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Is the thought-action repertoire a viable intervention target in substance use populations?

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ABSTRACT

Objective: This study examined if general population findings of positive correlations between happiness and breadth of thought-action repertoire (TAR) hold in substance use populations, and tests if the TAR is a modifiable intervention target.

Methods: Using data from a randomized online survey on 468 adults in recovery from problematic substance use, we compared 5 happiness exercises to two control exercises on participants' post-exercise TAR, as measured by Frederickson's Modified Open-Ended Twenty Statements Test (MOETST) and coded specifically for action tendencies. **Results:** A negative binomial regression model indicated that momentary happiness reported before exercise completion was significantly and positively related to the breadth of action tendency repertoires ($\exp(b) = 1.05$, $\exp(95\% \text{ CI}) [1.01, 1.09]$, $p = 0.012$). Two of five happiness exercises were associated with higher action tendency scores compared to the "Three Hard Things" control condition ("Savoring": $\exp(b)$ [95% CI]: 1.51 [1.10, 2.09], $X^2(df = 1) = 6.36$, $\text{adj. } p = 0.038$; "Rose, Thorn, Bud": 1.50 [1.09, 2.06], $X^2(df = 1) = 6.19$, $\text{adj. } p = 0.038$). None were significantly different from a neutral control. Effects were not significant for MOETST raw scores.

Conclusions: Results indicate that momentary happiness is associated with broadened action tendencies among individuals in recovery. Brief, self-administered happiness exercises can successfully broaden this aspect of the thought-action repertoire in this population.

1. Introduction

Recent years have seen a surge of interest in leveraging positive psychology to support health behavior change. Positive psychology interventions (PPIs) have been successfully implemented to facilitate health behavior change in the areas of smoking cessation, chronic pain management, cardiac health, and contingency management in the treatment of methamphetamine use. In smoking cessation, positive psychology based interventions have been developed for in-person [1,2] and smartphone app delivery [3]. In chronic pain management, the induction of positive mood states using PPIs has been associated with decreased bodily pain and increased pain tolerance in chronic pain sufferers [4]. Patients have also reported liking PPIs, and the use of PPIs has been linked prospectively with increased cardiac health behaviors [5,6]. A positive affect intervention in conjunction with contingency management was associated with both decreased craving and use among a sample of HIV-positive sexual minority men using methamphetamine [7]. These findings in diverse settings indicate the appeal and transportability of positive psychology approaches across diverse patient populations.

Scant research, however, has addressed whether positive psychological approaches could be viably implemented to support behavioral change in the area of problematic substance use. Addiction scientists have increasingly argued that the field of addiction needs to move beyond the elimination of substance use [8]. Patients as well have emphasized the importance of moving beyond substance use, as evidenced by the existence of the grass-roots efforts known as the recovery movement [9], where their expressed goals of recovery include finding inner peace, improving social connections and mental health, learning to enjoy life without substance use, and personal growth [10]. Despite this interest, however, current efforts have focused on assessment rather than intervention, with expert panels recommending the assessment of quality of life [11] and patient-reported outcome measures featuring outlook on life, including happiness, prominently [12], but research on actual interventions or proposed mechanisms of behavior change remain limited to a few pilot studies [13–15]. This lack of research on positive psychology approaches to improve substance use outcomes continues to exist despite findings highlighting the potential benefit of positive affect. For example, a pooled analysis of four randomized clinical trials

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($n = 416$) found that among people seeking outpatient treatment for substance use, positive affect was found to be positively correlated with positive treatment outcomes such as an increased maximum of abstinence achieved during treatment, treatment completion, and treatment completion with abstinence [16]. Meanwhile, pilot studies on treatment-receiving adolescents ($n = 20$) [13], alcohol use disorder outpatients ($n = 23$) [14], and methamphetamine-using men who have sex with men ($n = 21$) [15] have shown that PPIs are well received by these substance use populations, and can be feasibly implemented. To date, results from only one large-scale trial testing the efficacy of an intervention that incorporates principles of positive psychology with mindfulness training and cognitive-behavioral therapy for chronic pain patients taking opioids has been published [17], and large-scale trials of predominantly positive psychology approaches to substance use treatment or recovery have not yet been undertaken.

In this paper, we are taking a step back, and focus on the hypothesized mechanisms by which PPIs could confer benefit in the treatment of problematic substance use. We have recently demonstrated that self-administered, text-entry based happiness exercises increase momentary happiness in individuals in recovery from problematic substance use [18]. In this paper, we are extending this research by testing if happiness exercises impact the thought-action repertoire in this population.

