© Journal of the Indian Academy of Applied Psychology
Jan 2016, Vol. 42, No. 1, 154-160

Disengaging Attention from Affective Stimuli: Evidence for Valence-dependent Lateralization in Emotion Regulation

Danielle M. Pereira and Azizuddin Khan
IIT Bombay, Mumbai, India

The objective of this study was to determine the effect of laterality and valence on the ability to disengage attention from affective stimuli. Thirty right-handed postgraduate students participated in the study. A tachistoscopic method was used in a 2x2 within-groups factorial design, with laterality of presentation (right versus left visual field) and stimuli valence (positive versus negative) as independent variables. Time taken to disengage attention from affective word primes in milliseconds was the dependent variable. Results showed that there was no main effect of either laterality or valence. However, a significant interaction effect was found indicating that the mean reaction time for disengagement of attention was shorter for negative stimuli presented to the right hemisphere, and for positive stimuli presented to the left hemisphere. This suggests that there is valence-dependent lateralization in the inhibition of affective information. The findings of this study have interesting implications for research on cognitive processes in emotion regulation.

Keywords: Attentional disengagement, Emotion regulation, Brain lateralization, Valence.

Currently, the two dominant views on brain lateralization of emotion are the valence hypothesis (Silberman & Weingartner, 1986) and the approach-withdrawal hypothesis (Davidson, 1992). Both assert that the left hemisphere is dominant for positive/approach emotions while the right hemisphere is dominant for negative/withdrawal emotions, respectively. This assertion is supported by a large body of neuropsychological research, including lesion studies (e.g. Gainotti, 1969; Goldstein, 1939), WADA test studies (e.g. Lee, Loring, Meader & Brooks, 1990; Terzian, 1964), and EEG studies (e.g. Hecht, 2010; Heller, 1993; Moratti, Fernandez, & Rubio, 2012). However, the specific nature that this dominance takes is not clear. Results across studies using the same methodology are not consistent. Gainotti (1989) reviewed a number of studies on left versus right brain damaged patients that did not find a clear difference in lateralization of emotion. Similarly, several researches have failed to demonstrate valence lateralization of emotion in EEG studies (Collet & Duclaux, 1987; Gotlib, Ranganath, Rosenfeld, 1998; Reid, Duke, & Allen, 1998). A meta-analysis by Wager, Phan, Liberzon, & Taylor (2003) found limited support for a simple valence-based lateralization of emotion in the brain and concluded that lateralization of emotion in the brain is more complex and region-specific than early theories proposed.

Davidson (1992) proposed that the reason for differing results in various studies is that anterior cerebral asymmetry predisposes positive versus negative responses only in the presence of a specific emotion elicitor. This elicitor was not always present or consistent in the prior studies and thus results differed. Moreover, studies show that, in normal individuals, baseline anterior asymmetry in the hemispheres predicts emotional reactions to a specific emotional challenge but, is unrelated to general emotional state (Davidson & Fox, 1989; Tomarken, Davidson, & Henriques, 1990). This suggests that the frontal left and right hemispheres play a role in regulating emotion in response to affective stimuli.

This idea would be in line with neuro psychological theories of emotion regulation that generally concurs in positing a cortico-limbic circuit wherein regions of the prefrontal cortex exert inhibitory control on the limbic structures responsible for emotions (e.g. Banks, Eddy, Angstadt, Nathan, & Phan, 2007; Phan et al,, 2005). However, there is a debate about the hemisphere to which inhibitory control is attributed. Some studies implicate areas of the left prefrontal cortex in the regulation of negative emotions (e.g. Jackson et al., 2003; Mak, Hu, Zhang, Xiao & Lee, 2009). Others have found greater activity of right frontal areas associated with regulation of negative emotions (e.g. Beauregard, Paquette, Lévesque, 2006; Leyman, De Raedt, R., Vanderhasselt, & Baeken, 2009). Ochsner, Ray, Robertson, Cooper, Chopra, Gabrieli, and Gross (2004) found right hemisphere structures to be dominant for the down regulation of emotions and left hemisphere structures to be dominant for up regulation of emotions. Apart from the contradictory results obtained, studies on emotion regulation usually only test the regulation of negative emotions, using negative affective stimuli. Research on the regulation or inhibition of positive emotions is scarce.

