Commentary

Psychological Science
2015, Vol. 26(5) 657–663

DOI: 10.1177/0956797614566855
pss.sagepub.com

Review and Summary of Research on the Embodied Effects of Expansive (vs. Contractive) Nonverbal Displays

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Received 9/10/14; Revision accepted 12/12/14

In 2010, we published an article in which two experiments demonstrated that expansive (vs. contractive) nonverbal displays produced subjective feelings of power and increased risk tolerance (Carney, Cuddy, & Yap, 2010). One of these experiments demonstrated that such displays increased subjective feelings of power, risk tolerance, and testosterone, and decreased cortisol. Our two experiments were the eighth and ninth to be reported in the literature on the embodied effects of nonverbal expansiveness—seven experiments on this topic were published prior to 2010. Since our article in 2010, 24 additional experiments on the effects of expansive postures have been published (see Table 1). Embodiment and the long-standing discussion of mind-body connection has its experimental roots in William James's (1890/1950) theories of emotion and ideomotor action. Since then, many studies have demonstrated the bidirectional link between nonverbal behavior and human thought and feeling (see Laird & Lacasse, 2014). One such study was conducted by Ranehill et al. (2015), who reported a conceptual replication of one of our experiments: They found an effect of expansive posture on subjective feelings of power, but no effect of posture on risk tolerance, testosterone, or cortisol.

We offer four comments that we hope elucidate the similarities and differences among the 33 published experiments (harvested from the literature through extensive keyword searches and cross-referencing of published articles) and the newly published research of Ranehill et al. We also highlight the specific differences between our experiment and that of Ranehill et al. Unpublished findings were excluded in Table 1. Ranehill et al.'s commentary, with the review presented here, serves as an excellent springboard for identifying potential moderators of the psychological effects of nonverbally expansive (vs. contractive) posture.

Thirty-Three Published Results on Expansive Posture

In Carney et al. (2010), we reported that nonverbal expansiveness (vs. contractiveness) increased subjective feelings of power, risk taking, and testosterone, whereas it decreased cortisol. Using a conceptually similar paradigm (see differences in Table 2), Ranehill et al. reported no effect of nonverbal expansiveness on risk taking, testosterone, or cortisol—only an increase in subjective feelings of power. Prompted by Ranehill et al.'s commentary, we list in Table 1 all published tests (to our knowledge) of expansive (vs. contractive) posture on psychological outcomes. The work of Ranehill et al. joins a body of research that includes 33 independent experiments published with a total of 2,521 research participants. Together, these results may help specify when nonverbal expansiveness will and will not cause embodied psychological changes.

Differences Between the Ranehill et al. and Carney et al. Studies

Table 2 lists the methodological differences between the Ranehill et al. (2015) and Carney et al. (2010) studies. The summary of the literature reported in Table 1 suggests

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Table 1. Comparison of Studies on the Effects of Nonverbal Expansiveness