The thought-action repertoire (TAR) is a theorized mechanism by which happiness might support health behavior change. At any given moment, the arsenal of thoughts and action urges or tendencies one can call up consciously is called the TAR [19]. The link between the TAR and potential positive health behavior change is best described by Fredrickson's Broad-and-Build Theory [20]. This theory posits that positive affect broadens attention, cognitive appraisal, and attention and results in a broadened TAR. The more creative, diverse thought-action tendencies then encourage novel activities and social interactions (action tendencies) that subsequently help to build enduring personal resources such as skills, knowledge, social support, and resilience. These increased personal resources, in turn, not only enhance health, survival, and well-being, but also produce more positive emotions that subsequently create an upward spiral of increasing personal benefits.

In the addiction literature, recent preliminary findings suggest that such a broadened TAR might be relevant in the treatment of alcohol use disorder (AUD), where it has been shown that a broader repertoire of coping skills mediates the effect of behavioral intervention on AUD outcomes [21]. This finding, combined with findings from general population samples, suggests that a broadened TAR could help individuals in recovery better navigate the challenges of recovery by being able to come up with and enact more varied, and hopefully more healthful, actions. This proposed mechanism of behavior change, however, depends on interventions being able to successfully impact the TAR.

To address this research question, we conducted a secondary data analysis of an online randomized survey examining the effectiveness of happiness exercises on momentary happiness [18], which assessed the TAR as a secondary outcome. Our specific goals were to test if general population findings of positive correlations between happiness and breadth of TAR [22] hold in substance use populations, and furthermore, to test whether the completion of happiness exercises resulted in a broadened TAR in this population.

2. Materials and methods

2.1. Sample

As previously described, we conducted a randomized, one-time online survey to test the feasibility and effectiveness of five happiness exercises [18]. Compared to the sample reported in the previous manuscript, using surveys completed between 9/15/2016 and 2/9/2018, this secondary data analysis includes an additional 25 participants, who completed the open online survey up until 11/09/2018, the cut-date for this sample.

In order to be included in analyses, participants had to (1) be 18 years old or older, (2) consent to participate, (3) affirm they were either seeking or in recovery from alcohol or substance use, (4) correctly respond to two randomly placed check-questions within the survey (e.g., “Please select ‘agree’ for this item.”) to verify they were truly reading the questions, and (5) respond to the instrument that assessed the breadth of the TAR within the survey. Of 676 interested persons, 2 (0.3%) were < 18 years of age or did not provide an age, 4 (0.6%) did not provide consent, 26 (3.9%) self-reported that they were “Not really taking this survey, just clicking to browse through” in response to the introductory status check question, 19 (2.8%) self-reported that they were “Not in recovery, but supporting someone who is” to the introductory status check question, 18 (2.7%) were in recovery from other addictions (e.g., food, gambling, etc.), 10 (1.5%) provided incorrect answers to at least one check item, 48 (7.1%) did not provide any pre-exercise happiness rating, and 81 (12.0%) did not complete the TAR assessment (Online supplementary material, Fig. S1). The final sample included 468 participants.

2.2. Procedure

Interested individuals clicked a link that brought them to an online survey. After providing consent, they answered introductory questions, then completed one of seven randomly assigned text-entry exercises (5 happiness exercises, a negative control exercise, and a neutral control exercise). Following completion of the assigned exercise, participants' thought-action repertoires were assessed using the *Modified Open-Ended Twenty Statements Test (MOETST)* [22]. Thereafter, additional information was collected (e.g., demographics). All study procedures were approved by the Partners HealthCare Institutional Review Board.

2.2.1. Happiness exercises

Three of the five happiness exercises were modified versions of exercises that had previously been shown to be effective in enhancing positive affect [23–25]. These exercises were “Three Good Things” (participants enter text describing three good things that happened to them that day), “Experiencing Kindness” (participants describe an act of kindness they performed and one they witnessed that day), and “Savoring” (Participants enter text describing two experiences they savored). Two exercises were created by us based on relevant findings and existing practices. These exercises were: “Rose, Thorn, and Bud” (participants enter text into 3 textboxes, describing, in turn, the highlight of their day (rose), a challenge of the day (thorn), and something they look forward to tomorrow (bud)) and “Reliving Happy Moments” (participants browse pictures on their own smartphones, select one picture capturing one of their happy moments, and enter text describing this moment).

