Addictive Behaviors 87 (2018) 260–266

Contents lists available at ScienceDirect

Addictive Behaviors

journal homepage: www.elsevier.com/locate/addictbeh

Development and validation of a contextual behavioral distress intolerance task in cigarette smokers

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HIGHLIGHTS

- C-FiTT is a new task that considers the impact of contextual factors on DI
- C-FiTT produces increases in negative affect and smoking urges
- DI is increased when smokers are exposed to a high versus low-difficulty task
- DI is highest when smokers are primed for withdrawal paired with high-difficulty task

ARTICLE INFO

Keywords:
Distress intolerance
Negative affect
Persistence
Tobacco withdrawal
Measurement

ABSTRACT

Introduction: Distress intolerance, an individual's perceived or actual inability to withstand negative emotional or physical distress, contributes to the maintenance of smoking. However, there is limited understanding of the contextual factors that impact distress intolerance in general or among smokers specifically. This study aimed to adapt and test a computerized behavioral persistence task that requires re-typing a passage while adhering to specific instructions (Contextual-Frustration Intolerance Typing Task [C-FiTT]). C-FiTT was designed to model contextual factors that influence distress intolerance, negative affect, and smoking urges.
Method: Daily smokers (n = 550) were recruited through the use of Qualtrics Panels. Using a 2 × 2 + 1 experimental design, participants were randomly assigned to one of four C-FiTT conditions that crossed task difficulty (low or high difficulty) with passage content (neutral or tobacco withdrawal text), or a neutral control group.
Results: C-FiTT produced an average persistence time of 94.1 ± 114.3 s and 64.7% of participants self-terminated the task. C-FiTT also produced small to medium sized-increases in negative affect and smoking urges. Between-condition comparisons indicated that the high-difficulty C-FiTT produced shorter behavioral persistence, greater self-termination likelihood, and larger increases in negative affect and smoking urges. The combination of high-difficulty and withdrawal content resulted in the shortest persistence time, 100% self-termination rate, and largest increases in negative affect and smoking urges, compared to other conditions
Conclusions: Findings provide initial evidence for the validity of C-FiTT in smokers within the context of tobacco withdrawal at low and high levels of task difficulty. Avenues for refinement and use of C-FiTT are discussed.

1. Introduction

Distress intolerance (DI) reflects one's perceived or behavioral incapacity to withstand negative emotional or physical distress states (Leyro, Zvolensky, & Bernstein, 2010; Zvolensky, Leyro, Bernstein, & Vujanovic, 2010). DI is linked to the persistence of smoking (Leventhal & Zvolensky, 2015) including more severe tobacco dependence (Leyro, Bernstein, Vujanovic, McLeish, & Zvolensky, 2011), smoking to

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https://doi.org/10.1016/j.addbeh.2018.07.020
Received 6 June 2018; Received in revised form 26 July 2018; Accepted 27 July 2018
Available online 29 July 2018

alleviate negative affect (Trujillo et al., 2017), and greater nicotine consumption following nicotine deprivation (Bold, Yoon, Chapman, & McCarthy, 2013; Perkins, Karelitz, Giedgowd, Conklin, & Sayette, 2010). Certain aspects of DI, like intolerance for physical distress, are associated with poor smoking cessation outcomes (e.g., Kahler, McHugh, Metrik, Spillane, & Rohsenow, 2013), perhaps due to increased sensitivity to nicotine deprivation and heightened withdrawal severity (Farris, Zvolensky, Otto, & Leyro, 2015).

