

Adaptive Human Behavior and Physiology

Organized Adult Play and Stress Reduction: Testing the Absorption Hypothesis in a Comedy Improv Theater

--Manuscript Draft--

Manuscript Number:	AHBP-D-20-00037R1
Full Title:	Organized Adult Play and Stress Reduction: Testing the Absorption Hypothesis in a Comedy Improv Theater
Article Type:	Original Article
Order of Authors:	Cara Ocobock, Ph.D. Christopher Dana Lynn Mallika Sarma Lee Gettler
Abstract:	<p>Objective: Cognitive scientists suggest that stress reduction may be one of the important elements for the success of religion as a social structure. Studies among Christian Charismatics support this model, pointing to the importance of belief, training, and proclivity for psychological absorption in maximizing the influence of cultural rituals for reducing stress and positively influencing mood. Furthermore, this “absorption hypothesis” likely extends to other cultural settings.</p> <p>Methods: We test the role of absorption in influencing stress and emotional affect among members (N = 12) of a comedy improvisation (improv) theater in upstate New York. We tested for main and interaction effects of improv experience and absorption on self-reported mood and biomarkers of stress on improv and non-improv days.</p> <p>Results: We found a significant positive association between absorption and cortisol on improv days but no effects for improv experience and no significant interaction effects.</p> <p>Conclusions: These findings suggest absorption may be important for focus in skilled adult play, but involvement in comedy improv may not be analogous to active church membership. Keywords: play, absorption, comedy improvisation (improv), mood, cortisol</p>
Corresponding Author:	Cara Ocobock, Ph.D. University of Notre Dame Notre Dame, Indiana UNITED STATES
Corresponding Author Secondary Information:	
Corresponding Author's Institution:	University of Notre Dame
Corresponding Author's Secondary Institution:	
First Author:	Cara Ocobock, Ph.D.
First Author Secondary Information:	
Funding Information:	
Order of Authors Secondary Information:	
Author Comments:	The response letter is uploaded with the rest of the files.

[Click here to view linked References](#)

Organized Adult Play and Stress Reduction: Testing the Absorption Hypothesis in a Comedy Improv Theater

Cara Ocobock, Department of Anthropology, Eck Institute for Global Health, University of
Notre Dame, Notre Dame, IN 46556, ORCID ID # 0000-0002-6949-2029
Department of Anthropology, University at Albany, SUNY, Albany, NY 12222
cocobock@nd.edu

Christopher D. Lynn, Department of Anthropology, University of Alabama, Tuscaloosa, AL
35487, ORCID #0000-0002-7031-5281
cdlynn@ua.edu

Mallika Sarma, Department of Otolaryngology, Human Spaceflight Lab, Johns Hopkins
University School of Medicine Baltimore, MD, 21205, ORCID #0000-0002-6693-9382
University of Notre Dame, Notre Dame, IN 46556
msarma1@jhu.edu

Lee T. Gettler, Department of Anthropology, Eck Institute for Global Health, University of
Notre Dame, Notre Dame, IN 46556, ORCID #0000-0001-7325-8852
Lee.T.Gettler.1@nd.edu

Corresponding author: Cara Ocobock, cocobock@nd.edu

Abstract:

Objective: Cognitive scientists suggest that stress reduction may be one of the important elements for the success of religion as a social structure. Studies among Christian Charismatics support this model, pointing to the importance of belief, training, and proclivity for psychological absorption in maximizing the influence of cultural rituals for reducing stress and positively influencing mood. Furthermore, this “absorption hypothesis” likely extends to other cultural settings.

Methods: We test the role of absorption in influencing stress and emotional affect among members (N = 12) of a comedy improvisation (improv) theater in upstate New York. We tested for main and interaction effects of improv experience and absorption on self-reported mood and biomarkers of stress on improv and non-improv days.

Results: We found a significant positive association between absorption and cortisol on improv days but no effects for improv experience and no significant interaction effects.

Conclusions: These findings suggest absorption may be important for focus in skilled adult play, but involvement in comedy improv may not be analogous to active church membership.

Keywords: play, absorption, comedy improvisation (improv), mood, cortisol

1
2
3
4 **Introduction**
5
6

7 Cognitive scientists suggest that stress reduction may be among the important elements
8 for the success of religion as a social structure (Barrett, 2011). Studies among Christian
9 Charismatics support this model, pointing to a combination of belief, training, and a proclivity
10 for psychological absorption (i.e. focused attention) in maximizing effects. Charismatic religion
11 emphasizes experiential worship, which often includes speaking in tongues, intensive prayer, and
12 other “charisms” of “gifts of the Spirit” that lead to or involve highly absorptive states
13 (Luhmann, 2005). Benefits of this trifecta of belief, practice, and absorptive abilities include
14 reducing anxiety and daily stress (Luhmann, 2005, 2012; Luhmann et al., 2010; Lynn et al.
15 2010, 2011). Furthermore, this “absorption hypothesis” likely extends to other social and cultural
16 domains (Luhmann et al., 2010), and absorption may be a key psychological trait in positively
17 coping with cognitive stress (cf. Thompson, Steffert, Steed and Gruzelier, 2010). We tested the
18 role of absorption as a main and moderating influence on stress in a non-religious cultural
19 setting, a comedy improvisation (improv) theater in upstate New York. We investigated the
20 effects of improv training (years of improv experience) and absorption on stress using the stress
21 biomarker cortisol collected on improv performance and rehearsal days and non-improv days.
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42

43 Following Stromberg (2009), we predicted that participation in skilled and organized play
44 (improv) absorbs adults mentally, which may have the capacity to reduce distress or anxiety.
45
46 Play behavior increases positive coping in children (Christiano and Russ, 1996). Research on the
47 benefits of play for adults is limited, but a wealth of studies using rat models indicates that adult
48 play continues and has important functions. Adults use play to navigate sexual encounters and to
49 manipulate non-sexual dominance situations. Subordinate males, for instance, play fight to assess
50 dominance-holding capabilities of other males. In humans, language fills a greater role than the
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

1
2
3
4 physicality of non-human play, and humor in particular resembles play fighting because of its
5
6 natural ambiguity (i.e., humans deflect escalations in verbal banter by saying, “I was only
7
8 playing with you”). Studies contrasting play with social isolation indicate that play seems to fine-
9
10 tune coping skills for dealing with later adversity and unexpected situations. Specifically, playing
11
12 helps individuals calibrate emotional responses to situations so they can use motor, social, or
13
14 cognitive skills more effectively in dealing with stressful situations (Pellis and Pellis, 2013).
15
16
17

18
19 In the United States, anxiety disorders are the most common type of mental illness,
20
21 affecting 18.1% of Americans annually. Generalized anxiety disorder, panic disorder, and social
22
23 anxiety disorder each affect over 6 million US adults, while depression is the leading worldwide
24
25 cause of disability (WHO 2020). Kaiser and colleagues (2015) find widespread reports of
26
27 “thinking too much,” which entails ruminating, intruding, or obsessive thoughts associated with
28
29 lifetime accumulations of problems or fixations on single issues. Such preoccupations become
30
31 associated with sadness and depression-related phenomena. Heightened cortisol production from
32
33 the hypothalamic-pituitary-adrenal (HPA) axis often accompanies psychological phenomena that
34
35 evoke such feelings of social threat and lack of control (Miller, Chen and Zhou, 2007) but can
36
37 also be preparatory for cognitively and emotionally demanding activity, regardless of valence
38
39 (Adam, Hawkley, Kudielka and Cacioppo, 2006; Wüst et al., 2000). Cortisol has
40
41 psychobiological effects on the brain, facilitating mental states, such as arousal, attention, and
42
43 fear. Such mental states can be acutely beneficial and ultimately adaptive in stressful or
44
45 demanding conditions but may also enhance anxiety (Erickson, Drevets and Schulkin, 2003).
46
47 Chronic elevated production of cortisol has been linked to many deleterious physical (e.g.,
48
49 inflammation) and mental conditions (e.g., depression, anxiety). Therefore, activities that
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

1
2
3
4 attenuate its production can have important public health implications (Miller, Chen and Cole,
5
6
7 2009).