2.2.2. Control exercises

The control exercises were variations of the “Three Good Things” exercise, the mostly widely known and used happiness exercise of the five happiness exercises. Namely, these exercises were “Three Hard Things” (participants enter text describing three “things that have been hard” that day) and “Three Things” (participants enter text describing three things that happened that day). The “Three Hard Things” is a clinically relevant comparison, because treatment frequently addresses encountered challenges. The “Three Things” exercise is an effort to create a theoretically neutral comparison, which acts as an attention-control without valence.

2.3. Measures

2.3.1. Thought-action repertoire

The *Modified Open-Ended Twenty Statements Test (MOETST)* [22] was administered to assess the TAR. Typically, this test starts by evoking an emotion, oftentimes experimentally, using a visual cue or mood induction. Thereafter, participants are asked to name the emotion they

felt most strongly, and then are asked to feel it as vividly as possible. Then they are instructed: “Given this feeling, please list all the things you would like to do right now. You can list as many or as few things as come to mind in the lines below.” In the present study, we used the emotion induced by the randomly assigned exercise. Specifically, right after participants completed the randomized text-entry exercise, the survey instructed: “Now take a moment to think back on the experiences you just described. What is the strongest emotion you felt while recalling those experiences?” After naming the emotion, instructions were the same as in the standard MOETST, followed in our case by twenty text boxes rather than twenty lines on a paper, in which participants could insert their answers, each prefaced with the stem text “I would like to...” To score, the number of entries are summed, resulting in a score ranging from 0 to 20, with higher numbers indicating a broader TAR [22].

2.4. Analytic strategy

2.4.1. Data preparation: qualitative coding

As per standard MOETST use, raw scores were computed by summing all statements. In so doing, however, we noted that numerous statements did not follow the instructions provided (i.e., participants writing “nothing”, or writing text that did not comply with the instructions: “[...] please list all the things you would like to do right now” [emphasis added]). To obtain a MOETST sum that specifically reflects the momentary repertoire of action tendencies, MOETST entries were coded into action tendencies and non-action thoughts. To this end, two authors (BH, SH) designed a coding structure which coded statements as non-action thought statements (i.e., not reflecting currently available actions) if they fell into the following categories: (1) wishful thinking (e.g., “I would like to...change the way I handled my life”, “... walk without pain”, “... win the lottery”), (2) states of being (e.g., “... be less down”, “... be grateful for having time off work”), (3) passively receiving (e.g., “... hear from friends”, “... have someone to cook and clean when I am in too much pain.”), (4) statements about idealistic long-term processes (e.g., “... eat healthier”, “... exercise regularly”), (5) vague, non-actionable statements (e.g., “... make a difference”, “... fulfill my purpose in life”), and (6) statements of not doing something (e.g., “... have no worries or fears”, “... not have a drink”). Using this coding structure, two other authors (HC, AL) then independently rated each statement as either a valid action (yes), not an action (no), or a case they were unsure about (maybe). Inter-rater agreement between raters was substantial (Cohen's weighted kappa [95% CI]: 0.73 [0.70, 0.75]), with raters agreeing on 86% of their ratings. Coding discrepancies (i.e., any non-identical ratings) and “maybe” ratings by either or both raters (4.6% of statements) were resolved by consensus, including the two independent raters and 1–2 other authors. The coding structure was updated based on clarifications agreed upon during consensus rating meetings. All statements were coded blind to randomized group assignment. The MOETST was then re-scored by summing only action statements (1820 out of 2708 statements entered [67.2%]) to provide the sum of action tendencies (MOETST-AT) and, conversely, the sum of non-action thought statements (MOETST-NA; the remaining 32.8% of the statements).

2.4.2. Analytic strategy

To test whether momentary happiness was associated with the breadth of TAR, we used a negative binomial regression model with the sum of action tendencies (MOETST-AT) as the outcome variable and pre-exercises momentary happiness ratings as the predictor (estimated dispersion [95% CI]: 0.66 [0.55, 0.80]). In a follow-up model, we then added randomized exercise as an additional predictor, using “Three Hard Things” as the reference category, to assess whether participation in the happiness exercises differentially affected MOETST sums. We used additional specific contrasts to also compare the effect of each happiness exercise to the “Three Things” control condition. We adjusted *p*-values for the comparisons of individual happiness exercises to each control

(five happiness exercises and the neutral “Three Things” exercise vs. the “Three Hard Things” exercise, and the five happiness exercises vs. the “Three Things” exercise) for false discovery rate [26], and evaluated significance at a two-sided $\alpha = 0.05$. All analyses were performed in SAS 9.4 for Windows. To test robustness of findings, we repeated this modeling approach for the MOETST raw score and the sum of the non-action thoughts (MOETST-NA) as dependent variables.

