p-ISSN: 2184-2205 e-ISSN: 2184-3414 ISBN: 978-989-53614-1-0 © 2022
https://doi.org/10.36315/2022inpact055

INTEGRATIVE RESEARCH REVIEW OF THE IMPACTS OF UNILATERAL HAND CLENCHING ON BEHAVIOR: CLINICAL IMPLICATIONS

Shannon Schierenbeck, & Ruth E. Propper
Psychology Department, Montclair State University (USA)

Abstract

Manipulations differentially activating the left or right cerebral hemisphere influence behavior in ways congruent with known theories of hemispheric lateralization of function. For example, rightward eye gaze increases positive mood via left hemisphere activity, and left unilateral nostril breathing increases right hemisphere spatial task performance. Determining under what conditions, and to what extent, simple techniques can be used to alter mental and emotional state holds considerable appeal because methods might be used as adjuncts to other tactics to mitigate negative affect in clinical situations, or to improve cognition in neurocognitive impairment. One method demonstrating promise for altering cognition and emotion, and that could be used in home-settings, is sustained unilateral hand clenching. The goal of the present paper was to analyze the literature to examine i. typical methods used for this manipulation; ii. in what manner such movements alter cognition and/or emotion; iii. whether one versus the other hemisphere, is particularly affected by manipulation. A literature search was conducted using relevant search terms, resulting in 24 articles. Across the literature, a wide range of domains was examined, including memory, decision making, creativity, language, emotion, and social perception, with many examining more than one domain. Nine included neurophysiological measures. Overall, 4 studies reported an impact of only unilateral right-hand clenching and 5 of only unilateral left-hand clenching, on behavior. Twelve reported an impact of both hand clenching conditions. Three reported no impact of hand clenching on performance. Future work should examine unilateral hand clenching in clinical populations.

Keywords: *Hemispheric lateralization, unilateral hand clench, emotion, cognition.*

1. Introduction

Manipulations that differentially activate the left or right cerebral hemisphere influence behavior in predictable ways. For example, increasing left, relative to right, hemisphere activity results in increased language ability, memory encoding, approach motivations, risk-taking, and attention to local details. Conversely, increasing right, relative to left, hemisphere activity is associated with superior spatial navigation, memory retrieval, withdrawal motivational states, risk-avoidance, and attention to global aspects of information. Some methods used to differentially activate the left or right hemisphere include mood induction (e.g.; Gable & Harmon-Jones, 2010) dichotic or monaural listening (e.g.; McCormick & Seta, 2012), unilateral gaze (e.g.; Propper, Brunye, Christman, & Januszewski, 2012), bilateral alternating gaze (e.g.; Christman, Garvey, Propper, & Phaneuf, 2003), unilateral finger tapping (e.g.: McElroy & Seta, 2004), unilateral hand clenching (e.g.; Goldstein, et al, 2010), unilateral nostril breathing (e.g.; Jella & Shannahoff-Khalsa, 1993) and sidewards body orientation (Drake, 1991).

Delineating under what conditions, and to what extent, simple techniques can be used to alter mental and emotional state holds considerable appeal; for example, such methods might be used as an adjunct to other tactics to mitigate negative affect in clinical situations, or to improve cognition in neurocognitive impairment. Even slightly effective methods that could be easily initiated and sustained in private and as needed by individuals, rather than only within a laboratory or clinical setting, could potentially dramatically improve mental health in some populations.

One method that has demonstrated promise for altering cognition and emotion, and that could theoretically be used in the home-setting, is sustained unilateral hand clenching. Via increased activity of one versus the other hemisphere, sustained unilateral hand clenching may result in a processing bias toward the more activated, contralateral, hemi-cortex, and to a hemisphere-concordant change in behavior. Neurophysiologically, it has been proposed that unilateral hand clenching increases contralateral activity of cortical motor areas. This cortical activity has been suggested to spread beyond motor cortex, to frontal areas involved in emotion and cognition (e.g.: Harmon-Jones, 2006), resulting in a bias in performance and experience aligned with known lateralization of hemispheric functions associated with a given (more active) hemisphere (and the one that is contralateral to the hand that is engaging in unilateral clenching).