Article and experiment	Independent variable	Dependent variable	Cover story	Findings	Key features of paradigm
Allen, Gervais, & Smith (2013): main experiment (N = 97 females)	Configured posture	Eating less (social context)	Marketing and physiology	Expansive posture + body concern → eating more	Cover story, social context
Arnette & Pettijohn (2012): main experiment (N = 42)	Mimicked photos of postures	Choice of leader seating (nonsocial context)	None	Expansive posture → selected leader seating	No instruction given, nonsocial context
Bohns & Wiltermuth (2012): Experiment 1 (N = 89)	Configured posture	Pain (nonsocial context)	Yoga stretching	Expansive posture → increased pain tolerance (measured with tourniquet)	Cover story, nonsocial context
Bohns & Wiltermuth (2012): Experiment 2 (N = 30)	Naturally occurring posture in Tiedens & Fragale (2003) complementarity paradigm (social context)	Pain	Social interaction	Expansive posture → increased pain tolerance	Cover story, social context
Briñol, Petty, & Wagner (2009): main experiment (N = 71)	Configured Posture × Thought Direction (positive vs. negative)	Positive attitude toward self	Acting and body muscles	Expansive posture → increased thought confidence; expansive posture + positive thoughts → positive attitude toward self	Cover story, semisocial context
Carney, Cuddy, & Yap (2010): pilot experiment (p. 1367; N = 49)	Mimicked photos of postures	Risk, power feelings (social context)	Bodies and impressions	Expansive posture → increased power feelings and risk tolerance	Cover story, social context
Carney et al. (2010): main experiment (N = 42)	Configured posture	Power feelings, endocrine responses, and risk tolerance (social context)	Physiological measurements; above and below heart level	Expansive posture → increased power feelings, risk tolerance, and testosterone; decreased cortisol	Cover story, social context
Cesario & McDonald (2013): Experiment 1 (N = 216)	Configured Posture × Social Context (social vs. nonsocial)	Risk taking	Physical body and memory	Expansive posture → increased risk taking only when context was social	Cover story, social context manipulated as moderator
Cesario & McDonald (2013): Experiment 2 (N = 167)	Configured Posture × Imagined Social Context (dominant vs. submissive)	Risk taking (social context)	Physical body and memory	Expansive posture → no effect on risk taking; imagined role (dominant vs. submissive) → increased risk taking	Cover story, social context, imagined power trumped effect of posture
Cuddy, Wilmuth, Yap, & Carney (in press): main experiment (N = 66)	Experimenter explained and configured posture; Trier Social Stress Test job interview	Power feelings, job interview performance, nonverbal presence	Physical motion and performance	Expansive posture → marginally increased power feelings, increased performance and nonverbal presence	Cover story, social context
Fischer, Fischer, Englich, Aydin, & Frey (2011): Experiment 2 (N = 36)	Configured posture with chairs	Power feelings, confirmatory processing (semisocial context)	None	Expansive posture → increased power feelings, confirmatory processing	No instructions, semisocial

(continued)

Table 1. (continued)

Article and experiment	Independent variable	Dependent variable	Cover story	Findings	Key features of paradigm
Huang, Galinsky, Gruenfeld, & Guillory (2011): Experiment 1 ($N = 77$)	Configured Posture × Assigned Power Role (high vs. low)	Word fragments completed with power words, power feelings (social context)	Marketing test for ergonomic chairs	Expansive posture → increased cognitive accessibility of power-related words, power feelings; role assignment → increased powerful feelings	Cover story, social context
Huang et al. (2011): Experiment 2 ($N = 77$)	Configured Posture × Assigned Power Role (high vs. low)	Action orientation, abstract thinking, power feelings (social context)	Marketing test for ergonomic chairs	Expansive posture and role → increased action orientation, abstract thinking	Cover story, social context
Huang et al. (2011): Experiment 3 ($N = 57$)	Configured Posture × Assigned Power Role (high vs. low)	Action orientation (social context)	Marketing test for ergonomic chairs	Expansive posture and role → increased action orientation	Cover story, social context
Lee & Schnall (2014): Experiment 2 ($N = 41$)	Configured posture with chairs	Weight estimation of boxes (semisocial context)	Ergonomics of work environment	Expansive posture → decreased estimation of box weight	Cover story, social context
Michalak, Mischnat, & Teismann (2014): main experiment ($N = 30$ psychiatric inpatients)	Configured posture with chairs and instructions	Memory bias (semisocial context)	Effects of relaxation positions on stress	Expansive posture → equal recall of positive and negative words; contractive posture → increased recall of negative words	No instructions; semisocial
Nair, Sagar, Sollers, Consedine, & Broadbent (2014): main experiment ($N = 74$)	Configured posture	Self-esteem, arousal, mood, fear, use of negative words, use of pronouns (semisocial context) during speech task	Physiological measurements	Expansive posture → higher self-esteem; more arousal; better mood; less fear; fewer negative words	Cover story; semisocial
Park, Streamer, Huang, & Galinsky (2013): Experiment 2a ($N = 213$)	Configured posture of American- and Asian-born participants	Power feelings (social context)	Body postures being pretested for a pilot study	Expansive posture (expansive-hands-spread-on-desk pose) → increased power feelings for both American and Asian participants	Cover story, social task
Park et al. (2013): Experiment 2b ($N = 119$)	Configured posture of American- and Asian-born participants	Power feelings (social context)	Testing for ergonomic quality of chairs	Expansive posture (expansive-upright-sitting pose) → increased power feelings for both American and Asian participants	Cover story, social task
Park et al. (2013): Experiment 3 ($N = 106$)	Configured posture of American- and Asian-born participants	Priming of power words, power feelings (social context)	Testing for ergonomic quality of chairs	Expansive posture (feet-on-desk pose) → increased cognitive accessibility of power-related words, power feelings for American participants only	Cover story, social task
Park et al. (2013): Experiment 4 ($N = 83$)	Configured posture of American- and Asian-born participants	Action orientation (social context)	Testing for ergonomic quality of chairs	Expansive posture (expansive-feet-on-desk pose) → increased action orientation for American participants only	Cover story, social task