3. Results

Participants ($n = 468$) were 50.7 ± 12.6 years old, predominantly female (65%), non-Hispanic white (91%), and either seeking or in recovery from alcohol use (77%; Table 1). Of the five happiness exercises, “Savoring” was the most consistent in evoking positive emotions, where 96% participants named a positive emotion in the emotion-naming part of the MOETST, followed by “Reliving Happy Memories” (88%); “Rose-Thorn-Bud” evoked the fewest positive emotions of the five happiness exercises (66%; Table 2). The neutral control exercise “Three Things” elicited positive emotions from the majority of participants assigned to this exercise (59%), while the negative control condition “Three Hard Things” elicited very few positive emotions (13%).

Overall, momentary happiness reported right before exercise completion was significantly and positively related to the number of the action tendencies listed (exp(b) [95% CI]: 1.05 [1.01, 1.09], $X^2(df = 1) = 6.33$, $p = 0.012$; Table 3), indicating that for every 10-point increase in happiness rating (rated on a 0–100 scale) participants listed 5% more actions. Of the five happiness exercises examined, two were associated with higher sums of action tendencies (MOETST-AT) compared to the “Three Hard Things” control condition (Table 3). Specifically, the happiness exercises “Savoring” (exp(b) [95% CI]: 1.51 [1.10, 2.09], $X^2(df = 1) = 6.36$, adj. $p = 0.038$) and “Rose, Thorn, Bud” (1.50 [1.09, 2.06], $X^2(df = 1) = 6.19$, adj. $p = 0.038$) were associated with 51% and 50% increases in actions listed by participants, respectively, compared to the “Three Hard Things” exercise. None of the other three happiness exercises showed any significant difference in the number of action tendencies listed compared to the “Three Hard Things” exercise (all adj. $p > 0.15$; Table 3). Comparing the two control conditions, participants in the “Three Things” condition tended to write more action tendencies (estimate [95% CI]: 3.85 [3.07, 4.83]) than those in the “Three Hard Things” group (2.80 [2.21, 3.56]), but the difference was also not significant (exp(b) [95% CI]: 1.38 [1.18, 1.00], $X^2(df = 1) = 3.74$, adj. $p = 0.106$). We did not detect any differences in the number of action tendencies listed when comparing any of the five happiness exercises to the “Three Things” neutral control exercise (all adj. $p > 0.70$; Table S1, Online supplementary materials).

Pre-exercise happiness rating was not significantly related to MOETST raw scores (exp(b) [95% CI]: 1.01 [0.98, 1.05], $X^2(df = 1) = 0.76$, adj. $p = 0.385$) or MOETST-NA (exp(b) [95% CI]: 0.95 [0.90, 1.01], $X^2(df = 1) = 2.55$, adj. $p = 0.110$). Differences between randomized groups were also not statistically significant for either MOETST-raw or MOETST-NA (all adj. $p > 0.35$; Tables S2 and S3, Online supplementary materials).

4. Discussion

The present study is the first, to our knowledge, to examine the effects of momentary happiness on the TAR in a sample of people in recovery from problematic substance use. Importantly, our results indicate that momentary happiness, an affective state within the broader domain of positive affect, is associated with broadened action-tendency repertoires, but not overall thought-action repertoires, in this population of clinical interest, and that at least some PPIs show promising effects of increasing action-tendency repertoires compared to a negative control exercise. These findings are in line with earlier observations that positive affect is associated with approach-oriented coping and abstinence-related action tendencies among treatment-seeking

Table 1
Baseline participant characteristics (n = 468).