If simply clenching and unclenching one versus the other hand can effectively alter emotion and cognition, this technique could offer patients an opportunity for non-pharmaceutical self-regulation, and potentially to increased self-efficacy, which is known to positively impact treatment effects. The goal of the present paper was to analyze the literature to examine i. typical methods used for this manipulation; ii. if and in what manner such movements alter cognition and/or emotion; iii. whether one versus the other hemisphere, and resultant alterations in behavior, are particularly amenable to such manipulation.

2. Methods

A literature search was conducted using the search terms: “unilateral hand clench*” in conjunction with “cognit*”, “emotion*”, "perception", "behavior*" brain*, neuro* and “emotion* and cognit*” in various databases. 47,989 non-duplicate studies were found. Earliest article found was from 1993, and end date was 2021. Articles referencing single unilateral forced nostril breathing, facial contractions, or contractions of other muscles or body parts, or that did not discuss the effects of unilateral hand contractions on cognition or/and emotion were excluded. Hand clenching must have been in neurotypical individuals, and articles had to have been written in English. Articles must have described empirical research, not be a review article, and must have been peer-reviewed. Articles were further screened by reading the abstract and looking for mention of domains of cognition such as perception, memory, decision making, learning, language ability and/or attention, or references to emotion, affect, or mood. Twenty-one articles were removed after a full text screen. Three articles were excluded during data extraction, as their research orientation was ambiguous, and they were ultimately excluded. A total of 47,941 articles were removed for relevance, with the final article count 24 (See Table 1). See Figure 1 for Prisma (Liberati et al., 2009) exclusion and inclusion application.

3. Results

Across the literature, a wide range of cognitive, perceptual and emotional tasks were used, over many different areas. The majority of studies examined more than one area. Nine included neurophysiological correlates of hand clenching. 6 used electroencephalograph (EEG), 1 used EEG and evoked response potentials, 1 used Functional Near-Infrared Spectrography (fNIRS), and 1 used Functional Magnetic Resonance Imaging (fMRI). Hand clenching typically resulted in contralateral hemispheric activity (6 studies), though some studies reported ipsilateral activity as well (3).

Specific techniques/instructions for unilateral hand clenching included squeezing/clenching an item (most frequently a ball, 21 studies). Participants were most frequently instructed to ‘clench as hard as you can’ (13 studies), though there were deviations in this instruction. Most commonly, participants squeezed the object for 45 seconds, followed by 15 seconds of rest, in a series of repetitions that varied from 2- 4 times per condition being examined (16 studies), though some seemingly idiosyncratic methods were also used (see Table 2).

Regarding emotion, 12 studies placed their findings within the context of affect. All significant findings were framed within known theories of hemispheric lateralization of emotion. 8 reported increased positive/approach emotions following right unilateral hand clenching, and 5 reported increased negative/withdrawal emotions following left unilateral hand clenching.

Regarding cognition, a wide range of domains were examined, including memory (4), attention (7), sports performance (3), language (1), creativity (3), social perception (4), and 2 that were unable to be classified. Much research examined more than one domain in a given article. Changes in these areas were consistent with known theories of lateralization of cortical functions.

Overall, 4 studies reported an impact of only unilateral right-hand clenching and 5 of only unilateral left-hand clenching, on behavior. Twelve reported an impact of both hand clenching conditions. Three reported no impact of hand clenching on performance.

