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The Origin of Emotion

Determining conscious processing of the facial feedback hypothesis

The facial feedback hypothesis states that sensory feedback from the contractions of facial muscles can influence mood. Researchers have demonstrated this effect, but have not been able to determine whether it occurs consciously or unconsciously (Dimberg & Söderkvist, 2011; Mori & Mori, 2010; Strack, Martin, & Stepper, 1988). The proposed study will determine if the facial feedback effect can occur through unconscious processing alone, allowing psychologists to better understand how the mind-body connection affects human emotion. The facial feedback effect will be viewed as changes in mood, which will be measured on scales using results from self-report questionnaires and emotional ratings of neutral photographs (Crawford & Henry, 2004; Libkuman, Otani, Kern, Viger, & Novak, 2007). Unconscious processing will be evaluated by using topical anesthetic to prevent a group of participants from feeling which of their facial muscles are being stimulated. Previous research has found little difference between individuals enacting the facial feedback effect using entirely conscious and semi-conscious techniques (Strack, Martin, & Stepper, 1988; Mori & Mori, 2009). Therefore, this study predicts that facial feedback effects are determined by unconscious processing and that strong facial feedback effects should be evident even when participants are not aware of the facial stimulation.

Keywords: psychology, facial feedback hypothesis, cognition, cognitive processing, consciousness, emotion, treatment, depression

The idea behind the facial feedback hypothesis was first conceptualized by Charles Darwin, who suggested that the expression and repression of emotions can, respectively, intensify and dampen feelings (1872). Building on this foundation, William James (1890) proposed that emotions arise from the perception of bodily changes, and that if no changes are felt, thoughts remain purely rational. However, these ideas were not elaborated upon until nearly a century later, when Silvan

Tomkins (1962) re-conceptualized the facial feedback hypothesis to allow for empirical testing: "the face expresses affect, both to others and the self, via feedback, which is more rapid and more complex than any stimulation of which the slower moving visceral organs are capable" (p. 205). This foundation continued to evolve into our current understanding of the facial feedback hypothesis: "skeletal muscle feedback from facial expressions plays a causal role in regulating emotional experience and behaviour" (Buck, 1980, p. 811). Studying this phenomenon can help us understand the origins and function of human emotions, as well as provide insight into how we form thoughts and judgments (McIntosh, 1996).

Many of the early facial feedback hypothesis experiments were aimed at defining the concept's theoretical boundaries. A seminal review of key experiments was done by Ross Buck in 1980 to determine whether the facial feedback hypothesis was a between-subjects phenomenon based on the emotional expressiveness of particular people, or a within-subjects effect that is situation-dependent but can affect everyone. Buck focused on two studies for his analysis. In the first, participants were repeatedly given electric shocks and told to exaggerate their pain, maintain artificial calm, or act naturally; skin conductance and subjective ratings of pain were found to vary significantly between the three groups (Lanzetta, Cartwright-Smith, & Kleck, 1976). In the second study, participants were asked to view and rate pictures while flexing facial muscles associated with smiling or frowning; their ratings determined that expressed emotions significantly influenced assessments of neutral stimuli (Laird, 1974). An analysis of these results led Buck (1980) to conclude that the facial feedback hypothesis was a within-subjects phenomenon that was consistent across individuals.

However, it was also noted that the methods used by the two studies were flawed (Buck, 1980). The principal weakness in Lanzetta's 1976 study was the possibility of demand characteristics, which could have resulted from participants being asked to express specific emotions. Laird's 1974 study attempted to control for demand characteristics by using deception to get participants to flex facial muscles without directly asking them to smile or frown. However, the results he obtained may nevertheless have been due to participants' ability to recognize and connect the contraction of their facial muscles to the corresponding emotions. While Laird opted to reinterpret conscious processing as the actual *modus operandi* of the facial feedback hypothesis (1974), other psychologists did not share this opinion and attempted to restructure their studies to eliminate the possibility of conscious processing (Buck, 1980; Izard, 1981; Winton, 1986; Adelmann & Zajonc, 1989).