Variable		
Age, years, M (SD)	50.7	(12.6)
Female, % (n)	65.0	(460)
White, non-Hispanic, % (n)	91.1	(417)
Education: College or more, % (n)	58.0	(269)
Currently in school, % (n)	9.1	(42)
Employment, % (n)		
Full-time	45.7	(207)
Part-time	15.9	(72)
None	38.4	(174)
Recovery stage, % (n)		
Seeking recovery	10.5	(49)
In recovery - < 1 month	7.7	(36)
In recovery - ≥ 1 month, but less than a year	24.4	(114)
In recovery - ≥ 1 year	56.4	(264)
In recovery - Unspecified	1.1	(5)
Primary substance of use, % (n)		
Alcohol	77.1	(361)
Other substance	20.7	(97)
Unspecified	2.1	(10)
Happiness and quality of life indices		
In-the-moment happiness rating, M (SD)	61.5	(22.7)
Low in-the-moment happiness rating, % (n)	25.0	(117)
SWLS total score, M (SD)	21.3	(7.4)
SHS mean score, M (SD)	4.6	(1.4)
MOETST raw sum, Md [IQR]	4	[3, 7]
MOETST action tendencies sum, Md [IQR]	3	[1, 5]
MOETST non-action sum, Md [IQR]	1	[0, 3]

Note: SWLS = Satisfaction with Life Scale, where higher scores indicate greater satisfaction with life (20 is the neutral point on the scale, where the respondent is about equally satisfied and dissatisfied) [31]; SHS = Subjective Happiness Scale, where higher scores indicate greater happiness (4.5–5.5 is considered average; [32]); MOETST = Modified Open-Ended Twenty Statements Test, where higher scores indicate a richer thought-action repertoire (possible range: 0–20; the range indicated in the table is the interquartile range of observed responses); MOETST action tendencies sum is based on the sum of action-tendencies listed by participants after removing non-action entries, as described in the Methods, where MOETST non-action sums are the numbers of statements identified as not being action-tendencies. Low in-the-moment happiness is defined as rating a score of ≤50 on the in-the-moment happiness rating scale (range 1–100). Of the people included in analysis, 0.9% (n = 4) did not complete the demographics questionnaire and 2.4% (n = 11) had only some missing demographics data, 3.2% (n = 15) did not complete the SWLS, and 3.6% (n = 17) did not complete the SHS.

methamphetamine users [27]. Given the recent interest in leveraging positive psychology to support health behavior change and the emergence of the recovery movement [9], our findings hold importance in suggesting that action-tendency repertoires may be a mechanism by which positive affect confers benefit in substance use treatment and in the recovery process, and by indicating that action-tendency repertoires might be an actionable intervention target. Both of these implications underline the importance of further research into positive affect as a construct and PPIs as intervention methods in substance use treatment and recovery research.

When compared to a neutral control, randomized groups did not differ significantly in the breadth of action-tendency repertoires. Given that 59% of participants randomized to the neutral control reported experiencing a positive emotion (for a full listing, please see Table S4, Online supplementary material), the lack of difference is not surprising, because the neutral control clearly failed in providing a neutral emotional state in most participants. Nevertheless, this null finding complicates the overall interpretation of the findings, as it precludes ruling out the possibility that observed effects with regard to the negative control may be due to increased negative affect in the control condition rather than increased positive affect in the treatment groups. Our previous finding regarding momentary happiness suggest that our thought-action tendency findings may be due to a combination of these effects, as we

observed both increases in happiness in the treatment groups and decreases in happiness in the negative control group [18]. Thus, it may be particularly impactful to leverage PPIs in situations in which positive affect is not at ceiling levels and in which there is a need to counteract expected increases in negative affect. Both qualifiers apply to persons in recovery from problematic substance use. Nationally representative data on persons in recovery suggest that quality of life indices, including happiness, initially decrease as persons start the recovery process [28], and recovery from problematic substance use entails many challenges, the attention to which may be heightened during SUD treatment.

Note also that our findings are further restricted to a broadening of the action-tendency repertoires, not the TAR in general. When using the MOETST raw score, we did not find any relationship to happiness ratings or randomized group differences. These null findings are in line with prior research that indicated that a brief emotion-induction intervention only led to differences in the breadth of social action urges, but not overall TAR, and suggested that the overall broaden-and-build theory may need refinement in this regard [29]. In our case, we also had reason to believe that the MOETST raw score may contain a relatively large amount of “noise” (e.g., participants writing in “nothing”). Given the brevity of the intervention itself (4 min), and the relative complexity of completing the MOETST (1.5 min), we sought to maximize the signal to noise ratio, and thus primarily focused on the coded MOETST action tendencies.

