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Preliminary findings on processes of change and moderators for cognitive defusion and restructuring delivered through mobile apps

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Keywords: mHealth; acceptance and commitment therapy; cognitive therapy; mindfulness; component analysis.

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Abstract

A process-based therapy approach emphasizes examining how and for whom specific therapeutic components linked to specific processes of change function. This preliminary study explored the processes of change for cognitive defusion and restructuring with daily ratings of self-criticism from a larger component trial as well as self-compassion as a moderator of these daily effects. A sample of 51 adults high in self-criticism (M age = 22.69, 78% female, 88% non-Hispanic White) were randomized to a cognitive defusion or restructuring mobile app for two weeks and completed daily assessments. Both conditions improved over time on daily frequency, defused noticing, challenging, and believability of self-critical thoughts as well as valued actions, with larger improvements in the defusion condition only for thought frequency and defused noticing. Global self-compassion moderated several effects such that only participants lower in self-compassion improved over time on daily self-criticism processes in the restructuring condition, while effects over time in the defusion condition generally did not vary by level of self-compassion. Improvements in daily frequency, defused noticing, and challenging self-critical thoughts as well as valued action each predicted global improvements in self-criticism at post-intervention across conditions. Overall, these preliminary results suggest cognitive defusion and restructuring may have some similar effects on self-criticism related processes of change, particularly for those low in self-compassion. However, defusion may produce larger effects on some targeted processes, especially among those with higher self-compassion.

Keywords: mHealth; acceptance and commitment therapy; cognitive therapy; mindfulness; component analysis.

Preliminary findings on processes of change and moderators for cognitive defusion and restructuring delivered through mobile apps for self-criticism

Comparing the underlying processes and moderators of cognitive-behavioral therapy (CBT) components can afford us a better understanding of not only their relative efficacy, but also *how* and *for whom* they work. From a process-based therapy perspective, this can facilitate development of more parsimonious interventions that can be flexibly applied based on ideographic case conceptualizations (Hayes & Hofmann, 2017).

Within the broad family of CBT approaches, cognitive defusion (most closely linked to acceptance and commitment therapy [ACT]; e.g., Hayes et al., 2012) and cognitive restructuring (most closely linked to cognitive therapy; e.g., Beck & Haigh, 2014) provide alternative ways to address cognitions. Cognitive defusion aims to change the function of thoughts so that they are noticed as just thoughts and have less rigid, excessive control over behavior (Hayes et al., 2012). In contrast, cognitive restructuring aims to modify maladaptive cognitions to increase their coherence with reality (Beck, 1970). These two approaches are often distinguished in terms of aiming to change the *content* of thoughts (i.e., restructuring) or how one *relates* to thoughts (i.e., defusion; Hayes, 2004). In the case of cognitive restructuring, maladaptive behavioral and affective consequences of irrational thoughts might be reduced by changing the thoughts that lead to them, while defusion reduces the literal functions of thoughts so that they might still occur, but no longer evoke such responses (i.e., decoupling; Levin et al., 2015). These theorized differences in how the two CBT components function are reflected in the different treatment techniques used (e.g., interacting flexibly with thoughts versus challenging accuracy of thoughts). Research is needed to test these theorized differences in how defusion and restructuring function as well as when each approach might be most applicable.

Research to-date directly comparing cognitive defusion and restructuring has been preliminary, and primarily focused on laboratory-based studies testing the effects of a single, brief intervention. These studies generally indicate that cognitive defusion and restructuring produce similar positive effects on outcomes such as body image concerns (Deacon et al., 2011), distress from negative thoughts (Yovel et al., 2014), and self-criticism (Levin, Haeger et al., 2018), but may work through distinct processes of change (Deacon et al., 2011; Larsson et al., 2016). Cognitive defusion has been found to result in decreased importance and believability of negative thoughts, and increased willingness relative to restructuring (Deacon et al., 2011; Larsson et al., 2016). In contrast, cognitive restructuring has been found to have a greater effect on the perceived accuracy of negative thoughts (Deacon et al., 2011). Consistent with theoretical predictions, improvements in acceptance and defusion from thoughts predict improvements in outcomes for cognitive defusion interventions, while increases in reappraisal and the importance of thoughts predict improvements in outcomes for cognitive restructuring (Deacon et al., 2011; Levin, Haeger et al., 2018; Yovel et al., 2014). Furthering our understanding of shared and unique processes of change for cognitive defusion and restructuring is critical for a process-based approach in which therapeutic strategies are selected and implemented based on their function for clients (Hofmann & Hayes, 2018).