These researchers attempted to build upon the technique of asking participants to suppress, exaggerate, or show normal emotional responding by disguising the purpose of asking participants to express emotions (Kraut, 1982), asking participants to display only parts of facial expressions (Rutledge & Hupka, 1985), and using physiological tests to measure bodily changes instead of relying on self-reports (McCanne & Anderson, 1987). These new approaches were highlighted by a pivotal experiment that attempted to bypass conscious processing by drawing participants' attention away from their facial muscles through clever misdirection (Strack, Martin, & Stepper, 1988). In this study, participants were told that the experiment was evaluating the difficulty people without hands had performing everyday tasks. They were given pens and asked to fill out a questionnaire that included the funniness rating of a cartoon, which was used to judge the facial feedback effect. Participants were then divided into three groups. The two test groups held their pens using their lips, which contracted the orbicularis oris muscle and created a frown, or their teeth, which contracted the zygomaticus major and risorius muscles and created a smile. The control group held their pens in their non-dominant hands. As predicted, results showed significantly more positive ratings of the cartoon when the participants inadvertently smiled. Additionally, this study effectively dealt with demand characteristics: "without an explicit probe, the participants expressed no suspicion about the study's purpose" (Strack, Martin, & Stepper, 1988, p. 773). In fact, the methodology of this approach appeared so sound that for the next two decades, studies would continue to test the facial feedback hypothesis using objects held in participants' mouths (Larsen, Kasimatis, & Frey, 1992), bandages that put pressure on their foreheads (Mori, & Mori, 2009), and elastics that pulled on key facial areas (Mori, & Mori, 2010). Unfortunately, while tests for demand characteristics did show that participants were not aware of the purpose of these studies, their emotional states may still have been influenced by connecting muscular contractions to the corresponding emotions. That is, these studies did not demonstrate whether the facial feedback hypothesis was driven by conscious processing of muscular feedback or by unconscious mechanisms.

Nevertheless, most researchers—satisfied with this new methodology—ventured instead into the study of new areas of facial feedback that included genuine versus forced smiles (Soussignan, 2002), the feedback effects of complicated emotional responses like crying (Mori & Mori, 2007), and previously untested emotions like surprise (Bermeitinger et al., 2013). Other psychologists were interested in determining whether facial feedback effects were sufficiently strong to induce an emotion that was entirely absent or whether these effects could only serve to intensify or temper existing emotions (Zajonc, Murphy, & Inglehart, 1989). One study that considered these possibilities examined a patient with a rare case of bilateral facial palsy, which caused facial paralysis (Keillor, Barrett, Crucian, Kortenkamp, & Heilman, 2002). The patient revealed that her ability to experience emotions was in no way affected by her condition. Testing using images from the International Affective Picture System (IAPS) (Bradley & Lang, 2007) led researchers to conclude that the facial feedback effect can only serve to modify existing emotions, not create new ones (Keillor, Barrett, Crucian, Kortenkamp, & Heilman, 2002).

This study served as an inspiration for a highly innovative exploration of the facial feedback hypothesis that used the paralyzing effects of botulinum toxin (BOTOX) to test whether the absence of afferent signals from facial muscles to the brain would diminish emotional states (Davis, Senghas, Brandt, & Ochsner, 2010). Using fMRI scans, the study determined that amygdala and brainstem activation in participants that were asked to imitate emotional expressions was significantly lower following BOTOX injections, indicating a strong facial feedback effect. While the aim of this study was to reaffirm that the facial feedback hypothesis only serves to modulate existing emotions, it also inadvertently served as a basis for determining whether the effect is driven by conscious or unconscious processing. Because the BOTOX rendered participants unable to feel their facial muscles contract, the study seemed to indicate that the facial feedback is interpreted unconsciously. However, the flaw in this study was its reliance upon asking participants to mimic specific emotions, thus reintroducing the possibility of demand characteristics and conscious processing.

The current proposal builds upon this research to determine whether the facial feedback effect occurs consciously or unconsciously, while at the same time eliminating the possibility of demand characteristics and participants' ability to feel their facial muscles contracting. Additionally, to determine the universality of the facial feedback effect, the proposed study would encompass several emotions and a diverse group of participants. Due to the ethical constraints of injecting key areas of participants' faces with BOTOX—the effects of which can last for months (Davis, Senghas, Brandt, & Ochsner, 2010)—as well as safety concerns arising from potential nerve damage and scarring (Coté, Mohan, Polder, Walton, & Braun, 2005), this study will instead use an effective combination of short-acting topical anaesthetics. To eliminate the demand characteristics that may result from asking participants to display specific emotions, it will rely upon neuromuscular electrical stimulation (Maffiuletti, Minetto, Farina, & Bottinelli, 2011) and instructions that portray the study as measuring the relationship between muscular tension and self-reflective thinking.