p-ISSN: 2184-2205 e-ISSN: 2184-3414 ISBN: 978-989-53614-1-0 © 2022

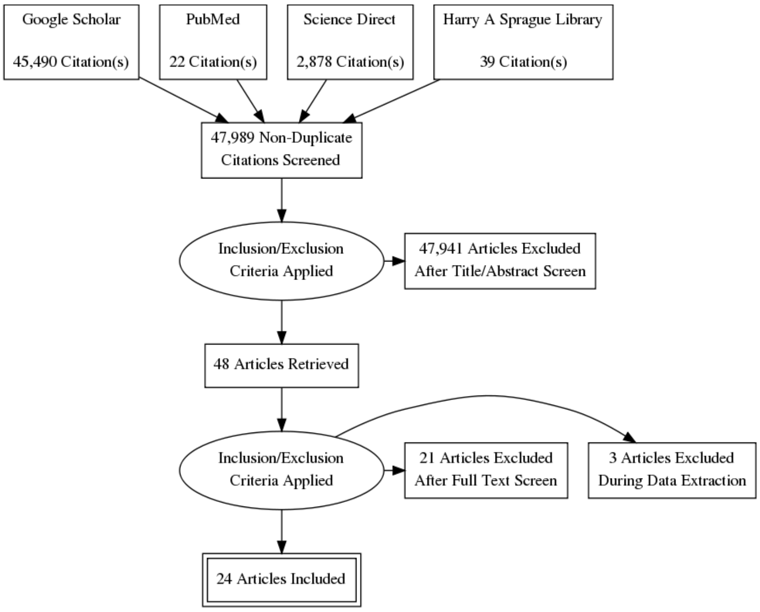
4. Discussion

Sustained unilateral hand clenching demonstrates an impact on cognition and emotion in a manner aligned with known hemispheric lateralization of functions. Neurophysiolgical mechanisms underlying the effects have been proposed, and have been replicated using different methodologies. Future research should examine the utility of unilateral hand clenching on cognition and emotion in clinical settings and populations. Sustained unilateral hand clenching might be a useful adjunct to traditional therapies in these circumstances.

Table 1. Authors and methods for included studies.

Authors	What was Clenched	How long they clenched
Andreau & Batán, (2018).	Two foam rubber balls (5 cm diameter)	45 seconds, relax for 15 seconds and then squeeze again for another 45 seconds. No instructions for squeeze strength
Baumann, Kuhl & Kazén (2005).	Soft ball	Experiment 1: Squeeze the ball for 1 minute Experiment 2: Squeeze 3 minutes. No instructions for squeeze strength
Beckmann, Fimpel, & Wergin (2021)	Racket grip or tennis ball	Squeeze racket or ball for 10-15 seconds Instructed to twice a second for 10–15 seconds with submaximal strength
Cross-Villasana, Gröpel, Doppelmayr & Beckmann (2016)	6 cm diameter soft rubber ball	45 seconds, relax for 15 seconds and then squeeze again for another 45 seconds. Instructed to squeeze the ball completely with all fingers.
Gable, Poole, & Cook (2013)	2.8-inch diameter rubber ball	45 seconds, relax for 15 seconds and then squeeze again for another 45 seconds. Instructed to squeeze as hard as they could
Goldstein, Revivo, Kreitler, & Metuki (2010).	7-cm diameter rubber ball	45 seconds, relax for 15 seconds and then squeeze again for another 45 seconds. Instructed to squeeze as hard as they could
Harlé & Sanfey (2015).	2-in. diameter rubber ball	45 seconds, relax for 15 seconds and then squeeze again for another 45 seconds. Instructed to squeeze as hard as they could
Harmon-Jones (2006)	5-cm diameter ball	45 seconds, relax for 15 seconds and then squeeze again for another 45 seconds. Instructed to squeeze as hard as they could
Hoskens, Masters, Capio, Cooke, & Uiga (2021).	Stress ball	45 seconds pre-task, ten blocks of 30 seconds during the task Instructed to firmly contract a stress ball at a self-paced rate
Mirifar, Cross-Villasana, Beckmann, & Ehrlenspiel (2020)	6 cm diameter soft rubber ball	Squeeze for 45 seconds Instructed to squeeze the ball completely with all fingers.
Moeck, Thomas & Takarangi (2020)	A moderately hard stress ball 6.37 cm diameter	45 seconds, 15-second rest Instructed to "squeeze the ball on-and-off, as hard as you can"
Nicholls, Bradshaw, & Mattingley (2001).	Just hand	2.5 – 3.5 seconds, during presentation of each stimulus No instructions for squeeze strength
Peterson, Shackman, & Harmon-Jones (2008)	Ball	45 seconds, relax for 15 seconds and then squeeze again for another 45 seconds. Instructed to squeeze as hard as they could
Peterson, Gravens, & Harmon-Jones (2010)	Toy ball	45 seconds, 15-second rest Instructed to squeeze as hard as they could
Propper, McGraw, Brunyé & Weiss (2013)	5cm diameter rubber ball	45 seconds, relax for 15 seconds and then squeeze again for another 45 seconds. Instructed to squeeze as hard as they could
Propper, Dodd, Christman, & Brunyé (2017)	Two pink, 5 cm diameter rubber racquetballs	45 seconds, relax for 15 seconds and then squeeze again for another 45 seconds. Instructed to squeeze as hard as they could
Prunier, Christman, & Jasper (2018)	Hand dynamometer	45 seconds, relax for 15 seconds and then squeeze again for another 45 seconds. Randomly assigned to squeeze the hand dynamometer at 0%, 25%, 50%, 75%, or 100% of their baseline maximum squeeze strength.
Rominger, Papousek, Fink, & Weiss (2014).	Customary training gripper	60-seconds total, followed by 60-second relaxation period No instructions for squeeze strength
Schiff & Truchon (1993)	2.5in diameter Rubber ball	45 seconds, relax for a few seconds, four times. No instructions for squeeze strength
Schiff & Lamon (1994)	2.5in diameter sponge ball	45 seconds, then relax, four times with intervals of 10 to 15 seconds between each contraction. Instructed to squeeze as hard as they could.
Schiff, Guirguis, Kenwood & Herman (1998)	5.08-cm diameter rubber ball	45 seconds, relax for 15 seconds and then squeeze again for another 45 seconds. Instructed to squeeze as hard as they could
Stanković & Nešić (2020)	Dynamometer	45 seconds, relax for 15 seconds and then squeeze again for another 45 seconds. Instructed to squeeze "as firmly as possible"
Turner, Hahn, & Kellogg (2017)	Tennis ball	45 seconds, relax for 15 seconds and then squeeze again for another 45 seconds. Instructed to squeeze as hard as they could
Walz, Doppl, Kaza, Roschka, Platz, & Lotze (2015)	Rubber ball	Instructed to press the ball with a target force of 33% MVC and 1 Hz clenching rate.