A related area of research is to identify the client variables and contexts that moderate the effects of cognitive restructuring and defusion, which can inform when each might be more effective for a given client. There has been scant research on variables that predict the differential effects of defusion and restructuring. To-date, one study found baseline cognitive distress was a moderator for eating behaviors, such that cognitive defusion was more effective than restructuring on reducing chocolate consumption only among those who were high in

cognitive distress (Moffitt et al., 2012). Other potential moderators might similarly be best studied in the context of applying these components to specific concerns.

One area particularly relevant to studying therapeutic approaches to addressing cognitions is self-criticism, in which individuals engage in repetitive, negative self-evaluations. Self-criticism is a transdiagnostic risk factor for a range of psychological disorders and is a key clinical feature in a variety of presentations (Gilbert et al., 2004; Zelkowitz & Cole, 2019). Self-criticism may also be ideal for research comparing cognitive defusion and restructuring given it has been found to be effectively targeted by both cognitive therapy (Rector et al., 2000) and ACT (Luoma & Platt, 2015).

Self-compassion may be an important moderator for cognitive defusion and restructuring applied to self-critical thoughts given it orients to the broader context of how people respond to and view themselves. More specifically, self-compassion focuses on the degree to which people relate to themselves and their suffering with kindness, openness, and as a common part of being human (Neff, 2003). Self-compassion is a strong predictor of symptom severity and quality of life (Van Dam et al., 2011) and has been consistently linked with psychopathology (MacBeth & Gumley, 2012). A recent clinical trial for perfectionism found moderation effects such that particularly participants with average levels of self-compassion responded better to ACT relative to a waitlist condition (Ong et al., 2019). Theoretically, individuals who respond to themselves, including their thoughts, with self-compassion may be more effective at defusing from self-critical thoughts than those lower in self-compassion, because they are more likely to naturally relate to such thoughts with openness and kindness. In contrast, those who struggle with self-compassion may have more difficulty noticing self-critical thoughts as just thoughts and may prefer methods that aim to identify and correct unwanted inner experiences through cognitive

restructuring. That said, it might also be theorized that cognitive defusion is particularly helpful for individuals who struggle with such self-compassion, while restructuring cognitions could be more effective for individuals who are able to take a compassionate stance towards these thoughts. Thus, the direction of potential moderation is unclear and warrants empirical testing.

The current study aims to extend preliminary research comparing the processes of change and moderators for cognitive defusion and restructuring through an exploratory secondary data analysis of changes in daily self-criticism variables from a larger component trial. We conducted a clinical component study comparing the effects of cognitive defusion and restructuring delivered via a mobile app for 87 adults high in self-criticism (*CITATION REMOVED*). Both cognitive defusion and restructuring apps led to improvements in self-criticism at two-week post-intervention relative to a waitlist control. In contrast to predictions, both restructuring and defusion improved equally on targeted processes of change for defusion and restructuring that improved relative to waitlist. However, changes in cognitive defusion processes predicted improvements in outcomes more strongly in the defusion condition than the restructuring condition, indicating these interventions impact self-criticism through distinct processes. Examination of fine-grained daily assessment data collected from the mobile apps may further elucidate similarities and differences in processes of change between these components, which may not have been adequately captured with the general, global assessment questionnaires at baseline and two-week post-intervention.

In the current exploratory study, we predicted daily frequency of self-criticism would improve equivalently over time across conditions, but the defusion condition would improve more on defusion-related processes (i.e., defused noticing of thoughts, fused action based on thoughts, valued action), while the restructuring condition would improve more on challenging

thoughts. We also tested whether self-compassion would moderate effects between conditions such that the impact of defusion and restructuring on daily self-criticism would vary differentially based on levels of global self-compassion, although this test was exploratory and did not have a predicted direction for moderation. Finally, we predicted improvements in daily processes of change over the intervention period would correlate with improvements in global self-criticism outcomes at post-intervention.

Methods

Participants

This secondary analysis study was conducted with 51 participants from a larger randomized component trial who downloaded the restructuring or defusion app and completed at least one of 14 daily diary assessments (restructuring $n = 26$, defusion $n = 25$). To be eligible for the component trial participants had to be at least 18 years of age, own an iPhone or Android, be interested in a mobile app intervention, and score at least 19 on the Inadequate-Self subscale of the *Forms of Self-Criticism and Self-Reassurance Scale (FSCRS)*; Gilbert et al., 2004), which indicated scoring above the median based on previous research with non-clinical samples (Baiao et al., 2015). From the initial sample of 59 participants in the larger study assigned to defusion or restructuring conditions, four from the defusion and two from the restructuring condition were excluded because they never used the app, and two were excluded (one from each condition) due to an error where app data was not saved.