Another gap in the existing literature is the tendency, when conceptualizing and operationally defining emotion regulation, to focus on emotion regulation strategies rather than processes. Furthermore, among the various strategies known, most researches are carried out on distraction and cognitive reappraisal, with comparisons between the two being most common. However, for neuropsychological studies, it is more important to break emotion regulation down into its basic component processes, so as to identify the brain areas or brain structures involved. Also, while regulatory strategies may be many, they may be manifestations of relatively fewer underlying cognitive processes. Thus, studying the processes involved is a more efficient method. Given that attention is a primary and basic cognitive process in emotion regulation, studying how this process takes place in the brain is important.

Attentional biases are of two types, based on the vigilance and maintenance models of attention (Weierich, Treat, & Hollingworth, 2008). The vigilance model looks at the initial focusing of attention, or orienting. An orienting bias is when individuals show a tendency to focus much faster on stimuli of a certain type. The maintenance model is concerned with the holding of attention once focused. A maintenance bias occurs when there is a difficulty shifting attention away from a stimulus once that stimulus is in focus. In this study, the attentional bias considered is the maintenance bias, specifically disengagement of attention. This is because, in emotion regulation, shifting attention away from an affective stimulus is an important part of controlling one's emotional reaction. In disorders like depression, an inability to disengage attention has been found to be linked to difficulty in regulating negative emotion (Joorman, Yoon & Zetsche, 2007).

The direct link between hemispheric asymmetry and the emotional regulatory process of disengaging attention was studied by Leyman et al. (2009). In this pioneering study, it was found that one session of High Frequency repetitive Transcranial Magnetic Stimulation (HF-rTMS) over the right Dorso lateral pre-frontal cortex (DLPFC) produces instant impairments in the ability to inhibit negative information, while these impairments were not seen when HF-rTMS was applied over the left DLPFC. It is interesting that researchers found the impairment in disengaging attention to be immediate but, there were no similar immediate changes in mood as reported by the participants. These results were replicated in studies by De Raedt et al. (2010) and Vanderhasselt, Baeken, Hendricks and De Raedt (2011).

In this study the tachistoscopic method was used and the stimuli were presented to either left or right visual field, thus, controlling the processing by right versus left hemisphere, respectively. This method has been found to be successful in other studies on emotional valence and hemispheric specialization. Alfano and Cimino (2008) gave participants a consonant trigram task wherein subjects had to read aloud the consonants in a trigram presented in either the left or right visual field. A positive or negative affective word prime was presented before the target trigram. It was found that when preceded by a positive prime, participants were faster in reading trigrams presented to the left hemisphere. On the other hand, negative primes led to superiority for the right hemisphere. This interaction effect over-ruled the general left hemisphere advantage associated with verbal stimuli.

The objective of the present study was to determine the effect of laterality and stimulus valence on the ability to disengage attention from affective stimuli. The study, thus, attempted to fill three gaps in literature. It first explored the idea that emotion regulation, specifically attentional disengagement, is lateralized in the brain rather than emotion itself, by presenting stimuli to either the left or right visual field in an attentional disengagement task. Secondly, it included regulation of positive emotions as well as negative ones by including both positive and negative affective stimuli in the study. Thirdly, it studied emotion regulation in terms of a basic cognitive process involved, attentional disengagement, rather than a strategy like cognitive restructuring.

Given the findings of previously cited research on lateralization of emotion in the brain, it was hypothesized that the variables valence and visual field would interact to influence reaction times for the four groups in the 2x2 design, rather than either of these variables having an effect singularly.

Method

Participants

30 students (undergraduate to PhD candidates) from a reputed educational institute in Mumbai participated in the study. Of these, 15 were male and 15 were female. Subjects' ages ranged from 23 to 49 years (M= 28.6, SD= 5.83). All participants met the criterion of right handedness since studies have shown that left handed people may differ in hemispheric specialization from right handed people.