Figure 1. Prisma inclusion/exclusion application.



References

Andreau, J. M., & Torres Batán, S. (2018). Exploring lateralization during memory through hemispheric pre-activation: Differences based on the stimulus type. *Laterality: Asymmetries of Body, Brain and Cognition*, *24*(4), 393–416.

Baumann, N., Kuhl, J., & Kazén, M. (2005). Left-hemispheric activation and self-infiltration: Testing a neuropsychological model of internalization. *Motivation and Emotion*, *29*(3), 135–163.

Beckmann, J., Fimpel, L., & Wergin, V. V. (2021). Preventing a loss of accuracy of the tennis serve under pressure. *PLOS ONE*, *16*(7). E0255060

Christman, Stephen & Propper, Ruth & Phaneuf, Keri. (2003). Bilateral eye movements enhance the retrieval of episodic memories. *Neuropsychology. 17.* 221-9.

Cross-Villasana, F., Gröpel, P., Doppelmayr, M., & Beckmann, J. (2016). Correction: unilateral left-hand contractions produce widespread depression of cortical activity after their execution. *PLOS ONE*, *11*(2). e0150048

Drake, R. (1991) Processing Persuasive Arguments: Recall and recognition as a function of agreement and manipulated activation asymmetry. *Brain and Cognition 15,* 83 – 94.

Gable, P., & Harmon-Jones, E. (2010). The blues broaden, but the nasty narrows: Attentional consequences of negative affects low and high in motivational intensity. *Psychological Science, 21,* 211- 215.

Gable, P. A., Poole, B. D., & Cook, M. S. (2013). Asymmetrical hemisphere activation enhances global–local processing. *Brain and Cognition, 83, (3),* 337-341.

Goldstein, A., Revivo, K., Kreitler, M., & Metuki, N. (2010). Unilateral muscle contractions enhance creative thinking. *Psychonomic Bulletin & Review*, *17*(6), 895–899.

Harlé, K. M., & Sanfey, A. G. (2015). Unilateral hand contractions produce motivational biases in social economic decision making. *Neuropsychology*, *29*(1), 76–81.

Harmon-Jones, E. (2006). Unilateral right-hand contractions cause contralateral alpha power suppression and approach motivational affective experience. *Psychophysiology*, *43*(6), 598–603.

Hoskens, M., Masters, R. S. W., Capio, C. M., Cooke, A., & Uiga, L. (2021). The effects of unilateral hand contractions on conscious control in early motor learning. *The Journal of Sport and Exercise Science*, *5*(1). 21-31

Jella, S.A. & Shannahoff-Khalsa, D.S. (1993). The effects of unilateral forced nostril breathing on cognitive performance. *International Journal of Neuroscience, 73,* 61-68.