Within the sample of 51 participants analyzed for the current study, 78.4% were female (19.6% male, 2.0% other) with a mean age of 22.69 ($SD = 7.60$, range = 18-52). Participants were 88% non-Hispanic White, 6% Hispanic/Latinx, 2% Portuguese, 2% Asian, and 2% multiracial. In terms of employment status, 43% were full-time students, 37% were employed

part-time, 8% were employed full-time, 8% were unemployed, and 4% were stay-at-home parents. Participants reported clinical levels of self-criticism on the FSCRS inadequate-self scale ($M = 34.53$, $SD = 5.60$), which was one SD above the mean score in previous clinical samples ($M = 27.47$, $SD = 7.51$; Baiao et al., 2015).

Procedures

Participants were recruited through flyers, online advertising, and class announcements and completed an online screening before enrolling in the study. After an online baseline assessment, participants were randomized to one of three conditions (defusion app, restructuring app, or waitlist). However, the waitlist condition was not included in the current secondary study due to a lack of daily diary data collected. After two weeks, participants completed an online post-intervention assessment. Ethical approval was provided for this study by the authors' institutional review board.

Participants assigned to the defusion or restructuring app conditions were provided an online, self-guided tutorial on how to use their assigned app and were asked to use their respective app over two weeks between baseline and posttreatment assessments. Apps were provided through LifeData, a secure research platform for developing mobile applications, and downloaded onto the participant's phone as a native app. Researchers contacted participants by email within two days of randomization to ensure they were using the app without difficulty, and provided additional standardized email prompts to continue using the app if participants stopped engaging. Random notifications to use the app were delivered three times per day between 9am and 9pm, asking participants if they were struggling with negative thoughts at that moment, and recommending skills in the app if so.

Each app included interactive training exercises to help apply defusion/restructuring skills to a thought that they were struggling with. The cognitive restructuring app included skill sessions focused on identifying and challenging cognitive distortions, evaluating evidence for a thought, reviewing alternative thoughts, and decatastrophizing. The cognitive defusion app included skill sessions focused on noticing and defusing from fused thoughts, applying defusion metaphors, and using interactive flexibility exercises to notice thoughts as just thoughts. Each app also included 19 “Quick tips” which were brief descriptions of in-the-moment defusion or restructuring techniques (see *CITATION REMOVED* for further details).

Both apps included a scheduled prompt at 8pm every evening asking participants to complete a daily assessment over the two-week intervention period (for a total of 14 daily diary assessments). In the daily assessment participants reflected on their day and rated themselves on several variables related to self-critical thoughts.

Measures

Daily assessment. The daily assessment included six items designed to assess frequency of and defused/restructuring responses to self-critical thoughts for that day. These items were developed for the current study and were not previously validated in prior research. Frequency of self-critical thoughts was measured with the item, “How often did you have self-critical thoughts today?” rated on a visual analogue scale from 0 (Not at all) to 100 (All the time).

Four items were used to assess features of defused/restructuring responses to self-critical thoughts rated on a visual analogue scale from 0 (Strongly disagree) to 100 (Strongly agree). One item assessed a defused response to self-critical thoughts (“Overall, when I had a self-critical thought, I was able to notice it without getting totally overwhelmed by it” [*Defused noticing*]) and one item assessed a fused response (“Overall, my self-critical thoughts controlled what I did

today” [*Fused action*]). One item assessed a restructuring response to self-critical thoughts (“Overall, I was able to challenge my self-critical thoughts today” [*Challenging*]) and one item assessed the believability of thoughts, which might be relevant to both restructuring and defusion (“Overall, I didn't believe my self-critical thoughts were true today” [*Not believing*]). A final item asked about valued action (i.e., personally meaningful actions), “Overall, I was able to do what matters to me today” which was adapted from previous research (Levin, Krafft et al., 2018).

Forms of Self-Criticism and Self-Reassurance Scale (FSCRS; Gilbert et al., 2004).

The FSCRS was assessed at baseline and post-intervention as a measure of global self-criticism. The FSCRS includes subscales for inadequate self-criticism (judging/devaluing oneself), hated self-criticism (severe self-criticism and contempt), and self-reassurance (relating to oneself positively). The FSCRS has demonstrated good validity and reliability in previous samples (Baiao et al., 2015; Gilbert et al., 2004). In our sample, internal consistency was good for inadequate self-criticism ($\alpha = 0.83$) and self-reassurance ($\alpha = 0.82$), but marginal for hated self-criticism ($\alpha = .66$).

