance also found that creativity resides among the right hemisphere's processing.

Interhemispheric Integration and Creativity

Rather than a lateralized right hemisphere locus for creativity, an alternate view holds that creativity results from the large-scale interaction of neural networks, and integration of information, between the hemispheres. According to this model, both hemispheres play a critical role in creative ideation, and it is in their interaction that creativity has its genesis. In the light of the pervasive right hemisphere creativity view, across many studies, both hemispheres are involved in creativity . Confirmed the importance of inter-hemispheric interaction during the execution of creative tasks through the measure of EEG coherence while participants completed verbal, visual and musical creativity tasks. All the tasks prompted increased intra- and inter-hemispheric long-distance coherence in comparison to the baseline, highlighting the importance of communication and cooperation between distant and disparate brain regions in tasks requiring creative ideation. Similar findings were reported by Carlson, Wendt, and who measured regional cerebral blood flow while high- and low-creativity participants completed tests of verbal creativity (including alternate uses). Their results indicated increased bilateral blood flow in the highly creative group while performing the alternate uses task, whereas the non-creative group relied predominantly on the left hemisphere. Such findings suggest that an ability to engage both hemispheres leads to the generation of more creative solutions than relying predominantly on one side of the brain, implying that Interhemispheric interaction is a vital component of the creative process.

One of the hallmarks of creativity is that memory is searched more widely and in a less-defined manner than that seen during every day thinking. This broader memory search allows for the connection of disparate and distant concepts, fostering the generation of the truly novel ideas that are characteristic of creative thought. Such thinking is often termed divergent thinking, and is the foundation for creative ideation. This characteristic form of creative thinking uses information in existing semantic knowledge structures, including categories and schemas, as the starting point for generating novel entitie, from which memory is searched without directional boundaries. Interhemispheric interaction would clearly be valuable here as the integration of information from both the left and right hemispheres via Interhemispheric interaction can bring together more distantly related semantic concepts than if a memory search were theoretically restricted solely to one region or one hemisphere. Little wonder then that research examining hemispheric activation during divergent thinking tasks confirms the engagement of both hemispheres. Foley and Park's (2005) near-infrared optical spectroscopy study found evidence of bilateral frontal activation while participants performed the alternate uses tasks (a measure tapping divergent thinking) [46-51].

Interhemispheric interaction is similarly important in the ability to apprehend humor, as this is, in essence, a creative act. Jokes involve juxtaposing seemingly unrelated ideas, and/or approaching material from novel vantage points, both of which form core components of creativity. Findings that damage to either side of the brain compromises humor are thus consistent in suggesting that creativity requires the function of both hemispheres. For example, when asked to select the appropriate punch line for a joke, patients with left hemisphere damage choose the logical but unfunny option, whereas patients with right hemisphere damage favor a surprising slapstick, but logically incoherent; Gardner. The ability to successfully integrate content across parts of a narrative in a coherent fashion (left hemisphere) combined with the capacity to revise initial interpretation to understand hidden meaning and retain the element of surprise (right hemisphere) suggests that hemispheric interaction is needed during the creative act of understanding humor.

Carlson, Wendt and Rydberg aimed to investigate the relationship between creativity and hemispheric asymmetry. They measured regional cerebral blood flow while high and low creativity participants completed tests of verbal creativity and found the increased bilateral blood flow in highly creative group. Gibson, Foley, and Park (2009) demonstrated a qualitative and quantitative difference in brain activation between musicians and non-musicians, using near-infrared optical spectroscopy to measure activation during a divergent thinking task. Results indicated that musicians engaged bilateral frontal cortical networks, whereas non-musicians' pattern of activation was predominantly left-literalized. Such findings imply that creative training enhances Interhemispheric communication, which, in turn, fosters creative ideation and enhances creative performance.

The enhanced Interhemispheric interaction noted in more creative individuals suggests that training leads to changes in neural processing, and indeed, research confirms that the brains of people engaged in creative professions differ reliably from those employed in other realms. For example, musicians' brains differ from those of non-musicians, showing a reduction in hemispheric asymmetry and more efficient hemispheric interaction [52-55], both characteristics linked to enhanced creative thinking.

The research strongly suggests that creativity is contingent upon Interhemispheric interaction: enhanced interaction enhances creativity. Such a relationship appears consistent with Aldous's recent model of creative thinking. Quantitative assessment of the way in which 405 people solve problems led Aldous to propose that creative thinking involves the interplay between a series of three processes: (1) the interaction between visual-spatial and analytical-verbal reasoning; (2) listening to the "self"; and (3) the interaction between conscious and non-conscious reasoning. Step 1 of Aldous's model necessarily involves interaction between the left and right hemispheres, given that visual-spatial processing is predominantly controlled by the right hemisphere, and analytical-verbal reasoning is a function of the left hemisphere. Consequently, the findings of increased hemispheric interaction in creative thinkers discussed in this section completely support Aldous's proposition that creativity requires interaction between the modes of thinking characteristic of the left and right hemispheres.