Design

The experimental design was a completely repeated measure of 2 (Laterality: Left Visual Field or LVF and Right Visual Field or RVF) X 2 (Valence: Positive and Negative) factorial design. Laterality was operationally defined as a presentation of the word prime five degrees to the left versus right of the centre of the screen. The positive and negative word primes and the neutral target stimuli were taken from the Balanced Affective Word List (Siegle, 1994). The affective-neutral pairs were controlled such that both words in each pair had the same initial letter. Order of presentation was randomized across subjects. The position of the affective and neutral words in the pair, that is "up" versus "down", was counterbalanced across trials.

Instrument

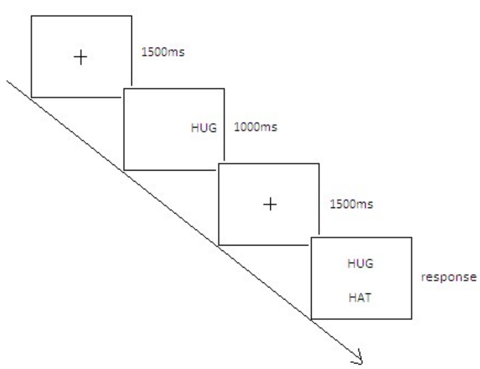
The paradigm of the experiment was computerized using the experiment builder software, OpenSesame version 0.27.4 (Mathôt, Schreij, & Theeuwes, 2012). An ASUS Eee PC 1015CX netbook was used with a 10.1 inch LED backlit screen having a resolution of 1024x 600 pixels.

Procedure

Data was collected individually from each subject. They were asked to record age, gender, education and handedness. They were then seated at a distance of approximately 30 cms from the screen. They then performed the attentional disengagement task on the laptop. In the studies by Leyman et al. (2009) and De Raedt et al. (2010), an exogenous cueing task was used. This task measures attentional disengagement indirectly, by presenting affective stimuli before an unrelated reaction time task. In this study, however, a new task was created that measures attentional disengagement more directly. Each subject was presented with the same block of 48 trials, that is, twelve trials in each of the four conditions – Positive-Left Visual Field, Positive-Right Visual Field, Negative-Left Visual Field and Negative-Right Visual Field. The 48 trials were presented in random order. Each trial consisted of the following sequence – (i) 1500 ms presentation of a fixation cross in the center of the screen, (ii) 1000 ms presentation of an affective word prime, either lateralized to the left or right visual field, (iii) 1500 ms presentation of the fixation cross at the center of the screen and (iv) presentation of the affective word prime paired with a neutral target presented one below the other at the center of the screen as shown in Figure No.1. In the current study, the exposure times were calculated to serve the dual purpose of being short enough to manipulate hemispheric processing as well as long enough to evoke the necessary emotional reaction. The parameters are modeled on exposure times of a set of experiments with a similar method but, different objective. These were conducted to determine the effect of affective primes on the ability to perform a consonant trigram identification task (Van Strien & Morpurgo, 1992; Van Strien & Heijt, 1995; Van Strien & Lupin, 1999; Alfano & Cimino, 2008).

Figure 1: The attention disengagement task. One complete trial included presentation of a fixation cross, an affective word display, another fixation cross and lastly the display of the affective-neutral word pair to which the participants had to respond.

The experimental task involved disengaging



indicating the new neutral word by pressing one of two keys. Disengagement of attention was operationalized as time taken to inhibit the primed response and indicate the neutral target. The paradigm is graphically represented below:

The instructions to each subject were presented on the screen at the start of the experiment and standardized as follows:

"Welcome! This is an experiment to measure category judgement. A cross will appear in the centre of the screen for a short time. It will then disappear, and a word will appear on either the left or right side of the screen. The cross will then appear again in the centre of the screen. After the second cross, two words will be shown in the centre of the screen, one below the other. One of these will be the word you have just seen; the other will be a new word. Your task is to indicate which word is new.

If the upper word is the new word, press up. If the lower word is the new word, press down.

Once again, your task is to decide which word is NEW and press the appropriate key. Be accurate but, also answer as quickly as possible. Throughout the task, please be in the same position; in particular, do not move your head. If you have any doubts, ask the researcher to clarify them."