Self-Compassion Scale-Short Form (SCS-SF; Raes et al., 2011). The 12-item SCS-SF assessed global self-compassion at baseline as a potential moderator. The SCS-SF measures three positive components of self-compassion (self-kindness, common humanity, and mindfulness) and three negative components (self-judgment, isolation, and over-identification). This measure has good reliability for the total score and is highly correlated with the longer Self-Compassion Scale (Raes et al., 2011). In the present sample, internal consistency was moderately good ($\alpha = 0.74$).

Data analysis

Analyses were conducted using a combination of R and SPSS with daily diary data collected over the 14-day intervention period. Multilevel models (MLM) were conducted with the lme4 R package (Bates et al., 2015) to test whether daily self-criticism improved over time and whether effects differed by condition. A series of MLM included time, condition, and time by condition fixed effects on each daily self-criticism variable, with random intercepts modeled at the participant level given data was nested within participants. Analyses were conducted in a stepwise fashion so that in step 1, time effects could be interpreted alone, without the addition of time by condition effects that were added in step 2. In step 3, baseline global self-compassion was tested as a moderator of time and time by condition effects for each daily self-criticism variable. The final models in step 3 included a random intercept at the participant level, fixed effects for condition, time, and global self-compassion, two-way interactions between each fixed effect, and a three-way interaction with condition, time, and SCS.

In order to examine the relation of changes in daily self-criticism variables over time with pre- to post-intervention changes in global self-criticism, slope estimates were calculated for time in a separate series of linear regression models for each participant on each daily self-criticism variable. Partial correlations were conducted in SPSS between daily self-criticism slope estimates (i.e., change in daily self-criticism over time) and each post FSCRS self-criticism subscale, controlling for the respective baseline FSCRS subscale.

Results

Preliminary analyses

Overall, there were 509 completed daily observations, with 205 observations missing (29% missing data). This equated to 257 completed observations and 93 missing observations (27%) in the defusion condition and 252 completed observations and 112 missing observations

(31%) in the restructuring condition. There was no significant difference between conditions on rate of missing data ($\chi^2 = 1.54, p = .22$). Each daily assessment variable was normally distributed. Averaging across observations and conditions, means and standard deviations on daily diary variables were as follows: frequency ($M = 46.90, SD = 23.68$), defused noticing ($M = 62.78, SD = 22.09$), challenging ($M = 62.87, SD = 21.45$), not believing ($M = 57.63, SD = 23.36$), fused action ($M = 34.05, SD = 22.03$), and valued action ($M = 68.27, SD = 21.22$). There were no differences between the defusion and restructuring conditions on the first day of daily assessments ($p > .10$), suggesting these variables were equivalent between conditions initially.

Time and time by condition effects on daily self-criticism

A series of MLMs first tested time effects on each daily self-criticism variable, controlling for participant as a random effect (see Table 1). Significant time effects were found for daily frequency, defused noticing, challenging, valued action, and believing self-critical thoughts, all indicating improvements over time across conditions. No significant improvements were observed over time across conditions for daily levels of fused action.

A second step for each MLM tested time by condition interactions on each daily self-criticism variable (Table 1). Significant time by condition effects were only found for daily frequency and defused noticing of self-critical thoughts. In the defusion condition, improvements over time were found for daily frequency, $b = -1.46, t(238.57) = -4.66, p < .001$, and defused noticing of self-critical thoughts, $b = 1.16, t(240.36) = 3.98, p < .001$. In the restructuring condition, improvements in daily frequency were weaker, but still significant, $b = -.33, t(237.82) = -1.04, p = .03$, and were non-significant for defused noticing, $b = .29, t(238.05) = 0.95, p = .35$. Overall, participants across conditions generally improved on daily self-criticism variables,

including both defusion and restructuring processes of change, with greater improvements in the defusion condition on daily frequency and defused noticing of self-critical thoughts.

Moderation effects for baseline global self-compassion on daily self-criticism processes

A final series of MLM tested whether changes over time across and between conditions on daily self-criticism variables were moderated by baseline global self-compassion (see Table 1). There were no significant time by SCS interactions for any self-criticism variables, indicating that changes in daily self-criticism variables over time *across* conditions were not moderated by baseline self-compassion.