The enhanced creative thinking ability reported in left-handers could also be viewed as consistent with the hemispheric interaction model of creativity. As mentioned previously, left-handers' dominant hand is controlled by their right hemispheres, allowing more immediate access to processes lateralized to the right hemisphere.

However it is important to note that left-handers' brains are typically less discretely lateralized than those of right handers, and indeed, left-handers show more efficient hemispheric interaction than right handers. Consequently, the over-representation of left handers in creative professions and enhanced creativity reported in left handers appear consistent with research showing that enhanced interaction and integration of information between the hemispheres facilitates creative ideation [56-68].

Not all investigations have found that increased Interhemispheric interaction is linked to enhanced creativity. recently examined the intra- and inter-hemispheric networks activated during divergent thinking tasks. Contrary to their expectation of enhanced

Interhemispheric connectivity in creativity, they found that performance on the Torrance tests was negatively correlated with the size of the corpus callosum. Moore et al. suggest as one explanation that the incubation of ideas necessary during divergent thinking is effectively a lateralized process; it is the temporary inhibition of hemispheric modularity, and the communication of information between the hemispheres, that leads to the illumination or "aha!" component of creativity.

This notion is not new, having originally been proposed by Bogen. They argued that the highly creative brain is more regionally specialized, or "modular", than the less-creative brain; the momentary suspension of modularity allows the facilitation of Interhemispheric communication, leading to illumination and creative innovation. Jussive examination of EEG coherence offers support for greater modularity in the creative brain, confirming that highly creative individuals show greater decoupling between regions than less-creative individuals.

In a study investigating resting-state functional connectivity and creativity, Lots, Erhard, Neumann, Eickhoff, and found a positive relation between increased creativity scores and increased connectivity between right hemispheric caudate and left intraparietal sulcus, the former associated with executive control functioning (Berger & .

For experts in creative writing, Lots et al. found decreased resting functional connectivity between left and right inferior frontal gyri, which are associated with semantic selection (Jung-Beeman, 2005). Again, creativity was not associated with any one particular hemisphere but was associated with bilateral patterns.

The reviewed literature suggests that creativity is a distributed, whole-brain process. Rather than being solely a function of the right hemisphere, the present study sought to investigate the impact of Interhemispheric integration on creativity.

Materials and Methods

Research Design

The design of the present study is experimental. 2×4 factorial design is used in current study. The aim of the study is to explore the impact of Interhemispheric integration on creativity among young adults. Interhemispheric integration experiment was used. Experiment was performed in the online cognition lab under controlled conditions. Students were approached individually and experiments were conducted individually in a separate room avoiding noise and distraction. Laptop with 16.32 inch screen was used. Experiment was conducted individually.

Interhemispheric Integration

Digit comparison task was used to explore the connection of hemispheres. The task used is the modified version of letter matching paradigm by Posner and, which consisted of a pair of letters (one upper case and one lower case) which were presented in the left or right from center of the screen. In this experiment the differences between direct recruitment of cognitive resources versus Interhemispheric integration were studied by presenting spatial and symbolic tasks either in left or right visual field. Experiment consisted of 8 blocks. Each block contained 35 trials, making total of 280 trials. There was a fixation point in the middle of the screen, participants had to focus on the fixation point throughout the experiment. The digits were presented to the left and right visual field, center and on some distance of about 140mm from the fixation point. The task was to identify either the presented digits are same or different for the first four blocks. In the next four blocks, the task was to identify whether the sum of the two digits is greater than 9 or less or equal to nine. Configurable font size for stimulus was 18mm. Exposure time of stimulus was 180ms. For responses, two keys, X and M were identified. Participants responded to the stimulus by pressing one of the keys identified for specific response. If the digits were same, participants had to press M key and if the digits were different, the participants had to press the X key. Similarly, if the sum of the two digits was greater than 9 then the specific response key was M and for sum less or equal to nine, identified response key was X. same or different digits represented the spatial task. While sum greater or less than 9 represented the symbolic task. Scores for Interhemispheric integration were computed by subtracting the direct recruiting conditions from the contralateral conditions. For spatial tasks, right visual field scores were subtracted from scores of left visual field. While for symbolic tasks, scores of left visual field were subtracted from right visual field. For measuring creativity, biographical inventory of creative behaviors was used.