Previous research that used the MOETST to study the TAR used staff-administered, in-person interventions to affect TAR outcomes (i.e., 1–3 minute films aiming to elicit specific emotions), administered the MOETST in person, and recruited only non-clinical samples of participants [22,29]. These two studies reported an overall mean (± SD) of 11.60 (± 5.31) thought-action statements on the MOETST by university students [22], and means ranging from 6.96 (± 2.37) to 8.10 (± 4.49) among non-psychiatric adults completing the MOETST after watching film clips with different emotional valences [29]. In our study, by contrast, both the intervention and the MOETST were self-administered remotely, and we observed on average only 5.79 (± 4.82) thought-action statements per person. It is unclear whether the reduced TARs in our study are due to the psychological characteristics of our sample, survey administration, interventions to induce specific emotional experiences (i.e., self-administered PPI exercises vs. mood-specific film clips), or a combination of all three factors. Despite these methodological differences, however, we were able to show a clear, measurable effect of some PPIs on the action-tendency aspect of the TAR in a substance use recovery (i.e., clinical) sample.

The specific exercises that resulted in a broadened action-tendency repertoire were “Savoring” and “Rose, Thorn, Bud”. Previously, we had found that these two exercises plus one additional exercise, “Reliving Happy Moments,” were the three PPIs that were most strongly associated with increased momentary happiness [18]. Given the success of the “Reliving Happy Moments” exercise in increasing momentary happiness, its failure to impact the action-tendency repertoire is surprising. We speculate that the difference in performance may be due to how active versus passive the exercises are. Both “Savoring” and “Rose, Thorn, Bud” ask participants to actively think about unnamed experiences, without the use of cognitive aids. By contrast, “Reliving Happy Moments” asks participants to browse through their own pictures before choosing and describing one. Thus, it is a more passive exercise, in which participants react to a stimulus (i.e., their pictures). The relative immediacy of the described experience may also play a role, where “Reliving Happy Moments” may focus on experiences from the distant past, while “Savoring” and “Rose, Thorn, Bud” always focus on the 24 h surrounding the moment of assessment. Future research is warranted to examine the role of these factors in associations between positive affect (e.g., happiness) and the TAR more clearly.

In studies focusing on behavioral change, it may be particularly relevant to focus on assessing the TAR as it pertains to specific scenarios and to code the MOETST in a way that aligns with hypothesized mechanisms of action. With respect to specific scenarios, an example for

Table 2
Descriptive statistics of happiness outcomes, emotions reported, and MOETST coding and outcomes by treatment group.

Outcome	Randomized exercise assignment						
	3 Good Things (n = 63)	Experiencing Kindness (n = 63)	Savoring (n = 70)	Rose, Thorn, Bud (n = 74)	Reliving Happy Moments (n = 60)	3 Things (n = 70)	3 Hard Things (n = 68)
Happiness ratings							
Pre-exercise happiness, M (SD)	64.6 (23.9)	59.4 (24.0)	59.1 (23.7)	64.0 (21.1)	63.6 (20.5)	59.1 (21.8)	61.1 (23.7)
Post-exercise happiness, M (SD)	67.4 (22.3)	61.3 (25.7)	61.9 (22.3)	67.9 (19.2)	66.7 (19.5)	57.4 (21.1)	60.2 (22.9)
Emotion referenced for the MOETST^a							
Positive, % (n)	83 (52)	73 (46)	96 (67)	66 (49)	88 (53)	59 (41)	13 (9)
Negative, % (n)	11 (7)	19 (12)	0 (0)	28 (21)	7 (4)	30 (21)	82 (56)
Neutral or missing, % (n)	6 (4)	8 (5)	4 (3)	5 (4)	5 (3)	11 (8)	4 (3)
MOETST action-tendency coding							
Participants without non-actions, % (n)	46 (29)	38 (24)	49 (34)	41 (30)	42 (25)	43 (30)	31 (21)
For people with at least 1 non-action, number of non-actions Md [IQR]	2 [1, 3]	3 [1, 4]	2 [1, 5.5]	2 [1, 4]	2 [1, 4]	3 [2, 5]	3 [1, 4]
MOETST sums							
MOETST sum, Md [IQR]	4 [3, 7]	4 [3, 7]	4 [3, 8]	4 [3, 8]	4 [3, 7.5]	4 [3, 8]	4 [3, 6]
MOETST-AT sum, Md [IQR]	3 [1, 6]	2 [1, 4]	3 [2, 6]	3 [1, 5]	3.5 [2, 5]	3 [1, 5]	2 [1, 4]
MOETST correlations with happiness ratings							
MOETST - post-happiness correlation, <i>r</i>	-0.03	0.10	0.07	0.02	0.19	0.05	-0.26
MOETST-AT - post-happiness correlation, <i>r</i>	0.07	0.27	0.17	0.13	0.23	0.18	-0.09

Notes: MOETST = Modified Open-Ended Twenty Statements Test, MOETST-AT = Modified Open-Ended Twenty Statements Test action-tendencies only.