However, significant three-way interactions (time * condition * SCS) were found for daily frequency, defused noticing, fused action, challenging, and believing self-critical thoughts, suggesting baseline self-compassion moderated the effects between conditions over time. The only non-significant three-way interaction was for valued action. A series of post-hoc tests further decomposed significant three-way interactions by testing the interaction of baseline SCS and time within each condition and, when significant, changes over time at three levels of the SCS moderator ($M = 26.92$, $SD = 5.84$; 1 SD below the M [$n = 8$], M [$n = 33$], and 1 SD above the M [$n = 10$]).

Within the restructuring condition, time effects were moderated by self-compassion as indicated by significant time by SCS interactions for daily frequency ($b = .25$, $t[237.61] = 4.13$, $p < .001$), defused noticing ($b = -.16$, $t[239.24] = -2.62$, $p < .01$), fused action ($b = .20$, $t[242.02] = 3.34$, $p < .001$), and not believing self-critical thoughts ($b = -.20$, $t[240.17] = -3.25$, $p < .01$). Only participants low in self-compassion in the restructuring condition improved significantly over time on daily frequency (Low SCS $b = -3.80$, $p < .01$; Medium SCS $b = -.16$, $p > .10$; High SCS $b = .97$, $p > .10$), defused noticing (Low SCS $b = 3.48$, $p < .001$; Medium SCS $b = -.02$, $p >$

.10; High SCS $b = .06, p > .10$), or fused action (Low SCS $b = -3.04, p < .001$; Medium SCS $b = -.29, p > .10$; High SCS $b = 1.09, p > .05$). For the believing self-critical thoughts variable, participants with low and average self-compassion improved significantly over time, but not high in self-compassion (Low SCS $b = 4.14, p < .001$; Medium SCS $b = 1.25, p < .01$; High SCS $b = -.36, p > .10$). The only non-significant time by SCS interaction was for challenging self-critical thoughts ($b = -.22, t[240.81] = -1.87, p > .05$), suggesting participants improved over time on challenging thoughts in the restructuring condition irrespective of baseline levels of self-compassion. Overall, self-compassion generally moderated changes over time in daily self-criticism variables in the restructuring condition such that only participants low in self-compassion typically improved.

In contrast, in the defusion condition there was only one significant time by SCS interaction for daily challenging of self-critical thoughts ($b = .09, t[240.19] = 2.02, p < .05$). Participants in the defusion condition reported challenging thoughts more often over time when they were high in self-compassion, relative to medium or low self-compassion (Low SCS $b = .52, p > .10$; Medium SCS $b = .73, p < .05$; High SCS $b = 1.64, p < .01$). There were no other time by SCS interactions on other daily self-criticism variables in the defusion condition. Overall, changes over time did not vary by baseline levels of self-compassion in the defusion condition, except for challenging thoughts.

Correlations between changes in daily self-criticism processes and global self-criticism

Partial correlations examined relations between individual slope estimates on daily self-criticism variables (i.e., changes in daily self-criticism processes over two weeks) and post-intervention global self-criticism FSCRS subscales, controlling for baseline self-criticism (see Table 2). Lower global hated and inadequate self-criticism scores at post-intervention were

related to greater improvements over two weeks in daily frequency, defused noticing, and challenging self-critical thoughts as well as engaging in valued actions. Global self-reassurance scores at post-intervention were only related to changes in daily challenging of self-critical thoughts, such that those who increased more on challenging self-criticism over two weeks improved more on global self-reassurance at post-intervention. Changes in fused action and believing self-critical thoughts were not significantly related to changes in any global self-criticism subscales.

Discussion

This study examined the processes of change and self-compassion as a moderator of cognitive defusion and restructuring with daily reports of self-critical thoughts over a two-week intervention period. Both app conditions improved over time on almost all daily self-criticism variables, except for actions based on fusion. Surprisingly, there were few differences between conditions on daily self-criticism processes, but participants in the defusion condition reported greater improvements on defused noticing and frequency of self-critical thoughts relative to the restructuring condition. Global self-compassion moderated effects between conditions over time on all variables except valued action. For almost all variables, this was due to participants in the restructuring condition only improving over time if they were low in self-compassion. The exception was for the restructuring process variable (challenging thoughts), in which participants higher in self-compassion increased on challenging thoughts over time in the defusion condition, while self-compassion did not moderate changes in the restructuring condition. Finally, participants who improved more on daily frequency, noticing, and challenging of self-critical thoughts as well as valued actions also improved more on global self-criticism at post-intervention. Overall, these results highlight some shared functions of the defusion and

restructuring apps on daily self-criticism processes as well as some distinct effects, especially based on levels of global self-compassion.