Since previous research has consistently demonstrated the facial feedback effect in participants with both high and moderate cognitive processing potential (Strack, Martin, & Stepper, 1988), this study predicts that facial feedback effects are governed largely by unconscious processing. As a result, it is expected that there will be no significant difference in emotional ratings of neutral images and emotional self-reports between the control group, which will be able to consciously feel their facial muscles being stimulated, and the test group, which will not. If, on the other hand, the control group shows a significantly greater facial feedback effect, it would suggest that the facial feedback effect involves some degree of conscious processing. It is not expected that the control group will show less of a facial feedback effect than the test group.

METHODS

Participants

The participants will be 144 York University undergraduate psychology students fulfilling their degree requirements (York University, 2013a).[1] Nonprobability quota sampling will be used to mediate recruitment costs while ascertaining external validity of the results across races and genders (N = 144; 72 males, 72 females; 48 participants of African descent, 48 of Asian descent, 48 of European descent).[2] Equal numbers of males and females will be used for each racial subset.

Apparatus and materials

This study will use a neuromuscular electrical stimulation (NMES) device (Maffiuletti, Minetto, Farina, & Bottinelli, 2011) to stimulate participants' facial muscles, and a topical anaesthetic to manipulate their ability to feel the stimulation. The NMES device will be a Hasomed Rehastim 2, which is often used in modern NMES studies (Vidaurre et al., 2013). In accordance with therapeutic facial stimulation procedures, the device will be programmed to produce electrical impulses at 50 Hz, in 4-second bursts (Vrbová, Hudlická, & Centofanti, 2008). Test group participants will have a cream containing 20% benzocaine, 6% lidocaine, and 4% tetracaine applied to their faces. These compounds have proven effective for inducing facial anaesthesia (Oni, Rasko, & Kenkel, 2013) and are safer than other topical anesthetics (Chowdhary et al., 2013).

Measurement of the facial feedback effect will be conducted using a pictorial test of affect and a self-report questionnaire. The pictorial test will consist of 20 neutral images from the International Affective Picture System (IAPS) (Bradley & Lang, 2007), which will be rated by participants on numerical scales of happiness, sadness, or anger ranging from one to five. These emotions were chosen as they have reliably produced the facial feedback effect in other studies (Mori & Mori, 2010; Strack, Martin, & Stepper, 1988). IAPS has proven to have high reliability of emotional and neutral ratings of its images (Libkuman, Otani, Kern, Viger, & Novak, 2007). The self-report questionnaire used to supplement the pictorial test results will be the Positive and Negative Affect Schedule (PANAS), which is a list of 20 emotions with corresponding numbered scales also ranging from one to five (Watson & Clark, 1994). Studies have confirmed that PANAS has high external and construct validity (Crawford & Henry, 2004).

The Mood and Anxiety Symptom (MASQ) questionnaire (Keogh & Reidy, 2000) will be used to determine if the administration of the topical anaesthetic increases anxiety or negative affect in participants, which could contribute to increased emotional responding in the latter tests. The possibility of demand characteristics will be evaluated using the Perceived Awareness of the Research Hypothesis (PARH) scale (Rubin, Paolini, & Crisp, 2010), which has been shown to effectively demonstrate if participants are aware of deception (Allen & Smith, 2012).

Experimenter bias will be controlled for by employing a quasi-double-blind design where neither the participants nor experimenters will be aware of which emotion is being induced in which participants (the electrodes will be attached and removed by a separate experimenter), but will be aware of control and test groups due to the transparency of the anaesthetic's numbing effects. Since the questionnaires and rating systems used in this study will be numeric, no training will be required for experimenters to interpret the results. However, to ensure procedural integrity, experimenters will receive training in the use and calibration of the NMES device, as well as physician-supervised practice in the correct placement of the facial electrodes and administration of the topical anaesthetic.