(continued)

Table 1. (continued)

Article and experiment	Independent variable	Dependent variable	Cover story	Findings	Key features of paradigm
Riskind (1984): Experiment 1 ($N = 76$)	Configured Posture × False Feedback	Locus of control (nonsocial context)	Biofeedback	Expansive posture → helped buffer the negative impact of negative feedback on locus of control	Cover story, nonsocial context
Riskind (1984): Experiment 2 ($N = 51$)	Configured Posture × False Feedback	Depression, puzzle-solving persistence (nonsocial context)	Biofeedback	Both expansive posture and positive feedback → decreased depression; increased persistence	Cover story, nonsocial context
Riskind (1984): Experiment 3 ($N = 20$)	Configured posture; all in negative feedback	Depression, locus of control (nonsocial context)	Biofeedback	Expansive posture + negative feedback → more depression, higher locus of control	Cover story, nonsocial context
Riskind & Gotay (1982): Experiment 1 ($N = 20$)	Configured Posture × False Feedback	Persistence at solving puzzles (semisocial context)	Physiological measurements	Expansive posture → increased persistence	Cover story, semisocial
Riskind & Gotay (1982): Experiment 2 ($N = 20$)	Configured Posture × False Feedback	Persistence at solving puzzles (semisocial context)	Physiological measurements	Expansive posture → increased persistence	Cover story, semisocial
Stepper & Strack (1993): Experiment 1 ($N = 99$)	Configured Posture × Onset of Success Feedback	Feelings of pride (nonsocial context)	Ergonomic working positions and task performance	Expansive posture + success feedback → pride feelings	Cover story, nonsocial context
Strelan, Weick, & Vasiljevic (2013): Experiment 3 ($N = 85$)	Configured Posture × Chronic Power Feelings	Retaliation to multiple transgressions (social context)	Ostensibly unrelated experiment with bodies and a box	Expansive posture → chronically powerless more vengeful than chronically powerful	Cover story, social context
Welker, Oberleitner, Cain, & Carré (2013): Experiment 1 ($N = 91$)	Posture configured by experimenter and shown line drawings; Posture × Social Exclusion (inclusion vs. exclusion)	Threats to basic needs and mood	None; posture mentioned	Expansive posture and inclusion → decreased threat (posture effect marginal) and increased mood	No cover story, social context
Welker et al. (2013): Experiment 2 ($N = 84$)	Posture configured by experimenter and shown line drawings; Posture × Social Exclusion (inclusion vs. exclusion)	Threats to basic needs	None; posture mentioned	No main effect of expansive posture → decreased threat or mood; Posture × Exclusion interaction: expansive + excluded → decreased threat and increased mood	No cover story, social context
Yap, Wazlawek, Lucas, Cuddy, & Carney (2013): Experiment 1 ($N = 88$)	Configured posture	Stealing (social context)	Stretching and impressions	Expansive posture → increased cheating	Cover story, social task
Yap et al. (2013): Experiment 2 ($N = 34$)	Incidentally caused posture	Cheating (social context)	Feng shui and creativity	Expansive posture → increased cheating	Cover story, social task
Yap et al. (2013): Experiment 3 ($N = 71$)	Incidentally caused posture	Traffic violations (semisocial context)	Physiology and video games	Expansive posture → increased traffic violations	Cover story, semisocial task