Changes in daily self-criticism processes over time and between conditions

This study adds to a growing body of research comparing the effects of cognitive defusion and restructuring. Consistent with theoretical predications and previous literature (e.g., Deacon et al., 2011; Larsson et al., 2016), participants assigned to use a cognitive defusion app reported stronger improvements in noticing thoughts from a defused perspective. Participants assigned to cognitive defusion also reported greater reductions in daily frequency of self-critical thoughts than the restructuring condition, which is consistent with a prior study using daily assessments in which defusion was similarly more effective than restructuring in reducing negative thought frequency (Larsson et al., 2016). This effect is somewhat surprising given cognitive defusion strategies seek to change the function, but not the frequency of thoughts (Hayes et al., 2012), while restructuring more specifically aims to alter the occurrence of maladaptive thoughts. It may be that simply noticing thoughts, without getting overwhelmed with or trying to change them, leads to them occurring less frequently as a result of their decreased functional importance. That said, both the defusion and restructuring apps produced similar effects on global self-criticism at post-intervention (*CITATION REMOVED*), suggesting these are more indicators of differences in processes of change than in clinical outcomes.

Surprisingly, similar improvements over time were found in the defusion and restructuring conditions on challenging self-critical thoughts, despite this being a targeted process in only the restructuring app. Previous studies comparing defusion and restructuring have not examined challenging or reappraising thoughts as a targeted process for restructuring, instead focusing on perceptions of thoughts such as their accuracy and importance (e.g., Deacon

et al., 2011). Our larger component trial similarly found the restructuring condition did not have a greater effect on cognitive reappraisal than the defusion condition or the waitlist control (*CITATION REMOVED*). This may reflect a measurement problem or that the restructuring app was not effective in engaging its targeted process of change. It may also be that cognitive defusion, at least in a brief app format without other ACT components, increases naturalistic use of cognitive reappraisal, which might be strengthened by a defused perspective on one's thoughts. After all, cognitive defusion initially developed out of the cognitive distancing methods used in cognitive therapy (Zettle, 2005), although with the aims of altering the function of thoughts rather than subsequently challenging thoughts as one might do in cognitive restructuring. Similarly, both conditions improved equally on believability of self-critical thoughts, which might reflect the shared functions of the two therapeutic components that are rooted in cognitive distancing methods. However, this finding is not consistent with previous research indicating that believability of negative thoughts is a stronger mediator for ACT than cognitive therapy (Zettle et al., 2011).

Both the defusion and restructuring apps produced equivalent improvements over time on valued actions (i.e., personally meaningful actions) and neither condition improved over time on fused actions (i.e., actions guided by self-criticism). These findings were somewhat surprising given cognitive defusion more explicitly targets changing the function of thoughts on behavior. Defusion aims to reduce excessive behavior regulatory functions of thoughts on behavior (i.e., actions based on fusion) so that individuals can engage in valued activities even when difficult or self-limiting thoughts arise (Hayes et al., 2012). Yet, challenging maladaptive thoughts and generating more balanced, realistic thoughts could also alter overt behavior. It may be that restructuring and defusion led to improvements in valued actions, but through distinct pathways.

Few component studies have compared defusion and restructuring on overt behavioral outcomes, although one study found defusion was more effective than restructuring at reducing chocolate consumption in a craving induction preparation (Moffitt et al., 2012). Additional research is needed to explore the effects of both components on increasing engagement in valued actions and whether defusion alone effectively reduces maladaptive behaviors based on cognitive fusion.

As is common in more fine-grained examination of intensive longitudinal data, these results are preliminary, mixed, and highlight additional complexity to be explored. Future research is needed to further evaluate the shared and unique functions of these two intervention components, particularly using more refined measures and methods of examining intensive longitudinal data as well as ideographic effects within clinical samples.

Self-compassion moderation effects

Although restructuring and defusion appeared to share many functions in general in terms of processes of change, it may be that these components function differently for different participants. This is consistent with a process-based therapy approach that emphasizes matching therapeutic processes to clients based on relevant factors (Hofmann & Hayes, 2018). Our moderation results suggest that cognitive restructuring might share more functions with defusion (i.e., improving defused noticing, fused actions, believability) specifically among participants low in self-compassion. In contrast, baseline self-compassion generally did not alter changes over time in the defusion condition. However, the primary restructuring process (challenging thoughts) showed the opposite pattern in which self-compassion did not moderate the restructuring condition, but did for defusion such that challenging thoughts increased more among those higher in self-compassion. Thus, it may be these distinct therapeutic components linked to distinct therapeutic processes of change function more similarly or differently based on participant characteristics.