Procedure and design

This study will obtain approval for all medical equipment and experimental procedures and will comply with the ethical standards of the American Psychological Association (American Psychological Association, 2010) and the York University Human Participants Review Committee (York University, 2013b). All participants will arrive at the laboratory individually and be given instructions that attempt to prevent them from focussing on their emotions. They will be told that the study aims to measure the relationship between muscular tension and self-reflective thinking and that the device attached to their faces operates by sending and receiving electrical impulses, which may create a tingling/tensing sensation. They will then sign a consent form that will reaffirm these instructions, outline that no identifying information will be collected in order to ensure their privacy, and explicitly state that they can withdraw from the study at any time without losing credit for their participation.

Participants will be assigned (matching for race and gender) to a test group, which will have a topical anaesthetic applied to their faces to "minimize distraction from the electrical sensations," or to a control group, which will be given a regular face cream portrayed as a "conductor gel" and told to ignore the electrical sensations.[3] After the anaesthetic and cream are applied, participants will be asked to fill out the MASQ questionnaire to determine whether the effects of the facial anaesthetic are creating any additional anxiety in the test group, which may heighten emotional responding. Participants in both control and test groups will then be assigned (again matching for race and gender) to receive NMES of either: 1) the zygomaticus major muscles associated with smiling and happiness; 2) the depressor anguli oris muscles associated with frowning and sadness; or 3) the orbicularis oculi and orbicularis oris muscles associated with a furrowed brow and anger (Waller, Cray, & Burrows, 2008).[4] All participants will be led to a private room, where they will sit in a relaxed position with the NMES device stimulating one of their three muscle groups. After one minute of stimulation, a projector will begin to cycle through the twenty neutral IAPS photographs, allowing thirty seconds for the participants to evaluate and rate each one. After the cycle is complete, participants will fill out the PANAS questionnaire to rate their overall affect and the PARH questionnaire to control for guesses of deception. All participants will then be debriefed about the true nature of the study and will sign a second consent form to reaffirm their agreement for their results to be kept and analyzed. They will also be asked to sign a pledge not to discuss the experiment with other students so as not to hamper experimental integrity.

This 2x3 between-groups design will examine two independent variables: 1) ability of participants to feel their facial muscles being stimulated; and 2) placement in the smiling, frowning, or brow-furrowing conditions. There will be 24 participants (matched on gender and race) in each of the six groups.[5] The main effects and interactions will be measured with an Analysis of Variance, with the significance level set to alpha = .05 for all statistical tests. The dependent variable will be the facial feedback effect, measured by comparing the groups' affect scores on the IAPS picture ratings and on the PANAS questionnaire.

REFERENCES

Adelmann, P. K., & Zajonc, R. B. (1989). Facial efference and the experience of emotion. *Annual Review of Psychology*, *40*, 249-280. doi:10.1146/annurev.ps.40.020189.001341

Allen, A. P., & Smith, A. P. (2012). Demand characteristics, pre-test attitudes and time-on-task trends in the effects of chewing gum on attention and reported mood in healthy volunteers. *Appetite, 59*(2), 349-356. doi:10.1016/j.appet.2012.05.026

American Psychological Association (2010). Ethical principles of psychologists and code of conduct. Retrieved from http://www.apa.org/ethics/code/index.aspx

Bermeitinger, C., Machmer, A., Schramm, J., Mertens, D., Wilborn, D. L., Bonin, L., . . . Koch, F. (2013). Facial feedback in implicit sequence learning. *International Journal of Psychology & Psychological Therapy, 13*(2), 145-162.

Bradley, M. M., & Lang, P. J. (2007). The international affective picture system (IAPS) in the study of emotion and attention. In J. A. Coan & J. J. B. Allen (Eds.), *Handbook of emotion elicitation and assessment* (pp. 29-46). Oxford: Oxford University Press.