Results

The objective of this study was to determine whether the ability to disengage attention from affective stimuli is related to the valence of the stimulus and the hemisphere that is processing it. A completely repeated measure of the 2 x 2 factorial design was used wherein all the subjects were exposed to the two independent variables, namely Visual Field and Valence. Mean reaction times were calculated for each level of these two independent variables separately as well as for each of the four possible level combinations as shown in Table 1.

Table 1. Mean reaction time and standard error in msecs for the two levels of each of the two independent variables

Variable	Level	Mean reaction time (msec)	Std. Error
Visual field	Left visual field	946.763	31.515

	Right visual field	936.131	32.295
Valence	Positive	938.336	32.055
	Negative	944.558	31.406

Mean reaction time for stimuli presented to the left visual field, that is, the right hemisphere was 946.76 msec as compared to 936.13 msec for stimuli presented to the right visual field, or left hemisphere. With respect to the second independent variable, valence, the mean reaction time for positive stimuli was 938.34 msec as compared to 944.56 msec for the negative stimuli. All descriptive statistics are reported in Table 2.

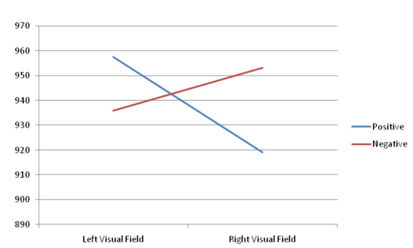
Table 2. Mean reaction time and standard deviation for each of the four interactions of visual field and valence

Condition	Mean	Std. Deviation	N
LVF_POS	957.5187	192.01754	30
LVF_NEG	936.0077	164.49284	30
RVF_POS	919.1533	172.81500	30
RVF_NEG	953.1087	190.04512	30

A two way repeated measure of ANOVA was carried out on the data. Results are reported in Table 3. No main effect was found for either of the variables i.e. for visual field ($F(1,29)= 0.88$, $p= 0.36$) or valence ($F(1,29)=0.46$, $p= 0.5$). However, a significant interaction effect ($F(1,29)= 4.43$, $p= 0.04$, partial eta-squared= 0.13) was found as shown graphically in Figure 2 & Table 3.

Figure 2: Mean reaction time in msecs for the variable Visual field as a function of Valence of the stimulus.

Table 3. Summary of two-way repeated measures of ANOVA results for the main effects of visual field and valence and for the interaction between the two



Source	df	F	Significance	Partial Eta^2
Visual field	1	.876	.357	.029
Valence	1	.459	.504	.016
Visual field *Valence	1	4.429	.044*	.132

*p < 0.05

Mean reaction time for disengagement was shorter for the negative stimuli (M=936.01, SD= 164.29) as compared to the positive stimuli (M=957.52, SD=192.02) when presented to the right hemisphere. The direction of difference was reversed for the left hemisphere where mean reaction time was shorter for the positive stimuli (M=919.15, SD=172.82) as compared to the negative stimuli (M= 953.11, SD=190.04).

Discussion and Conclusion

The objective of this study was to determine the effect of laterality and stimulus valence on the ability to disengage attention from affective stimuli. It was hypothesized that there would be a difference in reaction time for disengaging from positive versus negative affective stimuli and this difference would be mediated by presentation of the stimuli to the left versus the right hemisphere. This mediation was expected given that extensive research has found emotions to be lateralized in the brain, with the left hemisphere linked to positive emotions and the right hemisphere to negative emotions. As such, it was expected that the reaction time would not be singularly affected by either valence or laterality but, by the interaction between the two. This was supported by the results of the ANOVA in this study.

The results indicate that inhibition of positively valenced affective stimuli is faster when presented to the left hemisphere, while inhibition of negatively valenced information is faster when presented to the right hemisphere. This suggests that there is valence-dependent lateralization for the inhibition of affective information. Each hemisphere appears to be more efficient in terms of time in inhibiting affective stimuli when there is a match between the valence of the stimulus and the known valence dominance of that hemisphere. Results in this direction have not been reported by any of the dominant emotion regulation perspectives. However, generally, these neuropsychological studies measure emotion regulation in terms of regulatory strategies like cognitive reappraisal, which are higher level cognitive processes (Koole, 2009). Here, emotion regulation at its initial and most basic stage was measured. This study used a relatively small sample and thus, the interpretation value of results is limited. However, if replicated in a larger study, these findings have sizeable implications for research on cognitive processes in emotion regulation and disorders related to emotional regulation.