It may be that if an individual is low in self-compassion, either learning how to respond objectively to thoughts and evaluate their accuracy *or* how to notice thoughts as just thoughts is an incremental step towards greater cognitive flexibility. This is reflected in the similar effects between conditions on both defusion and restructuring processes among those low in self-compassion. However, individuals who are more self-compassionate may only improve on defusion-related processes if they learn defusion-related skills. As both self-compassion and cognitive defusion both entail viewing thoughts as experiences to notice nonjudgmentally, regardless of their content, it would make sense that individuals who already are more self-compassionate would improve on such skills with defusion as opposed to restructuring strategies. This is consistent with the overlap between compassion-focused therapy and underlying principles with ACT (Neff & Tirsch, 2013). Thus, while any approach that fosters cognitive flexibility may produce broadly adaptive functions among those low in self-compassion, it may be that cognitive defusion has more targeted effects among those with moderate to high self-compassion.

Interestingly, this pattern flipped for the restructuring process of challenging thoughts. In this case, it appears that increasing daily challenging of thoughts was a common effect between the cognitive restructuring and defusion conditions among those with higher self-compassion, while among those low in self-compassion, challenging thoughts only improved in the restructuring condition. Because restructuring encourages looking at thoughts more objectively and analyzing their veracity, participants low in self-compassion might have found this approach to cohere better with their worldview and therefore more helpful to them. In contrast, among individuals high in self-compassion, it may be that defusion has a broader effect in flexible responding to cognitions, which includes both noticing thoughts as just thoughts and challenging unhelpful thoughts.

These results are preliminary and the resulting interpretations are speculative, but they do begin to clarify how and for whom cognitive defusion and restructuring may have more shared or distinct functions. Discussions of moderation often focus primarily on the contexts in which one approach might be more effective than another, but it is also worth noting contexts in which either approach is equally effective *or* even has similar functions at the level of processes of change. It would make sense if there are some contexts in which either approach is equally effective, which is consistent with findings where defusion and restructuring sometimes produce equivocal results (e.g., Levin, Haeger, et al., 2018; Yovel et al., 2014).

It would be important to conduct further research with larger samples to have adequate power to test a priori predictions with moderation effects. In part, this is a pilot study regarding how such moderation effects might be explored more broadly with regards to testing specific components and processes of change. Future research is needed examining other moderators that affect when components have distinct versus shared functions, particularly with intensive longitudinal designs that afford opportunities for more fine-grained examination of effects. Such an approach can serve to further develop a knowledge base to inform process-based therapy decision making, particularly the contexts and client variables that are key for tailoring when one component or another is indicated (Ong et al., 2020).

Relations between changes in daily processes and global self-criticism

This study focused on daily self-criticism variables as processes of change for cognitive restructuring and defusion. Thus, analyses also tested whether changes in daily self-criticism processes predicted improvements in global assessments of self-criticism outcomes at post-intervention. Several correlations were observed consistent with predictions, with improvements in frequency of self-critical thoughts, challenging thoughts, defused noticing, and valued action all

related to improvements in hated and inadequate self-criticism at post-intervention. These results suggest a variety of processes, including those related to both defusion and restructuring, may be functionally related to improvements in outcomes.

Inconsistent with predictions, neither changes in believing or fused actions based on self-critical thoughts were related to changes in any global self-criticism outcomes. The fused action variable was also the only process that did not improve over time, suggesting potential measurement issues or that this variable was less relevant for the two interventions. The non-significant relations with believability was more surprising given believability of thoughts specifically has been found to mediate treatment effects in depression with ACT (Zettle et al., 2011) and the effects of the cognitive defusion component alone on weight-related distress (Deacon et al., 2011). It may be that other processes, such as noticing thoughts, challenging thoughts, and engaging in valued activities, were more critical for improvements in self-criticism.

In contrast to the results with inadequate and hated forms of self-criticism, the only process variable that related to improvements in global self-reassurance at post-intervention was challenging self-critical thoughts. Self-reassurance is a subscale of the FSCRS that is negatively correlated with the other scales (Gilbert et al., 2004), assessing a positive alternative pattern of reassuring oneself rather than being critical. In the larger component trial, participants in both the defusion and restructuring condition improved on self-reassurance at post-intervention relative to the waitlist (*CITATION REMOVED*). However, it may be these improvements occurred through processes other than the daily self-criticism variables assessed, with the exception of challenging thoughts, which aligns most closely with a practice of developing positive thinking patterns. Future research is needed to further examine the distinct functional pathways through which cognitive defusion and restructuring might lead to improvements in clinical outcomes such as self-criticism.