8
9 Anecdotally, improv performers say that the focus required to practice and perform “gets
10
11 them out of their own heads” and reduces the psychosocial stress they feel as a matter of course.
12
13
14 Being good at improv requires focusing attention or absorption on the dynamics of
15
16 improvisational comedy, the mechanisms of which may underlie different types of absorption
17
18 observed cross-culturally (Seligman and Kirmayer, 2008). This absorption is facilitated by talent
19
20 and training (Luhmann et al., 2010). The concept of absorption is roughly synonymous with
21
22 focused attention and is positively correlated with hypnotic susceptibility. High absorption is
23
24 associated with being able to maintain attention on a task despite distractions and to suppress
25
26 orienting response, or automatic attention to novel stimuli (Jamieson, 2005). Improv relies on
27
28 unscripted and improvised performances, but also encourages audience suggestions and
29
30 participation. The four basic tenets of improv—accept all offers, build on those offers, make
31
32 your partner look good, and there are no mistakes—stress vivid focus on the present moment,
33
34 fellow performers, and audience and the alternate reality performers generate in real time
35
36 (Wasson, 2017). As such, improv troupes are ideal for studying the potential anxiety-reducing
37
38 effects of absorptive play among adults.
39
40
41
42
43
44

45
46 Drawing on a small, repeated-measure study of members of a US improv theater, we
47
48 predicted that, similar to religious groups, improv players with more improv experience and
49
50 greater proclivity for absorption would have lower stress (cortisol) on non-improv days than
51
52 those with less improv experience and lower proclivity for absorption. Furthermore, we predicted
53
54 that absorption would have a moderating effect on improv experience, amplifying the stress
55
56 reduction.
57
58
59
60
61
62
63
64
65

Materials and Methods

We worked with a comedy improv theater in Schenectady, New York in research design and data collection and collected measures of salivary cortisol and self-reported mood on rehearsal days, performance days, and days off, following Lynn et al. (2010, 2011). Study participants included four women and eight men (aged 26-53), who were active members of one of two troupes that practiced and performed at the theater and had been involved in improv for a mean \pm SD of 12 ± 6.98 years. This comedy theater offered classes, rehearsals, performances, and corporate training and had two main troupes that rehearsed and performed on a regular basis. Rehearsals occurred once a week, and there are typically 3-5 performances per week. Rehearsals consisted of warm-up games, followed by games that more closely related to upcoming performances. Performances at this theater included a range of improv styles. All participants were in good health, voluntarily participated in this study, and provided informed consent. Participants completed a baseline survey that queried demographic information, absorption, mood, and perceived stress at the beginning of the study and provided saliva samples each morning upon awakening and completed a survey about current mood on each of six study days.

We used a modified 34-item version of the Tellegen Absorption Scale (MODTAS; Jamieson, 2005) to assess absorption. The MODTAS is a valid and reliable metric for assessing absorption and the most widely used metric for measuring the construct of absorption (Tellegen and Atkinson, 1974). The construct has five inter-correlated primary factors with a single higher-order factor (the absorption trait). These factors include aesthetic involvement in nature (e.g., “I am deeply moved by a sunset”), profound alterations in sense of self or reality (e.g., I sometimes step outside myself and experience an entirely different state of being”), imaginative involvement (e.g., “I imagine some things so vividly that they hold my attention as a good movie

1
2
3
4 or story does”), extrasensory experiences (e.g., “I know what someone is going to say before
5
6 they say it”), and synesthesia (e.g., “I find that different odors have different colors”) (Jamieson,
7
8 2005). Cronbach’s alpha for our study was .78, indicating internal validity of the scale. We used
9
10 a 4-point Likert scale to query how much each item described the attitude or experience of
11
12 participants (0 = never to 3 = very often) and scored the questionnaire by summing items.
13
14

15
16 To measure mood, we administered the 60-item Positive and Negative Affect Schedule
17
18 (version 10, PANAS-X) (Watson and Clark, 1999) at the beginning of the study (baseline) and in
19
20 conjunction with biomarker measure (pre- and posttest for each samples improv and non-improv
21
22 day). The PANAS-X is a list of feelings and emotions (e.g., cheerful, disgusted, attentive).
23
24 Respondents rate the degree to which each state describe them “at this moment” on a 5-item
25
26 Likert scale (1 = very slightly or not at all, 5 = extremely). The PANAS-X reliably measures the
27
28 two broad, general factors—positive and negative mood, which are measured by summing the
29
30 items comprising these factors (Watson and Clark, 1999). As our study focused on the benefits
31
32 of improv practice for wellbeing, we used only positive mood in analysis.
33
34
35
36
37

38 We assessed baseline psychological stress using the 4-item Perceived Stress Scale (PSS;
39
40 Cohen, Kamarck and Mermelstein, 1983). The PSS is the most widely used self-report for
41
42 psychological stress and positively correlates with physiological stress measures (Cohen and
43
44 Williamson, 1988) and had good reliability for our study (Cronbach’s alpha = .80).
45
46
47

48 Study days for measuring salivary cortisol and mood involved three couplets: (1) a non-
49
50 improv day and the following day, (2) a rehearsal day and the following day, and (3) a
51
52 performance day and the following day. The following day in each couplet was a non-improv
53
54 day. The two days within each couplet were consecutive, and there was at least one non-improv
55
56 day in between couplets. All couplets were completed within a month with the exception of one
57
58
59
60
61
62
63
64
65

1
2
3
4 participant whose measurements took place over six weeks due to the participant's heavy improv
5
6 performance schedule. All participants took part in each of the three couplets.
7
8

9 Participants provided saliva samples via passive drool in 2mL polypropylene cryovials
10 with the use of a saliva collection aid. Individuals provided saliva at waking and 30 minutes
11 (wake+30) and were asked not to eat, drink, or brush their teeth prior to providing the waking
12 and wake+30 samples. We used these measures to calculate the cortisol awakening response
13 (CAR). CAR is the measure of the sharp increase of cortisol shortly after awakening before
14 declining as part of normal daily cycling. CAR has relatively high intra-individual stability.
15 Furthermore, CAR is distinct from diurnal variation of HPA axis activity and may be more
16 related to the orientation of self in time and space when waking (Adam et al., 2006). Importantly
17 for the present study, CAR is strongly linked with depression, anxiety, and exhaustion and other
18 important psychiatric states (Fries, Dettenborn and Kirschbaum, 2009). We collected additional
19 measures at midday, immediately before rehearsal or performance, and immediately after
20 rehearsal or performance to assess total cortisol output (area under the curve) for improv and
21 non-improv days. On non-improv days, participants provided the two final daily saliva samples
22 at times mirroring before and after times of the rehearsal and performance days.
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42