However, there are several limitations of the study. First, the stimuli used in the study were matched on valence but, not on arousal. Research has shown that stimuli differ in their level of arousal and this is an important influencing factor that should be controlled. Second, the affective and neutral pairs were matched on initial letters but, not on the word length. This made differentiating between the two easier for some pairs (e.g. BORED - BANANA), which would influence results.

References

Alfano, K. M., & Cimino, C. R. (2008). Alteration of expected hemispheric asymmetries: valence and arousal effects in neuropsychological models of emotion. *Brain and Cognition, 66*(3), 213–20.

Banks, S. J., Eddy, K. T., Angstadt, M., Nathan, P. J., &Phan, K. L. (2007). Amygdala-frontal connectivity during emotion regulation. *Social Cognitive and Affective Neuroscience, 2*, 303-312.

Beauregard, M., Paquette, V., Lévesque, J. (2006). Dysfunction in the neural circuitry of emotional self-regulation in major depressive disorder. *Neuroreport., 17*, 843-846.

Collet, L., & Duclaux, R. (1987). Hemispheric lateralization of emotions: Absence of electrophysiological arguments. *Physiological Behavior, 40*, 215–220.

Davidson, R.J. (1992). Anterior cerebral asymmetry and the nature of emotion. *Brain and Cognition, 20*, 125-151.

Davidson, R. J. & Fox, N. A. (1989) Frontal brain asymmetry predicts infant's response to maternal separation. *Journal of Abnormal Psychology, 98,* 127-131.

De Raedt, R., Leyman, L., Baeken, C., Van Schuerbeek, P., Luypaert, R., Vanderhasselt, M.A., & Dannlowski, U. (2010). Neurocognitive effects of Hf-rTMS over the dorsolateral prefrontal cortex on the attentional processing of emotional information in healthy woman: An event-related fMRI study. *Biological Psychology, 85*, 487-495.

Gainotti, G. (1989). Disorders of emotions and affect in patients with unilateral brain damage. In F. Boiler & J. Grafman (Eds.), *Handbook of Neuropsychology, Vol. 3*, 345-361, New York: Elsevier.

Demaree, H. A., Everhart, D. E., Youngstrom, E. A., & Harrison, D. W. (2005). Brain lateralization of emotional processing: Historical roots and a future incorporating "dominance". *Behavioral and Cognitive Neuroscience Reviews, 4*(1), 3-20.

Gotlib, I. H., Ranganath C., Rosenfeld, J. P. (1998) *Frontal EEG alpha asymmetry, depression and cognitive functioning. Cognition and Emotion, 12*(3), 449-478.

Hecht, D. (2010). Depression and the hyperactive right-hemisphere. *Neuroscience Research, 68* (2), 77-87.

Jackson, D. C., Mueller, C. J. C. J., Dolski, I., Dalton, K. M. K. M., Nitschke, J. B., Urry, H. L., Davidson, R. J. (2003). Now you feel it , now you don't: Frontal brain electrical asymmetry and individual differences in emotion regulation. *Psychological Science, 14*(6), 612–617.

Joormann, J., Yoon, K. L., & Zetsche, U. (2007). Cognitive inhibition in depression. *Applied and Preventive Psychology, 12*(3), 128–139.

Koole S. L. (2009). The psychology of emotion regulation: An integrative review, *Cognition & Emotion, 23*(1), 4-41.

Lee, G.P., Loring, D. W., Meader, K. J., Brooks, B. B. (1990). Hemispheric specialization for emotional expression: A reexamination of results from intracarotid administration of sodium amobarbital. *Brain and Cognition, 12*(2), 267-280.

Leyman, L., De Raedt, R., Vanderhasselt, M. A., & Baeken, C. (2009). Influence of high-frequency repetitive transcranial magnetic stimulation over the dorsolateral prefrontal cortex on the inhibition of emotional information in healthy volunteers. *Psychological Medicine, 39*, 1019-1028.