Note: All results reported were significant unless specified otherwise; comparisons between nonverbal expansiveness versus contractiveness (or neutral control posture). Reports demonstrating causal effects of other power- and pride-related nonverbal behaviors were excluded (e.g., making fists, pride postures, crossing arms, tilting the head up, making an angry face, lowering the voice). Also excluded were the hundreds of published experiments on effects of expanded body posture as an *expression* of power or dominance and on effects such as perceptions, attributions, and social interaction.

Table 2. Comparison of Ranehill et al. (2015) and Carney, Cuddy, and Yap (2010)

Study characteristic	Ranehill et al. (2015)	Carney, Cuddy, and Yap (2010)	Comment
Timing of collection	Experiment conducted recently	Experiment conducted between 2008 and 2009	In the past few years, research on nonverbal expansiveness has been well covered in the media and in many university courses and textbooks; therefore, participants might have had exposure to the research and postural manipulation.
Participant population	Students from University of Zurich and the Swiss Federal Institute of Technology in Zurich	Students from Columbia University	Culture is a likely moderator, as was the case in Park, Streamer, Huang, and Galinsky (2013).
Sample size	200	42	Variability in sample size can affect results because small sample sizes are underpowered.
Gender ratio (female:male)	98:102	26:16	Gender could be a moderator.
Cover story	None (participants were told that the study examined how physical position affects hormone levels and behavior)	Elaborate cover story about physiological signals above and below hearing level	Results from past experiments favor using a cover story and not explicitly telling participants the study's purpose before the experiment begins. This framing could be a moderator.
Instruction method	Instructions given via computer (specific instructions not clear)	Participants' poses manually configured by experimenter	Method of delivery of instructions (e.g., via computer vs. experimenter, with vs. without use of pictures) is likely to be a moderator.
Time in poses	6 min	2 min	Participants in Ranehill et al.'s study held the poses 300% as long as participants in Carney et al.'s study. Duration and comfort of poses are very likely to be moderators.
Filler task during pose	Construct words from letters and spaces	View and form impressions of nine faces (a social filler task)	The social nature of the task is a known moderator (Cesario & McDonald, 2013). Cognitive taxation by the word task could also be a moderator.
Risk measure	Computer-mediated coin flips: Participants made six binary choices between a safe and a risky option in a gain domain and six more choices in a loss domain	Participants were given $2 and told they could keep the money—the safe bet—or roll a die and risk losing the $2 for a payoff of $4 (a risky but rational bet; odds of winning were 50/50). Participants rolled an actual die and saw the money they could win.	The risk task used (e.g., computer mediated or not) could be a moderator.
Self-report moderators	Competitiveness measure included	No competitiveness measure included	There are many individual difference measures that are of theoretical interest.
Computation method of hormone-change score	Difference score (Time 2 – Time 1)	Regression controlling for Time 1	This difference in analytic strategy often yields different results.
Saliva collection at Time 1	Immediately on arrival	10 min after arrival	Neuroendocrine-reactivity studies should include a rest period of 10 to 40 min before the initial saliva sample is collected. This downtime after arrival at the lab allows hormones to return to resting baseline levels, resulting in cleaner, more interpretable data (e.g., Blascovich, Vanman, Mendes, & Dickerson, 2011).

that all significant results were obtained using paradigms with complex, detailed cover stories when participants were unaware of the hypothesis of the experiment, which suggests that awareness of the hypothesis may be a moderator. And many, but not all, significant results were obtained with paradigms situated in a social context, which suggests social context as a moderator. By "social context," we mean there was either a social interaction with another person (e.g., participant or experimenter) during the posture manipulation or participants were engaging in a real or imagined social task. Indeed, Cesario and McDonald (2013) found direct evidence that social context (present vs. absent) moderated the effect of expansive posture such that effects were found only when the participant was in a social context.