43 Saliva samples were stored a -80°C freezer until they were assayed for salivary cortisol
44 (µg/dL) using enzyme immunoassay protocols developed for use with saliva samples
45 (Salimetrics: Kit No. 1-3002). Interassay coefficients of variation (CV) were 5.6% and 15.6% for
46 high and low kit-based controls; the intra-assay CV was 6.0%. In the present analysis, eight later-
47 evening samples had cortisol below the level of detection for the assay. We ascribed these
48 samples a value of 0.007 µg/dL, which is the lower limit of sensitivity of the assay according to
49 Salimetrics. We excluded one participant from analysis because their saliva samples were blood-
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

1
2
3
4 contaminated on visual inspection. Cortisol measures were log-transformed because of the
5
6 skewed distribution typical of biomarkers. We calculated the CAR as a simple change score
7
8 subtracting the waking value from the wake+30 value. We used area under the curve (AUC) as a
9
10 proxy of total cortisol output for each day, calculated with respect to ground using the trapezoid
11
12 formula (Pruessner, Kirschbaum, Meinlschmid and Hellhammer, 2003).
13

14
15
16 To test for differences in mood or stress on improv versus non-improv days, we used
17
18 paired samples *t*-tests to compare cortisol and mood measures within respective couplets. We
19
20 then aggregated all improv and all non-improv day measures, respectively, to retain statistical
21
22 power in regression analysis. We used analysis of covariance (ANCOVA) to regress positive
23
24 mood, improv experience, and absorption on AUC in separate models for improv and non-
25
26 improv days, controlling for CAR. To determine if stress levels on improv days impacted those
27
28 on non-improv days, we controlled for improv-AUC in the non-improv model and vice versa.
29
30 Finally, we tested for a moderating effect of absorption by creating interaction variables using
31
32 cross-products. Because of their known effects on stress response, we created dummy variables
33
34 for self-reported medication ($n = 1$ for oral contraception), tobacco, drug, and alcohol use and
35
36 included them in preliminary models to assess their potential impacts on cortisol (Hellhammer,
37
38 Wust and Kudielka, 2009; Kirschbaum, Pirke and Hellhammer, 1995). No significant
39
40 associations were observed, so these variables were not used in subsequent analysis. Statistics
41
42 were considered significant if $p < 0.05$.
43
44
45
46
47
48
49

50 All protocols were approved by the improv theater and the University at Albany
51
52 Institutional Review Board (17-E-281).
53
54
55
56
57
58
59
60
61
62
63
64
65

1
2
3
4 **Results**
5
6

7 Fig. 1 illustrates the mean cortisol CAR and AUC for couplet measurements. We
8 compared mean measurements within couplets and found no significant differences. Table 1
9 shows *t*-test comparisons for aggregated positive mood and cortisol for improv and non-improv
10 days and indicates a significantly higher mean for positive mood on improv days.
11
12
13
14
15
16
17
18

19 **Fig. 1** Couplet comparisons of cortisol CAR (Fig. 1a) and AUC (Fig. 1b)
20
21
22
23

24 **Table 1** Comparisons of positive mood and cortisol CAR and AUC on improv
25 and non-improv days using student's *t*-test.

	Improv		Non-improv	
	Mean	SD	Mean	SD
Positive mood*	16.62	2.01	13.64	2.24
Cortisol awakening response	37.96	56.35	38.73	68.64
Cortisol area under the curve	2.10	0.48	2.39	0.99

26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

**p* < 0.05

36 We tested the prediction that improv experience and absorption interact to benefit
37 wellbeing by conducting hierarchical regressions on cortisol AUC for aggregated non-improv
38 and improv days, respectively. As indicated in Table 2, all models for cortisol AUC on improv
39 and non-improv days were statistically significant. On improv days, there was a significant
40 and non-improv days were statistically significant. On improv days, there was a significant
41 inverse effect for CAR and a significant positive effect for absorption. On non-improv days,
42 there was a significant inverse effect for positive mood and a significant positive effect for CAR.
43 All models account for large percentages of variance in aggregated cortisol AUC. There were no
44 significant interaction effects for improv experience-by-absorption, though the effect approaches
45 significance for the non-improv days. Following Dawson (2014), we graphed this interaction at
46 ±1 SD (Fig. 2) and found that, contrary to our predictions, those higher in absorption and improv
47 experience had higher total cortisol output on non-improv days.
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

Table 2 Hierarchical ANCOVA on cortisol for non-improv and improv days.

	Improv days			Non-improv days		
	β	p	Adjusted r^2	β	p	Adjusted r^2
<i>BLOCK 1 Constant</i>		<0.01	0.78*		<0.01	0.93*
AUC ^a	0.83	0.002		1.02	<0.01	
Positive mood ^b	0.19	0.28		-0.41	0.01	
CAR ^b	-0.24	0.17		0.441	0.01	
<i>BLOCK 2 Constant</i>		<0.01	0.90*		0.002	0.92*
AUC ^a	0.81	0.003		0.99	0.002	
Positive mood ^b	0.03	0.841		-0.41	0.02	
CAR ^b	-0.32	0.048		0.41	0.05	
Improv experience	0.001	0.996		0.09	0.46	
Absorption	0.37	0.043		-0.08	0.56	
<i>BLOCK 3 Constant</i>			0.90*		0.003	0.97*
AUC ^a	0.92	0.01		0.88	0.003	
Positive mood ^b	0.05	0.72		-0.34	0.02	
CAR ^b	-0.28	0.09		0.30	0.06	
Improv experience	-0.01	0.95		0.08	0.34	
Absorption	0.19	0.41		0.89	0.44	
Improv experience-by-absorption	-0.22	0.34		0.26	0.08	

^aNon-improv AUC is covariate in improv day models, and improv day AUC is covariate in non-improv day models.

^bImprov days positive mood and CAR are covariates in improv days models, and non-improv days positive affect and CAR are covariates in non-improv days models.

*Model p -value < 0.05

Fig. 2 Improv experience-by-absorption interaction effect ($\beta = .259, p = 0.08$) at ± 1 SD on mean area under the curve for cortisol on non-improv days (Covariates include mean improv-days-AUC, mean non-improv-days-CAR, and mean non-improv-days-positive mood) (<http://www.jeremydawson.co.uk/slopes.htm>)

Discussion

Our study tested the hypothesis that regular participation in comedy improv and a proclivity for absorption could, combined, have long-term health benefits. While we did not find the expected effect for improv experience or a stress-reducing role for absorption and improv experience on non-improv days, we did detect a statistically significant main effect for absorption on improv days. This finding suggests that absorption is important in the skill and attention required to rehearse and perform comedy improv, only partially supporting the

1
2
3
4 absorption hypothesis (Luhmann et al., 2010). Positive mood had a significant inverse
5
6 association with cortisol on non-improv days, affirming the intuitive assumption that positive
7
8 mood interrelates with lower activity of stress-related physiology (Smyth et al., 1998). There was
9
10 no association between positive mood and cortisol on improv days, which could be explained by
11
12 the aroused state associated with comedy improv performance. Cortisol increases are associated
13
14 with excitement and activity, along with negatively appraised and socially threatening conditions
15
16 (Adam et al., 2006). Finally, while CAR is considered an independent indicator of adrenal
17
18 capacity for stress response (Pruessner et al., 1997), the positive associations between CAR and
19
20 AUC in both models in our study may suggest higher cortisol exposure in the mornings.
21
22
23
24