Mak, A. K., Hu, Z. G., Zhang, J. X., Xiao, Z. W., Lee, T. M. (2009). Neural correlates of regulation of positive and negative emotions: an fMRI study. *Neuroscience Letters, 457*(2), 101-106.

Mathôt, S., Schreij, D., & Theeuwes, J. (2012). OpenSesame: An open-source, graphical experiment builder for the social sciences. *Behavior Research Methods, 44*(2), 314-324.

Moratti, S., Fernandez, A. & Rubio, G. (2012). Neurophysiological and neuropsychological models of depression. In Lopez-Munoz, F. & Alamo, C. (Eds) *Neurobiology of depression*. Florida: Taylor and Francis.

Ochsner, K. N., Ray, R. D., Robertson, E.R., Cooper, J. C., Chopra, S., Gabrieli, J.D.E., and Gross, J.J. (2004). For better or for worse: Neural Systems Supporting the Cognitive Down- and Up-regulation of Negative Emotion. *Neuroimage, 23* (2), 483-499.

Phan, K. L., Fitzgerald, D., Pradeep, J. N., Gregory, J. M., Uhde, T. W., & Tancer, M. E. (2005). Neural substrates for voluntary suppression of negative affect: a functional magnetic resonance imaging study. *Biological Psychiatry, 57*(3), 210-219.

Reid, S.A., Duke, C.M. & Allen, J.J.B. (1998). Resting frontal electroencephalographic asymmetry in depression: Inconsistencies suggest the need to identify mediating factors. *Psychophysiology, 35*, 389-404.

Silberman, E. K., & Weingartner, H. (1986). Hemispheric lateralization of functions related to emotion. *Brain and Cognition, 5*, 322- 353.

Strien, J.W. van & Morpurgo, M.M. (1992). Opposite hemispheric activations as a result of emotionally threatening and nonthreatening words. *Neuropsychologia, 30*, 845-848.

Strien, J.W. van & Heijt, R. (1995). Altered visual field asymmetries for letter naming and letter matching as a result of concurrent presentation of threatening and nonthreatening words. *Brain and Cognition, 29*, 187-203.

Strien, J.W. van & Luijpen, M.W. (1999). Hemispheric facilitation as a result of threatening and nonthr eatening words: Blocked versus mixed presentation effects and order effects. *Neuropsychologia, 37,* 617-621.

Terzian, H. (1964). Behavioural and EEG effects of intracarotid sodium amytal injections. *Acta Neurochirurgica, 12*, 230-239.

Tomarken, A. J., Davidson, R. J., & Henriques, J. B. (1990). Resting frontal brain asymmetry predicts affective responses to films. *Journal of Personality and Social Psychology, 59*(4), 791–801.

Vanderhasselt, M., Baeken, C., Hendricks, M., & De Raedt, R. (2011). The effects of high frequency rTMS on negative attentional bias are influenced by baseline state anxiety. *Neuropsychologia, 49*(7), 1824–1830.

Wager, T. D., Phan, K. L., Liberzon, I., & Taylor, S. F. (2003). Valence, gender, and lateralization of functional brain anatomy in emotion: A meta-analysis of findings from neuroimaging. *Neuroimage, 19,* 513-531.

Weierich, M. R., Treat, T. A., & Hollingworth, A. (2008). Theories and measurement of visual attentional processing in anxiety. *Cognition & Emotion, 22*(6), 985–1018.

Manuscript received on 4th April 2015
Final revision received on 31st August 2015
Accepted on 2nd September 2015

Danielle Pereira, Ph.D research scholar, Psychophysiology Laboratory, Department of Humanities and Social Sciences, Indian Institute of Technology Bombay, Mumbai, India. Email: danielle.pereira@iitb.ac.in

Azizuddin Khan, Associate Professor, Psychophysiology Laboratory Department of Humanities and Social Sciences, Indian Institute of Technology Bombay, Mumbai, Powai- 400076, Maharashtra, India. Email: khanaziz@iitb.ac.in