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gãtzsche, P. C., Ioannidis, J. P. A. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ* 2009; 339:b2700

McCormick, M., & Seta, J.J. (2011). A new method for selectively enhancing hemisphere processing: Voice frequency amplification influences the strength of attribute framing. *Laterality,* 17, 727-735.

McElroy, T., & Seta, J. J. (2004). On the other hand am I rational? Hemispheric activation and the framing effect. *Brain and Cognition, 55*(3), 572–580

Mirifar, A., Cross-Villasana, F., Beckmann, J., & Ehrlenspiel, F. (2020). Effects of the unilateral dynamic handgrip on resting cortical activity levels: A replication and extension. *International Journal of Psychophysiology*, *156*, 40–48.

Moeck, E. K., Thomas, N. A., & Takarangi, M. K. (2019). Using the landmark task to test the underlying assumptions of unilateral contraction research. *Laterality*, *25*(3), 363–389.

Nicholls, M. E., Bradshaw, J. L., & Mattingley, J. B. (2001). Unilateral hemispheric activation does not affect free-viewing perceptual asymmetries. *Brain and Cognition, 46*(1-2), 219-223.

Peterson, C. K., Gravens, L. C., & Harmon-Jones, E. (2011). Asymmetric frontal cortical activity and negative affective responses to ostracism. *Social Cognitive and Affective Neuroscience*, *6*(3), 277-285.

Peterson, C. K., Shackman, A. J., & Harmon-Jones, E. (2008). The role of asymmetrical frontal cortical activity in aggression. *Psychophysiology*. Jan;45(1):86-92

Propper, R. E., Dodd, K., Christman, S. D., & Brunyé, T. T. (2016). Relationship between sustained unilateral hand clench, emotional state, line bisection performance, and prefrontal cortical activity: A functional near-infrared spectroscopy study. *Laterality: Asymmetries of Body, Brain and Cognition*, *22*(6), 671–689.

Propper, R. E., McGraw, S. E., Brunyé, T. T., & Weiss, M. (2013). Getting a grip on memory: unilateral hand clenching alters episodic recall. *PLoS ONE*, *8*(4). E62474

Prunier, S., Christman, S., & Jasper, J. (2018). The effects of varying levels of hemispheric activation on episodic memory. *Laterality: Asymmetries of Body, Brain and Cognition*, *23*(4), 409–421.

Rominger, C., Papousek, I., Fink, A. & Weiss, E.M. (2014) Enhancement of figural creativity by motor activation: Effects of unilateral hand contractions on creativity are moderated by positive schizotypy, Laterality: Asymmetries of Body, Brain and Cognition, 19:4, 424-438

Schiff, B. B., Guirguis, M., Kenwood, C., & Herman, C. P. (1998). Asymmetrical hemispheric activation and behavioral persistence: Effects of unilateral muscle contractions. *Neuropsychology*, *12*(4), 526–532.

Schiff, B. B., & Lamon, M. (1994). Inducing emotion by unilateral contraction of hand muscles. *Cortex: A Journal Devoted to the Study of the Nervous System and Behavior, 30*(2), 247–254.

Schiff, B.B., Truchon, C. (1993). Effect of unilateral contraction of hand muscles on perceiver biases in the perception of chimeric and neutral faces. Neuropsychologia, Volume 31, Issue 12, 1993, Pages 1351-1365

Stanković, M., & Nešić, M. (2020). No evidence of improved emotion perception through unilateral hand contraction. *Perceptual and Motor Skills, 127*(1), 126-141.

Turner, C.E., Hahn, M.E., & Kellogg, R.T. (2017). Semantic processing in the left versus right cerebral hemispheres following unilateral hand contractions, Laterality: Asymmetries of Body, Brain and Cognition, Mar;22(2):219-232.

Walz, A., Doppl, K., Kaza, E., Roschka, S., Platz, T., & Lotze, M. (2015). Changes in cortical, cerebellar and basal ganglia representation after comprehensive long term unilateral hand motor training. *Behavioural Brain Research,278*, 393-403.