Tables 1 and 2 taken together suggest that there are three differences between Ranehill et al.'s research and our previously published experiment that may account for the varied results. First, in our two experiments, we were careful to conceal experimental purpose with a detailed cover story; in their experiment, Ranehill et al. told participants the purpose of the study—to investigate effects of posture on hormones. Second, our two experiments involved a social task during the postural manipulation; Ranehill et al.'s experiment did not. Finally, in our experiments, we used postural manipulations that were comfortable, easy, and short in duration; Ranehill et al.'s experiment employed postures that were three times as long as those reported in our 2010 paper.

Contributions of Ranehill et al.

Some of the variables listed in Tables 1 and 2 suggest future directions for research. One key moderator may be awareness of the hypothesis of the experiment; virtually all of the published reports demonstrating significant effects of expansive posture used elaborate cover stories to distract participants from the goal of the experiment. As is common in economics research, Ranehill et al. did not use any deception in the experiment, and participants were told that the study examined how physical position affects hormone levels and behavior. Investigating the effects of awareness of what one is doing seems like an interesting and useful avenue for future research—one with practical implications.

Another avenue for future research is the length of time participants hold the expanded posture. Time in posture was rarely reported and is not listed in Table 1. In extensive pilot testing, we had settled on 1 min for each of two postures because longer expressions of the feet-on-the-desk pose were uncomfortable and difficult if held longer than 1 min. Ranehill et al. (2015) tripled the amount of time participants held all postures—including the uncomfortable ones. Although it may make intuitive sense that longer time in the posture would increase effects, holding some postures for too long may cause discomfort, become awkward, or habituate a body to the effects of the posture. Length of time in posture should be directly tested.

Finally, the experimenters' blindness to the experiment's hypotheses was impossible to determine from most articles and is not listed in Table 1. Ranehill et al. used experimenters blind to the hypothesis, and we did not. This is a *critical* variable to explore given the impact of experimenter bias and the pervasiveness of expectancy effects.

Looking Forward

Although we hope that Tables 1 and 2 will assist in moving forward the study of nonverbal expansiveness, at present, direct replications are needed of Carney et al. (2010) and many of the other reports in Table 1. Note that in other disciplines, such as human physiology, similar results as those we obtained have shown that holding an expansive yoga-style pose for 2 to 3 min significantly increases blood-serum levels of testosterone and decreases blood-serum levels of cortisol (Minvaleev, Nozdrachev, Kir'yanova, & Ivanov, 2004). For the purposes of a direct replication of Carney et al., all materials can be obtained from the first author or downloaded from her Web site (http://faculty.haas.berkeley.edu/dana_carney/PRS%20Materials%20-%20to%20replicate.zip).

Author Contributions

D. R. Carney drafted the manuscript and Table 1. A. J. Yap drafted Table 2. D. R. Carney, A. J. C. Cuddy, and A. J. Yap read and revised all text and tables.

Acknowledgments

We would like to thank the following colleagues for providing helpful corrections and suggestions to this manuscript: Jill Allen, Manzarin Banaji, R. Bhaskar, Vanessa Bohns, Joe Cesario, Adam Galinsky, Li Huang, Johannes Michalak, Mike Norton, Brian Nosek, Lora Park, Jeff Pfeffer, Simone Schnall, Peter Strelan, Milica Vasiljevic, Mario Weick, Keith Welker, Scott Wiltermuth, Brian Winters at the Association for Psychological Science, and members of the Social and Nonverbal Behavior Lab at the University of California, Berkeley.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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