Biographical Inventory of Creative Behaviors

Biographical inventory of creative behaviors was used in present study to assess the creativity of young adults. The biographical inventory of creative behaviors is a self-report measure of the tendency of an individual to engage in creative activities. Biographical inventory of creative behaviors contains 35 items with forced choice (yes/no) response format. The alpha reliability of the biographical inventory of creative behaviors is 0.76 respectively.

Sample

Sample of the study consisted of 250 young adults. Data was collected from different university students. Convenient sampling technique was used in the present study. Age ranged from 19 to 25 years.

Procedure

The present study was based on experiment. Informed consent was taken from the participants and afterwards demographic sheet and questionnaire was given to the participants. Demographic sheet asked for age, gender, years of education, number of siblings, birth order, marital status, employment status, family system and dominant hand. Experiment was conducted after the students have filled the questionnaire. Participants performed the experiment in the presence of researcher. Proper guidelines were given before the start of the experiment. Experiment was performed in the online cognition lab. Laptop of 16.32 inches screen was used.

Results

Statistical analysis was conducted to achieve the objectives of the study. Exploratory factor analysis was used for exploring the factors of biographical inventory of creative behaviors. The psychometric properties were established through analyzing the data. Internal consistency of the scale was established through Cronbach's alpha reliability coefficient. Distribution of scores was assessed through mean, standard deviation, skewness and kurtosis. To determine the relationship between variables Pearson Product Moment coefficient was used. Group differences were explored by computing independent sample t-test and one way analysis of variance (ANOVA). Regression, moderation analysis were used for hypotheses testing.

Exploratory Factor Analysis (EFA) of Biographical Inventory of Creative Behaviors

S.No	Item no.	Statements	Factor loadings (λ)		
			λ1	λ2	λ3
1	11	Drawn a doodle.	0.67		
2	23	Adapted an item and used it in a way that was not designed to be, in what you consider to be ingenious way.	0.63		
3	5	Designed and produced a textile product (e.g. made an item of clothing or house hold object).	0.58		
4	8	Drawn a cartoon.	0.51		
5	21	Made someone a present.	0.49		
6	6	Redesigned and redecorated a bedroom, kitchen, personal space etc.	0.48		
7	13	Formed a sculpture using any suitable materials.	0.47		
8	7	Invented and made a product that can be used.	0.40		
9	15	Produced your own food recipes.	0.33		
10	18	Produced a theory to explain a phenomenon.		0.64	
11	31	Devised an experiment to help understand something.		0.57	
12	29	Delivered a speech.		0.56	
13	12	Had an article published?		0.56	

14	33	Been made a leader / captain of a team / group (e.g. debating society, chairperson, captain of the hockey team etc.).		0.53	
15	24	Published research.		0.44	
16	9	Started a club, association or group.		0.38	
17	17	Produced your own website.		0.33	
18	16	Produced a short film.			0.62
19	28	Acted in a dramatic production			0.56
20	27	Produced a portfolio of photographs (NOT photographs of a holiday, party etc.).			0.47
21	4	Produced a TV / Play script.			0.47
22	25	Choreographed a dance.			0.43
23	32	Made up a joke.			0.39
24	19	Invented a game or other form of entertainment.			0.37
25	34	Composed a piece of music.			0.35
26	26	Designed and planted a garden.			0.34
27	1	Written a short story.			0.31

Note. λ = factor loadings of items.

Table 1: Factor analysis for biographical inventory of creative behaviors through principal component analysis by using promax method (N =250).

Table 1 shows the factor analysis of biographical inventory of creative behaviors. Principal component analysis with promax rotation was used. Sample adequacy with Kaiser-Meyer-Olkin (KMO) = 0.78 was shown by the factor solution. Assumption of sphericity was also supported by significant Bartlett's test ($p < .05$). Items with factor loading above .30 were retained, indicating that items fall in the acceptable range of above .30 factor loading .items are well indicators of creativity. While the items that cross-loaded and items that did not show any factor loading were deleted. The three meaningful factors extracted from the data explained a total of 28.89% of the item variance.