25
26 One possible explanation for the lack of an effect for improv experience is that all
27
28 participants had substantial previous experience. In other studies wherein self-reported cultural
29
30 experiences predicts health biomarkers, low experience groups also contained novices (Lynn,
31
32 Dominguez and Decaro, 2016; Lynn et al., 2019; Lynn et al., 2010, 2011). Our findings may also
33
34 suggest that membership in a comedy improv troupe may not exert as large an influence on
35
36 outside life as membership in a church and religious practice. Rather than detect the role of
37
38 training, we may have captured “flow” states facilitated by absorption among highly skilled
39
40 improv players during rehearsal and performance processes. Flow is a confluence of training,
41
42 ability, and absorption that enables performers to tune out other thoughts, sensory experiences,
43
44 and distractions and be “in the moment” (Csikszentmihalyi, 1990).
45
46
47
48
49

50
51 Improv may also provide benefits as a form of adult play, facilitated by a proclivity for
52
53 absorption. Improv is similar to role-playing games, such as Dungeons and Dragons, in that
54
55 troupe members enact fictional characters. By taking on such roles, they become absorbed in the
56
57 fictional scenario and portray emotions associated with the parameters of a scene or interaction
58
59
60
61
62
63
64
65

1
2
3
4 and may even experience the feelings commensurate with said emotions depending on the degree
5
6 of absorption in the role. As Stromberg (2009) points out, role-playing games are good places to
7
8 begin studying the values of play activities because they are taken up by groups, and it becomes
9
10 more obvious when people are absorbed in the activity than it is during individual pursuits.

11
12
13
14 Through this “affective mimicry,” one not only has the opportunity to imagine other points of
15
16 view but to experience emotions from those perspectives and, thus, more embody their fictional
17
18 characters. This has the added benefit of helping role players temporarily set aside “current
19
20 world with its anxieties and problems” (Harris, 2000:65, quoted in Stromberg 2009).
21
22
23

24 25 ***Limitations***

26
27
28 This study is exploratory, and, thus, interpretations must be viewed cautiously. Despite
29
30 the small sample size, we collected considerable data extending over several variables. It was not
31
32 possible to include all variables in models, and models are necessarily limited in statistical power
33
34 by the low degrees of freedom. Despite this, we observed a pattern with regard to predictive
35
36 variables that is consistent with theory. Furthermore, because of the small sample, there was
37
38 limited ability to detect between-subjects effects using a repeated measures paradigm, so we
39
40 aggregated measures by non-improv and improv days, which limited the grain of analysis. The
41
42 paradigm used was intended to enable us to test the design for future research with a larger
43
44 sample. Thus, any detectable pattern consistent with study predictions merits further research
45
46 using this design.
47
48
49
50
51
52

53 54 **Conclusion**

55
56
57 Our study tested the role of active membership in an improv comedy troupe, a form of
58
59 adult play popular in the United States and Europe, in enhancing health through harnessing the
60
61

1
2
3
4 human capacity for absorption in meaningful activities. We compared psychological and
5
6 physiological indicators of wellbeing on days when improv players were rehearsing and
7
8 performing to days when they were not engaged in improv activities. We found that absorption
9
10 does seem to play a role in facilitating player focus on improv rehearsal and performance days
11
12 but not non-improv days. There was no detectable influence of improv experience, but there
13
14 were no improv novices in the study—all participants had at least five years of previous improv
15
16 experience. It remains unclear if there is a benefit for engaging in improv that carries over to the
17
18 lives of improv players outside the improv context, but such research provides a model for
19
20
21 studying organized adult play as potential benefit for mental health and social wellbeing.
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

1
2
3
4 **Ethical Considerations:** All study participants provided informed consent, and all protocols
5
6 were approved by the improv theatre and the University at Albany Institutional Review Board
7
8
9 (17-E-281).

10
11 **Conflict of Interest:** The authors declare that they have no conflict of interest.
12
13

14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65

- Adam, E. K., Hawkey, L. C., Kudielka, B. M., & Cacioppo, J. T. (2006). Day-to-day dynamics of experience–cortisol associations in a population-based sample of older adults. *Proceedings of the National Academy of Sciences*, 103(45), 17058. doi:10.1073/pnas.0605053103.
- Barrett, J. L. (2011). Cognitive science of religion: Looking back, looking forward. *Journal for the Scientific Study of Religion*, 50(2), 229-239.
- Christiano, B. A., & Russ, S. W. (1996). Play as a predictor of coping and distress in children during invasive dental procedure. *Journal of Clinical Child Psychology*, 25(2), 130-138.
- Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of health and social behavior*, 24(4), 385.
- Cohen, S., & Williamson, G. M. (1988). Perceived stress in a probability sample of the United States. In S. Spacapan, & S. Oskamp (Eds.), *The social psychology of health* (p. 31). Newbury Park, CA: Sage.
- Csikszentmihalyi, M. (1990). *Flow: the psychology of optimal experience*. New York: Harper & Row.
- Dawson, J. F. (2014). Moderation in management research: What, why, when, and how. *Journal of Business and Psychology*, 29(1), 1.
- Erickson, K., Drevets, W., & Schulkin, J. (2003). Glucocorticoid regulation of diverse cognitive functions in normal and pathological emotional states. *Neuroscience & Biobehavioral Reviews*, 27(3), 233-246.
- Fries, E., Dettenborn, L., & Kirschbaum, C. (2009). The cortisol awakening response (CAR): facts and future directions. *International journal of Psychophysiology*, 72(1), 67-73.
- Harris, P. L. (2000). *The work of the imagination*. Blackwell Publishing.
- Hellhammer, D. H., Wust, S., & Kudielka, B. M. (2009). Salivary cortisol as a biomarker in stress research. *Psychoneuroendocrinology*, 34, 163.
- Jamieson, G. (2005). The modified Tellegen absorption scale: A clearer window on the structure and meaning of absorption. *Australian Journal of Clinical and Experimental Hypnosis*, 33, 119.
- Kaiser, B. N., Haroz, E. E., Kohrt, B. A., Bolton, P. A., Bass, J. K., & Hinton, D. E. (2015). “Thinking too much”: a systematic review of a common idiom of distress. *Social Science & Medicine*, 147, 170-183.
- Kirschbaum, C., Pirke, K. m., & Hellhammer, D. H. (1995). Preliminary evidence for reduced cortisol responsivity to psychological stress in women using oral contraceptive medication.