Buck, R. (1980). Nonverbal behavior and the theory of emotion: The facial feedback hypothesis. *Journal of Personality & Social Psychology*, *38*(5), 811-824. doi:10.1037/0022-3514.38.5.811

Chowdhary, S., Bukoye, B., Bhansali, A. M., Carbo, A. R., Adra M., Barnett S., . . . Leffler, D. A. (2013). Risk of topical anesthetic-induced methemoglobinemia: A

10-year retrospective case-control study. *JAMA Internal Medicine*, *173*(9), 771-776. doi:10.1001/jamainternmed.2013.75

Coté, T. R., Mohan, A. K., Polder, J. A., Walton, M. K., Braun, M. M. (2005). Botulinum toxin type A injections: Adverse events reported to the US Food and Drug Administration in therapeutic and cosmetic cases. *Dermatol*, *53*(3), 407-415. doi:10.1016/j.jaad.2005.06.011

Crawford, J. R., & Henry, J. D. (2004). The positive and negative affect schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. *British Journal of Clinical Psychology*, *43*(3), 245-265. doi:10.1348/0144665031752934

Darwin, C. (1872). *The expression of the emotions in man and animals.* London: John Murray.

Davis, J. I., Senghas, A., Brandt, F., & Ochsner, K. N. (2010). The effects of BOTOX injections on emotional experience. *Emotion*, *10*(3), 433-440. doi:10.1037/a0018690

Dimberg, U., & Söderkvist, S. (2011). The voluntary facial action technique: A method to test the facial feedback hypothesis. *Journal of Nonverbal Behavior*, *35*(1), 17-33. doi:10.1007/s10919-010-0098-6

Izard, C. E. (1981). Differential emotions theory and the facial feedback hypothesis of emotion activation: Comments on Tourangeau and Ellsworth's "the role of facial response in the experience of emotion." *Journal of Personality & Social Psychology*, *40*(2), 350-354. doi:10.1037/0022-3514.40.2.350

James, W. (1890). *The principles of psychology*. Cambridge: Harvard University Press.

Keillor, J. M., Barrett, A. M., Crucian, G. P., Kortenkamp, S., & Heilman, K. M. (2002). Emotional experience and perception in the absence of facial feedback. *Journal of the International Neuropsychological Society*, *8*(1), 130-135.

Keogh, E., & Reidy, J. (2000). Exploring the factor structure of the mood and anxiety symptom questionnaire (MASQ). *Journal of Personality Assessment*, *74*(1), 106-125. doi:10.1207/S15327752JPA740108

Kraut, R. E. (1982). Social presence, facial feedback, and emotion. *Journal of Personality & Social Psychology*, *42*(5), 853-863. doi:10.1037/0022-3514.42.5.853

Laird, J. D. (1974). Self-attribution of emotion: The effects of expressive behavior on the quality of emotional experience. *Journal of Personality & Social Psychology*, *29*(4), 475-486.

Lanzetta, J. T., Cartwright-Smith, J., & Kleck, R. E. (1976). Effects of nonverbal dissimulation on emotional experience and autonomic arousal. *Journal of Personality & Social Psychology, 33*(3), 354-370. doi:10.1037//0022-3514.33.3.354

Larsen, R. J., Kasimatis, M., & Frey, K. (1992). Facilitating the furrowed brow: An unobtrusive test of the facial feedback hypothesis applied to unpleasant affect. *Cognition and Emotion*, *6*(5), 321-338. doi:10.1080/02699939208409689

Libkuman, T. M., Otani, H., Kern, R., Viger, S. G., & Novak, N. (2007). Multidimensional normative ratings for the international affective picture system. *Behavior Research Methods*, *39*(2), 326-334.

Maffiuletti, N. A., Minetto, M. A., Farina, D., & Bottinelli, R. (2011). Electrical stimulation for neuromuscular testing and training: State-of-the art and unresolved issues. *European Journal of Applied Physiology*, *111*(2391). doi:10.1007/s00421-011-2133-7

McCanne, T. R., & Anderson, J. A. (1987). Emotional responding following experimental manipulation of facial electromyographic activity. *Journal of Personality & Social Psychology*, *52*(4), 759-768.