Variables					**Range**			
	No. of items	**α**	**M**	**SD**	**Min**	**Max**	**Skewness**	**Kurtosis**
IHI	-	-	-7.21	34.12	-139.41	80	-.51	1.05
IHM	-	-	17.99	47.19	-168	166	.03	.69
BDA	-	-	-14.03	49.76	-163	198	.25	1.69
IHI-LH	-	-	2.22	56.69	-177	153	-.38	.74
IHI-RH	-	-	-140.35	104.08	-538	114	-.89	2.10
BDA-LH	-	-	3.02	80.99	-341	215	-.60	1.83
BDA-RH	-	-	22.61	57.98	-178	219	.19	1.30
Creativity	35	.84	12.04	6.04	1	25	-.03	-1.0

AC	9	.69	3.95	2.19	0	9	.20	-.80
FC	8	.69	1.92	1.80	0	7	.82	-.05
EC	10	.63	2.90	2.06	0	9	.72	.05

Table 2: Descriptive statistics for study variables (N=250)

Note. M = mean, SD = standard deviation, IHI = Interhemispheric integration, IHM = Interhemispheric motor integration, BDA = bilateral distribution advantage, IHI-LH = Interhemispheric integration specific to left hemisphere implied by task, IHI-RH = Interhemispheric integration specific to right hemisphere implied by task, BDA-LH = bilateral distribution advantage specific to left hemisphere implied by task, BDA-RH = bilateral distribution advantage specific to right hemisphere implied by task, AC = aesthetic creativity, FC = functional creativity, EC = expressive creativity.(Table 2) shows the mean, standard deviation, skewness and kurtosis values of the study variables. The values of skewness and kurtosis are in acceptable range of -2 to +2 (George & Mallery, 2010), which indicates that data was normally distributed except for the Interhemispheric integration specific to right hemisphere implied by task and reaction time, whose values are not in acceptable range. The reliability of the biographical inventory of creative behaviors is .84. Reliability of aesthetic creativity, functional creativity and expressive creativity is .69, .69 and .63, respectively, which is in acceptable range of .60 to .90 (Bland & Altman, 1997), indicating the good internal consistency.

S. No	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Age	-	-.12	.61**	.11	-.03	-.17**	-.13*	-.17**	.01	-.04	.17**	.08	-.01	.12	-.01	.05	-.07
2	Gender		-	.03	.06	-.05	-.11	.00	.18**	-.05	-.08	-.06	-.10	-.12	-.11	-.10	.15*	-.00
3	Years of Education			-	.12	-.02	-.14*	-.12	-.01	.00	-.04	.13*	-.02	-.03	.07	.02	.00	.03
4	Number of Siblings				-	.24**	-.03	-.10	-.01	-.02	-.04	.03	-.08	.04	.00	.04	-.03	-.03
5	Birth Order					-	-.03	.07	.10	-.07	.14*	.06	.01	-.04	.05	-.00	.03	.03
6	Residence						-	-.21**	-.01	.01	.08	-.08	.10	-.09	-.04	-.08	.10	.02
7	Marital Status							-	.18**	-.04	-.02	-.05	-.13*	.01	-.06	.00	-.04	.03
8	Employment Status								-	-.04	.09	-.02	-.03	-.09	-.02	.01	.06	.08
9	Family Status									-	-.06	-.08	.07	.00	-.12	.10	-.04	.05
10	Dominant Hand										-	-.02	.06	-.03	.01	-.06	.06	-.05

11	**IHI**											-	.04	-.08	.75**	-.00	.10	.02
12	**IHM**												-	-.12	.05	.09	.06	.11
13	**BDA**													-	-.10	-.05	-.79**	-.60**
14	**IHI-LH**														-	-.16**	.10	.04
15	**IHI-RH**															-	.06	.02
16	**BDA-LH**																-	-.00
17	**BDA-RH**																	-

Table 3: Correlation between study variables (N = 250)

Note. IHI = Interhemispheric Integration, IHM = Interhemispheric Motor Integration, BDA = Bilateral Distribution Advantage, IHI-LH = Interhemispheric Integration specific to left hemisphere implied by task, IHI-RH = Interhemispheric Integration specific to right hemisphere implied by task, BDA-LH = Bilateral Distribution Advantage specific to left hemisphere implied by task, BDA-RH = Bilateral Distribution Advantage specific to right hemisphere implied by task.

Table 3 indicates the relationship between study variables. The relationship between age and Interhemispheric integration is positively significant. Gender has positively significant relationship with bilateral distribution advantage specific to left hemisphere. Years of education has significantly positive relationship with Interhemispheric integration and creativity. Relationship between residence and creativity is positively significant. Marital status has negatively significant relationship with Interhemispheric motor integration. Interhemispheric integration specific to right hemisphere has significantly negative relation with creativity.