- 1
2
3
4 *Psychoneuroendocrinology*, 20(5), 509. <http://www.sciencedirect.com/science/article/B6TBX-3YCDW7X-13/2/22d46c95a2e27e6163e78cf0f2e880f2>.
- 5
6 Luhrmann, T. M. (2005). The Art of Hearing God: Absorption, Dissociation, and Contemporary
7 American Spirituality. *Spiritus: A Journal of Christian Spirituality*, 5(2), 133.
8 <http://muse.jhu.edu.libdata.lib.ua.edu/journals/spiritus/v005/5.2luhrmann.html>.
- 9
10 Luhrmann, T. M. (2012). When God talks back: Understanding the American evangelical
11 relationship with God. Vintage.
- 12
13 Luhrmann, T. M., Nusbaum, H., & Thisted, R. (2010). The absorption hypothesis: Learning to
14 hear God in Evangelical Christianity. *American Anthropologist*, 112(1), 66. doi:10.1111/j.1548-
15 1433.2009.01197.x.
- 16
17 Lynn, C. D., Dominguez, J. T., & Decaro, J. A. (2016). Tattooing to "Toughen up": Tattoo
18 experience and secretory immunoglobulin A. *American Journal of Human Biology*, 28, 603.
19 doi:10.1002/ajhb.22847.
- 20
21 Lynn, C. D., Howells, M., Herdrich, D., Ioane, J., Hudson, D., & Fitiao, S. a. T. U. (2019). The
22 evolutionary adaptation of body art: Tattooing as costly honest signaling of enhanced immune
23 response in American Samoa. *American Journal of Human Biology*, e23347.
- 24
25 Lynn, C. D., Paris, J. J., Frye, C. A., & Schell, L. M. (2010). Salivary alpha-amylase and cortisol
26 among Pentecostals on a worship and nonworship day. *American Journal of Human Biology*,
27 22(6), 819. doi:10.1002/ajhb.21088.
- 28
29 Lynn, C. D., Paris, J. J., Frye, C. A., & Schell, L. M. (2011). Glossolalia is associated with
30 differences in biomarkers of stress and arousal among Apostolic Pentecostals. *Religion, Brain &*
31 *Behavior*, 1(3), 173. doi:10.1080/2153599x.2011.639659.
- 32
33 Miller, G. E., Chen, E., & Cole, S. W. (2009). Health psychology: Developing biologically
34 plausible models linking the social world and physical health. *Annual review of psychology*, 60,
35 501-524.
- 36
37 Miller, G. E., Chen, E., & Zhou, E. S. (2007). If it goes up, must it come down? Chronic stress
38 and the hypothalamic-pituitary-adrenocortical axis in humans. *Psychological bulletin*, 133(1),
39 25.
- 40
41 Organization, W. H. (2020). Mental health. World Health Organization.
42 https://www.who.int/mental_health/advocacy/en/#Factsheets. Accessed 28 May 2020.
- 43
44 Pellis, S., & Pellis, V. (2013). The playful brain: venturing to the limits of neuroscience.
45 Oneworld Publications.
- 46
47 Pruessner, J. C., Kirschbaum, C., Meinlschmid, G., & Hellhammer, D. H. (2003). Two formulas
48 for computation of the area under the curve represent measures of total hormone concentration
49 versus time-dependent change. *Psychoneuroendocrinology*, 28(7), 916. doi:Doi: 10.1016/s0306-
50 4530(02)00108-7.
- 51
52 Pruessner, J. C., Wolf, O. T., Hellhammer, D. H., Buske-Kirschbaum, A., Von Auer, K., Jobst,
53 S., et al. (1997). Free cortisol levels after awakening: a reliable biological marker for the
54 assessment of adrenocortical activity. *Life sciences*, 61(26), 2539-2549.
- 55
56 Seligman, R., & Kirmayer, L. J. (2008). Dissociative experience and cultural neuroscience:
57 Narrative, metaphor and mechanism. *Culture, medicine and psychiatry*, 32(1), 31.
58 <http://dx.doi.org/10.1007/s11013-007-9077-8>.
- 59
60 Smyth, J., Ockenfels, M. C., Porter, L., Kirschbaum, C., Hellhammer, D. H., & Stone, A. A.
61 (1998). Stressors and mood measured on a momentary basis are associated with salivary cortisol
62 secretion. *Psychoneuroendocrinology*, 23(4), 353-370.
- 63
64 Stromberg, P. G. (2009). Caught in play. <http://site.ebrary.com/lib/alabama/Top?id=10329901>.
- 65

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

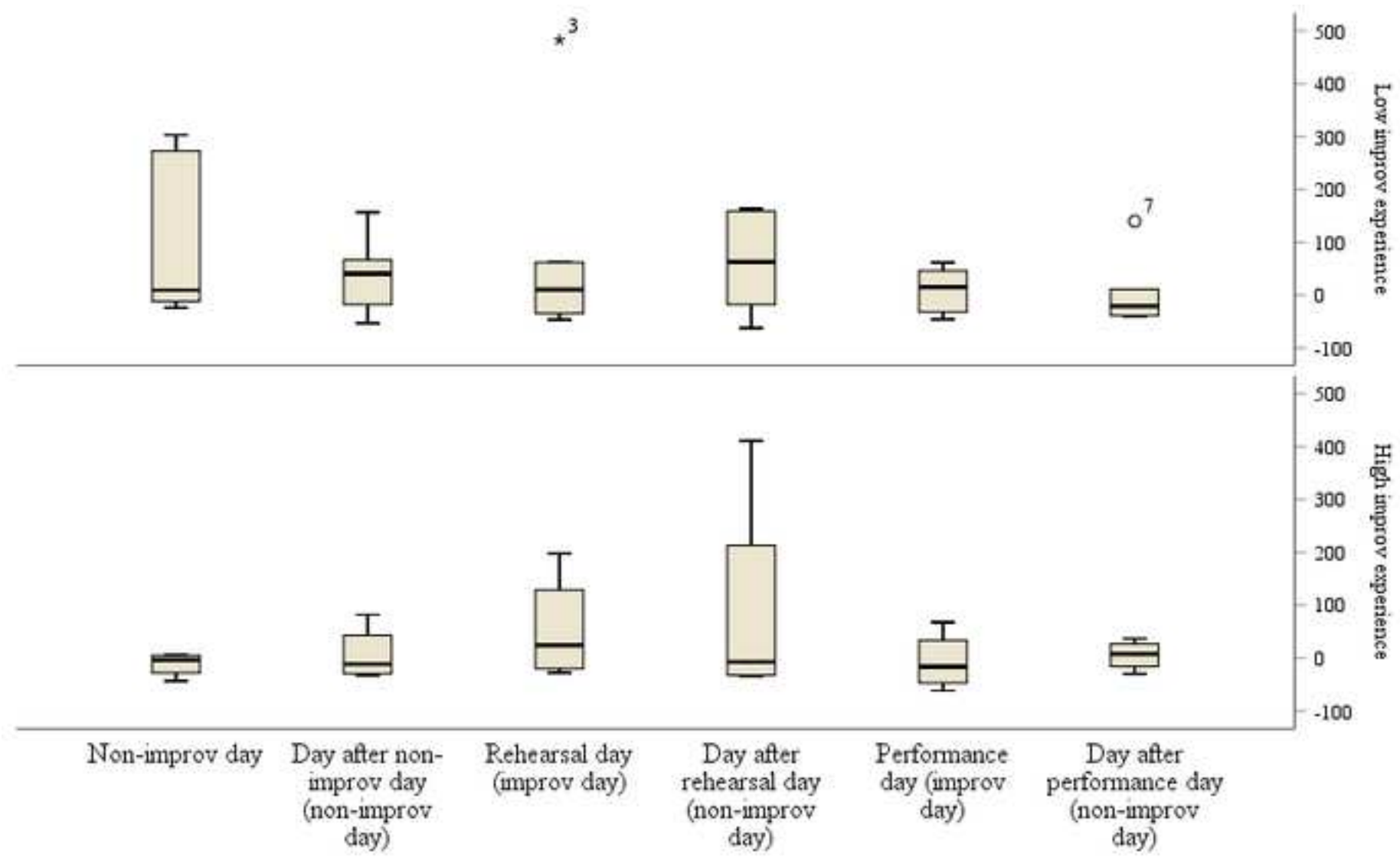
Tellegen, A., & Atkinson, G. (1974). Openness to absorbing and self-altering experiences ("absorption"), a trait related to hypnotic susceptibility. *Journal of abnormal psychology*, 83(0021-843; 3), 268.