Limitations and conclusions

The sample was 88% non-Hispanic White and 78% female, which may affect generalizability to more diverse populations. Similarly, the sample consisted primarily of university students that were mostly young adults and it is unclear how results might generalize to older or non-university populations. Finally, this study focused on individuals with elevated self-criticism in examining the effects of two widely used therapeutic components, and it is unclear how these findings might generalize when applying cognitive defusion and restructuring to other clinical and non-clinical presentations.

The study had a relatively low number of participants for the interaction effects tested and an a priori power analysis was not conducted to determine the target sample size for this study. As a secondary analysis study, this was an exploratory examination of effects on daily diary variables. Results should be considered preliminary given the lack of more specific a priori predictions for moderation effects with an adequate sample size collected to ensure adequate power. Although the use of multiple daily observations per participant increased statistical power, these assessments were designed as part of the app intervention, which participants varied on adherence to. This led to a large amount of missing data that further reduced statistical power and introduced potential bias in observed data. This study included several analyses given the number of process variables examined and interactions tested, but methods to adjust for alpha inflation were not used due to already limited statistical power and to reduce Type II error. In combination, these features highlight potential reproducibility issues that are common in underpowered exploratory studies that could lead to either Type I or Type II errors. Future research is needed to test whether these findings, particularly the moderation effects with self-compassion, replicate with adequate methodological controls.

The daily assessment items were originally developed as a clinical tool to support self-monitoring during the component intervention. Thus, the specific items have not been validated previously. This might have introduced measurement artifacts and affected findings. Furthermore, the study failed to include other dimensions of self-critical thoughts that previous studies have found to be impacted by cognitive restructuring such as importance and accuracy of thoughts (Deacon et al., 2011). Future research is needed to both develop well-validated items that lend themselves to intensive longitudinal designs comparing distinct therapeutic processes and using such measures to further examine the effects of restructuring and defusion.

Overall, this study adds to a growing body of research examining the shared and unique functions of cognitive restructuring and defusion as well as person-level moderators that might guide who would benefit from which approach. Consistent with the aims of process-based therapy, our findings contribute to the evidence base on the effects and moderators of cognitive restructuring and defusion as theoretically derived components designed to target distinct processes of change (Hofmann & Hayes, 2018).

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Table 1. MLM results for daily self-criticism variables.

Daily Variable	Step	Intercept <i>b</i>	Time <i>b</i>	Condition <i>b</i>	Time * Condition <i>b</i>	Time * SCS <i>b</i>	Time * Condition * SCS <i>b</i>
Frequency	1	54.24***	-.93***				
	2	58.61***	-2.60***	-9.01	1.14*		
	3	55.23***	-1.56	38.84	-5.65*	.00	.24**
Defused noticing	1	56.65***	.76***				
	2	54.92***	1.17***	3.73	-.87*		
	3	74.53***	-.40	-30.56	5.12*	.06	-.22**
Challenging	1	55.99***	.80***				
	2	56.01***	.86**	.00	-.14		
	3	85.12***	-1.40	-45.66*	5.22*	.09	-.20**
Not believing	1	48.51***	1.14***				
	2	49.04***	1.09***	-1.08	.11		
	3	54.62***	1.25	-40.18	5.48*	-.01	-.19*
Fused action	1	37.45***	-.38				
	2	41.60***	-.54	-8.23	.33		
	3	20.27	.18	31.64	-6.03**	-.03	.23**
Valued action	1	63.87***	.51**				
	2	63.16***	.52	1.40	-.03		
	3	77.25***	-1.01	20.72	2.28	.06	-.09

* $p < .05$; ** $p < .01$; *** $p < .001$. Step 3 also included fixed effects for SCS and SCS * Condition as relevant variables for testing the three-way interaction.

Table 2. Partial correlations between improvements on daily self-criticism over time and post global self-criticism.

Daily Slope Estimates	FSCRS Hated	FSCRS Inadequate	FSCRS Reassurance
Frequency	.40*	.31*	-.18
Defused noticing	-.32*	-.43**	.23
Challenging	-.47**	-.34*	.35*
Not believing	-.28	-.22	.18
Fused action	.13	.11	.00
Valued action	-.36*	-.39*	.28

* $p < .05$; ** $p < .01$; *** $p < .001$. Daily slope estimates are calculated based on each participants' regression coefficient for change on daily self-criticism over time. Each partial correlation is controlling for respective baseline FSCRS subscale.