McIntosh, D. N. (1996). Facial feedback hypotheses: Evidence, implications, and directions. *Motivation and Emotion*, *20*(2), 121-147. doi:10.1007/BF02253868

Mori, H., & Mori, K. (2007). A test of the passive facial feedback hypothesis: We feel sorry because we cry. *Perceptual and Motor Skills*, *105*(3), 1242-1244. doi:10.2466/pms.105.4.1242-1244

Mori, K., & Mori, H. (2009). Another test of the passive facial feedback hypothesis: When your face smiles, you feel happy. *Perceptual and Motor Skills*, *109*(1), 76-78. doi:10.2466/pms.109.1.76-78

Mori, K., & Mori, H. (2010). Examination of the passive facial feedback hypothesis using an implicit measure: With a furrowed brow, neutral objects with pleasant primes look less appealing. *Perceptual and Motor Skills*, *111*(3), 785-789. doi:10.2466/02.07.24.PMS.111.6.785-789

Oni G., Rasko Y., & Kenkel J. (2013). Topical lidocaine enhanced by laser pretreatment: A safe and effective method of analgesia for facial rejuvenation. *Aesthetic Surgery Journal*, *33*(6), 854-861. doi:10.1177/1090820X13496248

Rubin, M., Paolini, S., & Crisp, R. J. (2010). A processing fluency explanation of bias against migrants. *Journal of Experimental Social Psychology*, *46*, 21-28. doi:10.1016/j.jesp.2009.09.006

Rutledge, L. L., & Hupka, R. B. (1985). The facial feedback hypothesis: Methodological concerns and new supporting evidence. *Motivation and Emotion*, *9*(3), 219-240. doi:10.1007/BF00991829

Soussignan, R. (2002). Duchenne smile, emotional experience, and autonomic reactivity: A test of the facial feedback hypothesis. *Emotion*, *2*(1), 52-74.

Strack, F., Martin, L. L., & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: A nonobtrusive test of the facial feedback hypothesis. *Journal of Personality & Social Psychology*, *54*(5), 768-777.

Tomkins, S. S. (1962). *Affect, imagery, consciousness* (Vol. 1). New York: Springer.

Vidaurre, C., Pascual, J., Ramos-Murguialday, A., Lorenz, R., Blankertz, B., Birbaumer, N., & Müller, K. (2013). Neuromuscular electrical stimulation induced brain patterns to decode motor imagery. *Clinical Neurophysiology*, *124*(9), 1824-1834. doi:10.1016/j.clinph.2013.03.009

Vrbová, G., Hudlická, O., & Centofanti, K. S. (2008). *Application of muscle/nerve stimulation in health and disease*. Dordrecht, Netherlands: Springer.

Waller, B. M., Cray, J. J., & Burrows, A. M. (2008). Selection for universal facial emotion. *Emotion*, *8*(3), 435-439. doi:10.1037/1528-3542.8.3.435

Watson, D., & Clark, L. A. (1994). The PANAS-X: Manual for the positive and negative affect schedule-expanded form. Iowa City: University of Iowa.

Winton, W. M. (1986). The role of facial response in self-reports of emotion: A critique of laird. *Journal of Personality & Social Psychology, 50*(4), 808-812. doi:10.1037/0022-3514.50.4.808

York University (2013a). *Undergraduate Research Participant Pool*. Retrieved from http://psyc.info.yorku.ca/undergraduate-research-participant-pool/

York University (2013b). *Research Involving Human Participants*. Retrieved from http://www.yorku.ca/research/support/ethics/humans.html

Zajonc, R. B., Murphy, S. T., & Inglehart, M. (1989). Feeling and facial efference: Implications of the vascular theory of emotion. *Psychological Review, 96*(3), 395-416.

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[1] The number of participants was chosen to mirror samples from previous facial feedback hypothesis studies (Dimberg & Söderkvist, 2011; Mori & Mori, 2010) and to facilitate segmentation of participants into matched groups based on participant variables.

[2] While nonprobability sampling can lower external validity, two factors have influenced the decision to use this method: 1) this study will approximate the samples of previous facial feedback hypothesis research, which used university student participants (Mori & Mori, 2010; Strack, Martin, & Stepper, 1988), and 2) this study will examine unconscious processing of the facial feedback hypothesis, which is unlikely to be influenced by education level. The limitation of homogeneity of age within this sample cannot reasonably be avoided with current resources.

[3] Before either the anaesthetic or the inactive cream is administered to participants' faces, it will be applied to the inside of their forearms for 10 minutes to test for any allergic response; if a response manifests, participants will be discharged from the study, receiving full credit for their participation.

[4] Repeated measures will not be used to avoid testing effects and carryover of previous affect to other conditions.

[5] The participant variables of race and gender, while used to increase validity during participant selection and group design, will not be statistically analyzed to maintain viable group sizes and avoid a complex four-factor design.