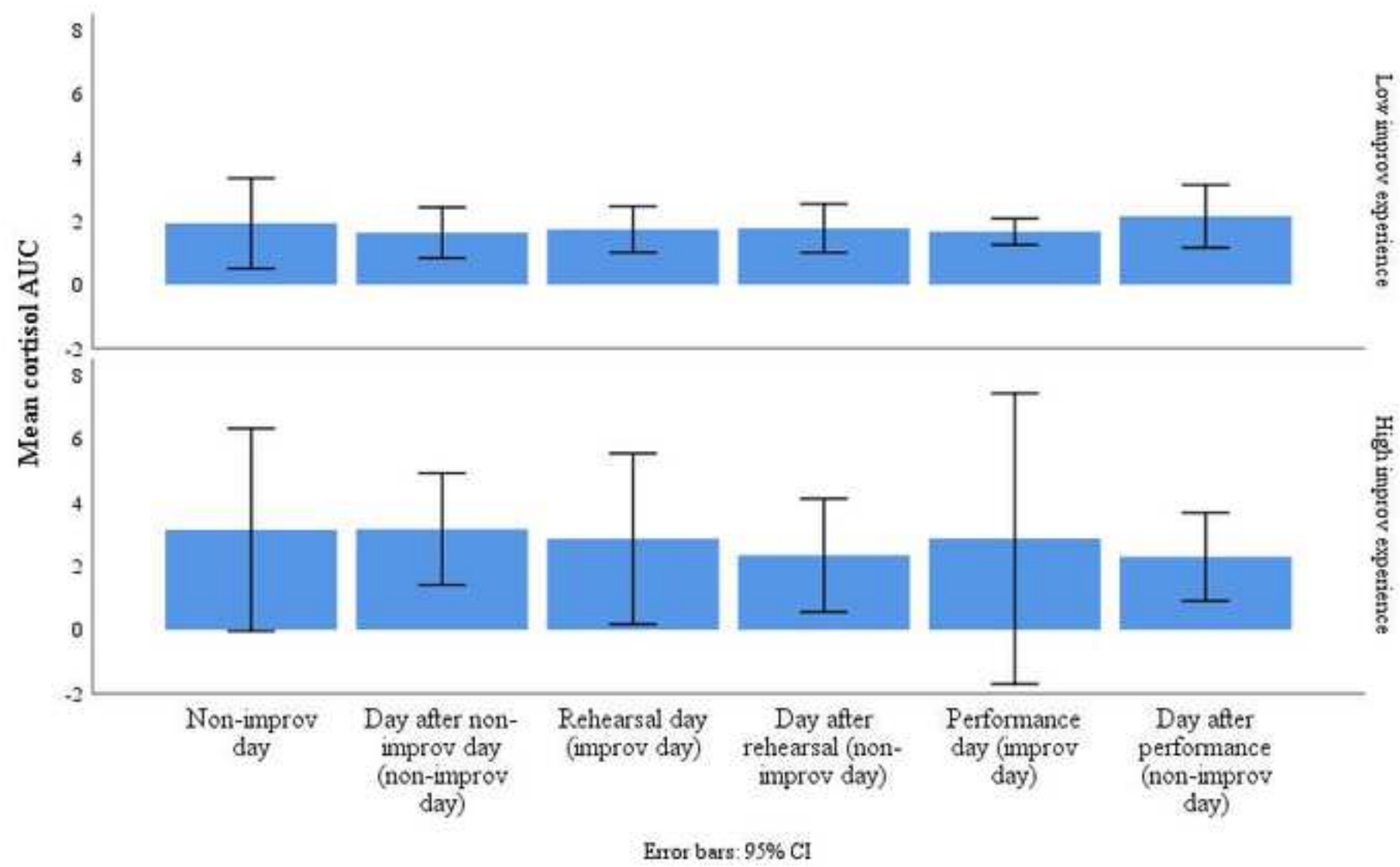
Thompson, T., Steffert, T., Steed, A., & Gruzelier, J. (2010). A randomized controlled trial of the effects of hypnosis with 3-D virtual reality animation on tiredness, mood, and salivary cortisol. *International Journal of Clinical and Experimental Hypnosis*, 59(1), 122-142.

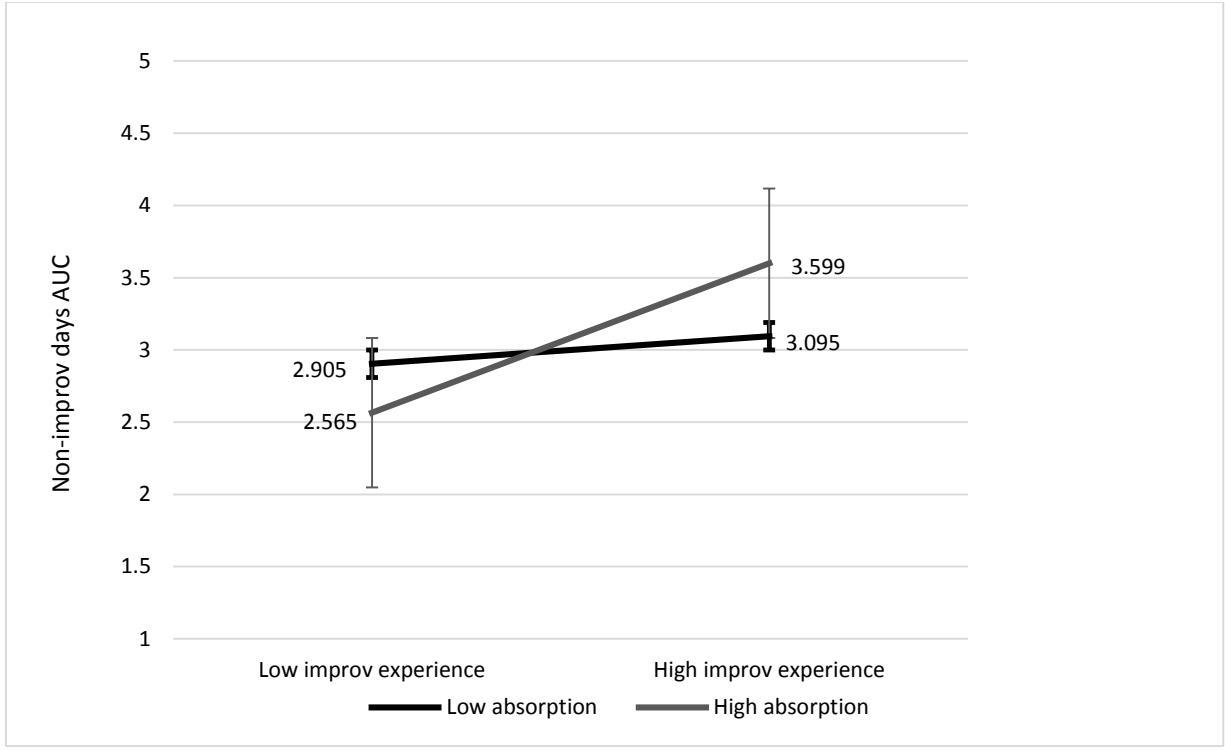
Wasson, S. (2017). *Improvisation: How we made a great American art*. Houghton Mifflin Harcourt.