^a Specific emotions and the frequency with which they were referenced is provided in the Table S2 (see Online supplementary material).

Table 3
Effect estimates and significance tests of the association between happiness exercises and the number of action tendencies in the thought-action repertoire (MOETST-AT) in comparison to the negative control condition ('3 Hard Things').

Parameter	Pre-exercise happiness			Pre-exercise happiness & exercise effects			
	exp(b)	exp[95% CI]	<i>p</i> > <i>X</i> ²	exp(b)	exp[95% CI]	<i>p</i> > <i>X</i> ²	Adj. <i>p</i>
Pre-exercise happiness	1.05	[1.01, 1.09]	0.012	1.05	[1.01, 1.09]	0.014	
Happiness exercises vs. "Three Hard Things"							
3 Good Things				1.31	[0.94, 1.83]	0.111	0.166
Experiencing Kindness				1.15	[0.82, 1.61]	0.411	0.411
Savoring				1.51	[1.10, 2.09]	0.012	0.038
Rose, Thorn, Bud				1.50	[1.09, 2.06]	0.013	0.038
Reliving Happy Moments				1.24	[0.88, 1.74]	0.215	0.258
3 Things				1.38	[1.00, 1.90]	0.053	0.106

Notes: Effect estimates shown are the exponentiated coefficients of negative binomial models of sums of action tendencies reported on the Modified Open-Ended Twenty Statements Test (MOETST-AT). Both raw *p*-values and *p*-values adjusted for false discovery rate (among happiness exercise comparisons to control conditions only) are shown and stars indicate effects that are significant at *p* < 0.05. Pre-exercise happiness was recoded so that the scale was centered at 50 on the scale ranging from 0 to 100 and divided by 10, so that a one-unit increase in pre-exercise happiness reflects a 10-point increase on the original scale used, starting at 50.

substance use research might be to ask participants to list actions they can think of that they could engage in instead of using the substance they seek to cease using. Such specifications could aid in the formulation and testing of more specific hypotheses about the mechanisms of behavior change. For example, changes in the breath of task-specific action tendencies may be indicative of an intervention's positive impact on immediate coping skills, while the impact of interventions on broadening cognitive awareness by including other thought-action content might have greater impact on more long-term behavioral change processes through shifts in values, goals, or perceived possibilities.

4.1. Limitations

The following limitations should be considered when interpreting these findings. First, the assessment of the TAR in this study, as well as in prior studies [22,29], is a post-test only design. Second, the sample over-represented female, white, and college-educated participants, which limits the generalizability of our results. The sample may also be especially motivated, based on our recruitment strategy, where ads specifically mentioned 'happiness' [18]. Additionally, our main analysis

of coded action-tendencies only included 67% of the completed statements that participants entered. Clearer directions and examples pertaining to what we would count as an "action tendency" should have been provided as part of the instructions. In addition, unhappy people were less likely to complete the full survey, so individuals who were unmotivated as a result of unhappiness did not complete the entire task. It is useful to note, however, that there is evidence of persons who experience fewer positive emotions having lower motivation to invest time in life goals [30], thus this effect is expected. Lastly, while this study provides a promising proof of concept that positive emotion exercises can induce transient increases in broader repertoires of action tendencies, it does not provide any information on the durability of these gains or their relevance to actual substance use outcomes.

5. Conclusion

Happiness and breadth of action tendencies are positively correlated in persons recovering from problematic substance use, in line with general population findings. Brief, self-administered happiness exercises can successfully broaden this aspect of the thought-action

repertoire. Given recent findings underscoring the importance of the breadth of coping repertoires, happiness exercises represent a promising tool to widen the repertoire of action tendencies, which may improve individuals' ability to navigate the challenges of recovery from problematic substance use.

Declaration of interest statement

None of the authors have conflicts of interest to report.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.genhosppsych.2019.06.006>.

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