Variables	**Male (n=125)**		**Female(n=125)**			**95% CI**	**Cohen's d**		
	M	SD	M	SD	t	p		LL	UL
IHI	-5.11	31.16	-9.30	36.85	.97	.33	-4.30	12.70	.12
IHM	22.51	44.55	13.48	49.46	1.52	.13	-2.69	20.76	.19
BDA	-8.25	47.77	-19.80	51.22	1.84	.06	-.79	23.88	.23
IHI-LH	8.35	48.53	-3.90	63.42	1.71	.08	-1.82	26.32	.22
IHI-RH	-129.9	87.71	-150.7	117.65	1.58	.11	-5.06	46.64	.20
BDA-LH	-8.67	70.48	14.71	89.05	-2.3	.02	-43.39	-3.37	.29
BDA-RH	22.86	59.77	22.36	56.37	.06	.95	-13.98	14.97	.01
Creativity	12.26	6.09	11.82	6.01	.58	.56	-1.06	1.95	.07
Reaction time	63.65	89.98	67.73	196.64	-.21	.83	-42.18	34.01	.03
Attention	4.74	3.26	4.97	3.08	-.56	.58	-1.01	.56	.07

Table 4: Mean differences in study variables across gender (N=250)

Note: p< 0.01, p < 0.001, M= mean, SD= standard deviation, p = probability, CI = confidence interval, LL = lower limit, UL = upper limit, IHI= inter-hemispheric integration, IHM= inter-hemispheric motor integration, BDA= bilateral distribution advantage, IHI-LH= Inter-hemispheric integration specific to left hemisphere implied by task, IHI-RH= Inter-hemispheric integration specific to right hemisphere implied by task, BDA-LH= bilateral distribution advantage specific to left hemisphere implied by task, BDA-RH= bilateral distribution advantage specific to right hemisphere implied by task. (Table 4) explains that there is no significant difference across male and females except for bilateral distribution advantage specific to left hemisphere. Females (M = 14.71) scored higher on bilateral distribution advantage specific to left hemisphere implied by task than males (M = -8.67).

	Creativity			
		Model 2		
			95% CI	
Variables	**Model 1 B**	**B**	**LL**	**UL**
Constant	-.083	.382	-13.39	14.15
Age	-.484*	-.560*	-1.07	-.05
Gender	-.537	-.934	-2.53	.66
Years of Education	1.027**	1.108**	.537	1.68
Residence	2.137**	1.996*	.37	3.62
Marital Status	2.291	2.245	-.27	4.76
Family system	-.282	-.073	-1.64	1.50
Dominant hand	.867	.802	-1.71	3.32
Interhemispheric Integration		.017	-.033	.034
Interhemispheric Motor Integration		.008	-.022	.011
Bilateral Distribution Advantage		.064	-.023	.23
IHI-LH		-.002	-.023	.02
IHI-RH		-.010**	-.017	-.022
BDA-LH		.049	-.014	.111
BDA-RH		.052	-.014	.118
R^2	.084	.120		
ΔR^2		.037		
F	3.16	2.30		
ΔF		1.40		

Table 5: Multiple linear regression analysis for the effect of study variables on creativity, controlling for demographics (N=250)

Note: B = unstandardized regression coefficients, β = standardized regression coefficient, CI = confidence interval, UL = upper limit, LL = lower limit, IHI-LH = Interhemispheric integration specific to left hemisphere, IHI-RH Interhemispheric integration specific to right hemisphere, BDA-LH = Bilateral distribution advantage specific to left hemisphere, BDA-RH = Bilateral distribution advantage specific to right hemisphere.

Table 5 illustrates the unstandardized coefficients and confidence intervals for multiple linear regression analysis. The effect of demographic variables (age, gender, years of education, residence, marital status, family system and dominant hand) was controlled in model 1. Results show that among demographics, age, years of education and residence are the significant predictors of creativity. Whereas Interhemispheric integration specific to right hemisphere implied by task is negatively predicting creativity by 1% (B = -.010).

Discussion

Interhemispheric integration specific to right hemisphere was negatively correlated with creativity. Creativity is right hemispheric specific task, so less integration is involved in creativity tasks. Hypothesis of the study states, “Interhemispheric integration will foster the creativity of individuals.” Results did not support the hypothesis. No significant relation of interhemispheric integration with creativity was shown in correlation analysis.To evaluate the differences between male and female, t-test was conducted. 125 male and 125 females participated in current study. Results revealed that the only significant difference was of bilateral distribution advantage specific to left hemisphere implied by task among males and females. Females scored higher on bilateral distribution advantage specific to left hemisphere implied by task than males. Bilateral distribution advantage refers to better performance when the stimulus is presented bilaterally than unilateral representation. Previous literature suggested that females and males have different brains. Males have more asymmetric brain while female brain is more bilateral (Levy &. When the stimulus was presented bilaterally, females' performance was better than males.

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