Watson, D., & Clark, L. A. (1999). *The PANAS-X: Manual for the positive and negative affect schedule-expanded form*.

Wüst, S., Wolf, J., Hellhammer, D. H., Federenko, I., Schommer, N., & Kirschbaum, C. (2000). The cortisol awakening response - normal values and confounds. *Noise and Health*, 2(7), 79.







We would like to thank the reviewers for their positive and constructive comments and suggestions. We have implemented or addressed the reviewers' concerns. We believe these changes have strengthened the manuscript. Below are the individual reviewer's comments and how we addressed them (in bold and italics). We also highlighted the manuscript in yellow where these changes have been implemented.

COMMENTS FOR THE AUTHOR:

Reviewer #1:

Organized Adult Play and Stress Reduction: Testing the Absorption Hypothesis in a Comedy Improv Theatre

This study investigated whether membership in a comedy improv troupe training could prove beneficial for psychological (mood) and physiological (cort concentrations) wellbeing, via improv experience and the concept of psychological absorption. Although the results did not support the hypothesis of improv experience and absorption as stress-reducing elements on improv or non-improv days, evidence was found that absorption has a positive association with cortisol during improv days.

Comments:

1) From the manuscript, it does not seem that the authors accounted for potential critical covariates that may interact with hormonal concentrations, such as the use of oral contraceptives, stage of menstrual cycle in female participants, time since waking, etc. Research has demonstrated this to affect both interpretation and endocrine responses to stressors. These variables would be particularly important with the attempts to define a single day cortisol measurement as being indicative of a stress biomarker that can be tied to "long term health benefits". In addition to these potential covariates, were exclusion criteria included for beyond current / past neurological disorders and the use of psychiatric medication, such as illness? Or were the twelve individuals selected based on a version of convenience sampling?

There were no exclusion criteria used in recruitment, but we did collect information on medication, drug, alcohol, and tobacco use. We created dummy variables for medication known to influence cortisol (e.g., oral contraceptives, anti-depressants, anti-seizure meds) and for alcohol and tobacco use. We included these in initial models and found no influence of any of these variables and did not use them in further analysis. We have included language to this effect in the manuscript. We do specifically note that only one of the female participants reported using oral contraceptives, thus with this small (single participant) cell size we did not include this in our analyses.

2) Given the theoretical framework of psychological absorption as being crucial to why improv may show similar benefits to religion, I found the discussion to be lacking in terms of connecting the concept of absorption to the methodology utilized and results found. I think the authors could improve this clarity in a few ways. A more detailed description of the MODTAS would help methodologically (perhaps an example item from the metric?). However, I think the biggest benefit would come from a deeper description of the theoretical construct of absorption

in the introduction and/or conclusion. For example, outside of the religious sphere, how was psychological absorption been studied in terms of its relationship to psychological and physiological markers of stress?

The authors agree and have removed some of this explanation to keep the report brief. We have restored explanations of the construct in the introduction and methods section.

3) Aside from covariates, the significance values associated with the hierarchical ANCOVA (both main effect of absorption on improv days and interaction effect of experience and absorption on non-improv days) are either just below 0.05 or above (defined as approaching significance by the authors). These probabilities are all the more reason why authors should consider including effect sizes in their reported analyses that extend beyond the overall r^2 values of each model (e.g., reporting eta-squared values for the significant main and interaction effect).

We agree on the importance of including effect size, so we included standardized beta statistics for each predictor. Effect sizes in hierarchical linear regression are indicated by standardized beta statistics. Partial eta² are effect sizes for SPSS GLM modeling.

4) I am seeking some clarification on the length in time separating the couplets of days used in data collection. How many days were aggregated to create non-improv days and improv days? How far apart in days were the couplets and the days aggregated to create non-improv days data and improv days data? Is there an equal sample across the aggregated improv days and non-improv days group? Though the small sample size is acknowledged, but would uneven groups cause consideration for different analytical tools (e.g., nonparametric)?

Greater detail has been added to the methods section describing the composition and timing of the couplets.

Minor comments:

5) How was perceived stress measured at the beginning of the study?

Since it was not a significant predictor, we had removed this information, but discussion of the Perceived Stress Scale and our use of it is restored.

6) Difficult in black/white to find difference in absorption groups in Figure 2. Further, were low and high absorption defined using a median split analysis?

As indicated in the text, we graphed the interaction at +1SD and -1SD using unstandardized betas from the regression model so that the graph also accounts for covariates. This technique uses the following template: <http://www.jeremydawson.co.uk/slopes.htm>. We have noted this in the caption as well, since the figure should be clear without resorting to the text.

Reviewer #2:

In this study the authors investigate the effects of participating in improv comedy on cortisol levels. They present the absorption hypothesis, which appears to explain how focusing attention to a specific activity (in this case improvisation during an "organized play" activity) have an antistress effect. They could not find full support for their hypothesis. I personally think that the idea of using actors' performance and experience is quite interesting. The use of multiple sampling is also a strong point in favor of this work. However, there are important limitations. One, as the authors recognized, is that despite the multiple sampling the study is likely underpowered and as it is presented it looks like a pilot study (they refer to it as "exploratory"), thus not something necessarily publishable (there must be strong reasons for publishing a pilot/exploratory study, two among them the uniqueness of the hypothesis or of the sample).

We defer to the editor as to whether to call this pilot or exploratory, but we do feel the uniqueness of the hypothesis and compelling sample merit publication.

The definition of "absorption" is never explicitly described. I apologize for my ignorance, but I have never heard of this construct before. The authors should be more specific about what absorption is and what it is not, not simply by placing in parenthesis "focused attention". I think that this is especially important as I believe within the field of human behavioral endocrinology, biological psychology and psychoneuroendocrinology the construct "absorption" has never been discussed (although I think it may have something to share with mindfulness?).

Because this study is exploratory/pilot, we were mindful of length and limited our discussion of the absorption construct. It has a relatively elaborate history and is most commonly associated with hypnotic susceptibility, as we have indicated. The Tellegen Absorption Scale, in particular, is widely used in psychology and psychological anthropology in relation to other state-trait metrics and biological outcomes. We are cautious about over-explaining this, given the nature of our report, but can provide more or less as reviewers/editors deem appropriate.

The title is compelling as it begins with "Organized adult play". Play is an important and interesting activity that has specific meaning and views within the evolutionary literature. I don't think the authors ever talk about play in the text though. I guess the authors assumes that play is an activity with anti-stress functions. The question though, is if it really exists such a kind of activity that can be defined as "play" in adult homo sapiens and what functions it may have. The authors refer to Stromberg, P. G. (2009). Caught in play for their hypothesis of play and absorption. However, given that AHPB is specifically concerns with Darwinian adaptation, I think the authors should calibrate their introduction by discussing the proximate causes of organized adult play, if indeed play is important.

As mentioned previously, we tried to limit long theoretical discussion because of the exploratory nature of this study, but play theory was one of our guiding approaches in this project. We have restored some discussion of play theory as it relates specifically to coping with stress and the application to adult behavior.

In line 39 the authors refer to psychological rumination and how "absorption" can reduce it.

Once again this is very similar to the concept of positive cognitive coping and mediation. I am not trying to push my personal view here, but I think that if the study is about some anti-stress effects of an activity and cortisol is used as a biomarker of such construct, then I believe that the authors should frame their work using (or citing at least) the relevant literature and see if and how their "absorption hypothesis" fits into it. In this way a reader could see if and how this hypothesis is new.

The reviewer is correct in asserting that cognitive coping and mediation are relevant here. However, we feel that the relationship between play and coping with stress/anxiety is well established. Using cognitive coping as a theoretical frame would not introduce any new insights. By contrast, absorption is the mechanism by which such coping work, so that, theoretically, those high in absorption get more benefit from a positive coping strategy like comedy improv. That is the novel hypothesis we are testing. We have added language to clarify this link and appreciate the opportunity to think more deeply about our approach vis-a-vis other options.

Line 37. I am not sure if the history of improv comedy really needs to be discussed, but if so, then you must cite references.

We have removed the history of improv and discuss only its format and tenets. We have also added a reference for this information.

Line 56. Where in the introduction did you precisely described "absorptive associated play"? where this kind of play stands in relation to the biological, psychological and anthropological concept of play?

Apologies. This should simply read "absorptive play." This has been corrected, and theoretical background on play and absorption have been expanded to provide context for this statement.

Methods and results.

The repeated measure sampling is great as is the CAR. However, I have an important critique. Of 12 participants, 4 were women. It is not clear how you controlled for the menstrual cycle as it can affect baseline cortisol levels. With such a small sample this methodological problem lead to wrong conclusions.

We appreciate the reviewer's concerns regarding this issue, and we agree that consideration of menstrual cycle stage/status can be important for studies focusing on aspects of female hormonal physiology. We did not collect that data in the current research, and based on prior critical reviews and meta analyses we do not think it would be an essential covariate in this study. For example, Nepomnaschy et al., 2011 thoroughly review the relatively large number of studies that have examined cortisol across the menstrual cycle and outline why researchers generally hold that basal levels of cortisol generally do not substantially vary across the menstrual cycle. Nepomnaschy and colleagues' own thorough results show that this is the case, except for relatively rare cycles in which the luteal phase is typically extended. Similarly, in a 2017 meta analysis, Liu et al. showed that menstrual cycle status was not significantly or

meaningfully linked to basal cortisol. Based on this context, we think it is highly unlikely that including menstrual cycle status would have affected the observed patterns.

Nepomnaschy, P. A., Altman, R. M., Watterson, R., McConnell, D. S., & England, B. G. (2011). Is cortisol excretion independent of menstrual cycle day? A longitudinal evaluation of first morning urinary specimens. PLoS One, 6(3), e18242.

Liu, J. J., Ein, N., Peck, K., Huang, V., Pruessner, J. C., & Vickers, K. (2017). Sex differences in salivary cortisol reactivity to the Trier Social Stress Test (TSST): a meta-analysis. Psychoneuroendocrinology, 82, 26-37.

15% CV for the low control seems pretty high. Could the authors provide some references of other studies that published their work with such a high CV?

**We understand the reviewer's concern regarding the relatively higher value for the inter-assay low control CV. Overall, we agree that this low CV value is modestly higher than we would have liked. That said, as indicated in the quotation below from Calvi et al., 15% is generally considered at the high end of the acceptable levels of between-plate variation for steroid hormones assayed via ELISA. This is especially the case for low control values, which (as the "low" name indicates) are typically measured on the low end of the assay's standard curve; see final paragraph in this response. We think it is important to consider that between-plate variation would tend to reduce the reliability of the data and make it less likely that we would observe statistically significant results, rather than increase the likelihood of false positives.*

from Calvi et al. (2017):

The scientific community recommendations provide guidelines that, on average, intra- and inter-assay precision, represented by the coefficient of variation (CV), should be less than 10 and 15%, respectively.

Calvi, J. L., Chen, F. R., Benson, V. B., Brindle, E., Bristow, M., De, A., ... & Klawitter, H. (2017). Measurement of cortisol in saliva: a comparison of measurement error within and between international academic-research laboratories. BMC research notes, 10(1), 1-6.

While the following (related) response is somewhat lengthier, we did also want to raise this point. There are many ways in which authors report quality control data. We follow the strictest possible reporting based on: Rodbard 1974 Clin Chem. 20: 1255-70 (Clinical Chemistry is the highest impact laboratory methods specialty journal). As the reviewer likely knows, reporting the duplicate CVs for both high and low controls gives additional insight into the precision profile of the assay and how it performs for specimens at the high and low concentrations. Some authors just report the average within sample CVs across samples; had we done that, our average cortisol CV would have been substantially lower. We reported the high and low control CVs as we wanted to be as transparent as possible- like most assays, the Salimetrics cortisol assay has higher variance for low concentration samples (i.e. the low control). This is partially due to the way CVs are calculated (standard deviation divided by the mean)- when the mean value is small, even slight changes in the standard deviation make the

CV exceptionally high. Importantly, there was no indication that the assay was systematically biased on one direction or another, just that the variance was somewhat elevated for the cortisol data at the lower end of concentrations. If anything, as we noted above, higher variance makes it more difficult to find a statistically significant effect because it reduces statistical power.

Two example studies that used Salimetrics cortisol kits and have CVs in the relevant range:

*(16%) >> Gray, P.B., Parkin, J.C., Samms-Vaughan, M.E., 2007. Hormonal correlates of human paternal interactions: A hospital-based investigation in urban Jamaica. *Horm. Behav.* 52, 499–507. doi:10.1016/j.yhbeh.2007.07.005*

*(16.4%) >>Ponzi, D., Muehlenbein, M.P., Geary, D.C., Flinn, M. V, 2016. Cortisol, salivary alpha-amylase and children's perceptions of their social networks. *Soc. Neurosci.* 11, 164–74. doi:10.1080/17470919.2015.1045988*

I am also quite skeptic with Table 2. I am not an expert statistician, but I am puzzled by the large R^2_{adj} , I have never (as far as I remember) seen them so high...

We aggregated measures across multiple days and people, so the variability is very reduced. This means that there is less variability to explain, so the r^2 is much higher than one would expect. We used adjusted- r^2 , which is a more conservative estimate (i.e., lower number) based on the number of variables in the model.

"Furthermore, because of the small sample, there was limited ability to detect between-subjects effects using a repeated measures paradigm, so we aggregated measures by non-improv and improv days, which limited the grain of analysis." I am not sure if I follow this... there are no between subject variables...you could have simply tried out a multilevel model (yep, stat power is important but you would have more data point for each subject...)

We appreciate this suggestion and, indeed, we did initially try running several multi-level models. Per the previous response, this approach not only reduced the statistical power of the modeling, it increased the variability of the DV beyond our power to detect anything.