DI is a higher order construct including intolerance for negative emotional states (e.g., frustration, anxiety) or physical sensations (e.g., pain, bodily discomfort; Zvolensky et al., 2010). One's *perceived* intolerance for distress can be evaluated with self-report measures that tap intolerance for general (Corstorphine, Mountford, Tomlinson, Waller, & Meyer, 2007; McHugh & Otto, 2012) or specific emotional distress (Buhr & Dugas, 2002; Harrington, 2005) and physical discomfort (Schmidt, Richey, & Fitzpatrick, 2006). Measures of *behavioral* intolerance for distress involve evaluating the duration of an individual's capacity to withstand an aversive task or stimulus, with shorter persistence being indicative of higher behavioral DI (Leyro et al., 2010). Several tasks have been developed and used to index behavioral DI, including persistence during exposure to thermal pain (Neufeld & Thomas, 1977; Rhudy & Meagher, 2003) or respiratory distress (Brown, Lejuez, Kahler, & Strong, 2002; Hajek, Belcher, & Stapleton, 1987; Marshall et al., 2008). Exposure to stressful/frustrating mental tasks (Lejuez, Kahler, & Brown, 2003; Quinn, Brandon, & Copeland, 1996; Strong et al., 2003) or to negative emotional pictures (Veilleux, Pollert, Zielinski, Shaver, & Hill, 2017) are used to measure intolerance for mental and emotional distress, respectively.

Notably, the convergent validity of self-repot and behavioral indices of DI is typically low (McHugh et al., 2011) and DI (especially behavioral indices) can be influenced by contextual factors (e.g., Szuhany & Otto, 2015) including acute nicotine deprivation (Bernstein, Trafton, Ilgen, & Zvolensky, 2008) and task-difficulty (Daughters et al., 2005; MacPherson, Stipelman, Duplinsky, Brown, & Lejuez, 2008). Moreover, DI indices have discrepant predictive validity in terms of smoking-relevant outcomes, like short-term abstinence and puff topography (Farris et al., 2015; Perkins, Giedgowd, Karelitz, Conklin, & Lerman, 2012). Measures of DI that are specific to smoking (relative to general) are posited to have increased predictive validity of smoking-relevant outcomes. For example, one self-report measure taps perceived DI for distress experienced during smoking abstinence (e.g., withdrawal; Sirota et al., 2010). However, no smoking-specific behavioral measures of DI have been developed.

To address these limitations, we developed the Contextual–Frustration Intolerance Typing Task (C-FiTT) to model contextual influences on persistence of goal-directed behavior, an index of DI. This task was developed based on theoretical principles of self-regulation and self-control (Baumeister, Bratslavsky, Muraven, & Tice, 1998). Self-regulation can be defined as goal-directed behavior that, in part, affords individuals the capacity to reduce discrepancy between standards and actual states, including thoughts, feelings, and behaviors (Hofmann, Schmeichel, & Baddeley, 2012). Self-regulation is posited to be a resource that can be depleted or conserved, much like physical energy (Muraven, Shmueli, & Burkley, 2006); thus demands on self-regulation resources (e.g., a challenging task) will limit availability for subsequent goal-direct behavior which can increase vulnerability for failure in self-regulation (Baumeister et al., 1998; Baumeister & Vonasch, 2015; Heatherton & Wagner, 2011). Failure of self-regulation is linked to the persistence of a wide range of health behaviors, including cigarette smoking (Baumeister & Vonasch, 2015). Self-regulation has been modeled utilizing a computer based re-typing task that requires individuals to retype a passage under conditions that are mentally taxing (instruction to type without use of letters “a” or “n” or spaces) which depletes self-regulation resources (Muraven et al., 2006). Similarly, behavioral DI marks one's inability to persist in goal-directed activity in the face of distress, and is commonly assessed with a challenging task requiring persistence to complete a goal (e.g., complete task). Drawing upon this work, we modified the previously developed computer based re-typing task (Muraven et al., 2006) and adapted it to assess DI, such that an individual with higher DI would experience greater frustration in response to the mental demand of the typing task, and be less capable of persisting and completing the task relative to someone lower in DI.

In the current study, we tested the feasibility and initial validity of the C-FiTT in two different contexts – task difficulty (omitting frequent and infrequent letters: low versus high difficulty) and content (typing tobacco withdrawal versus neutral text). In order to evaluate construct validity, we examined the association between the C-FiTT persistence with an established measure of DI, the Distress Tolerance Scale (DTS; Simons & Gaher, 2005). Additionally, we evaluated persistence time and DTS in terms of negative affect reactivity to the task, where evidence for DI as an individual difference variable would be seen if (a) persistence time accounted for significant variance in negative affect reactivity and (b) both DI measures performed consistently in predicting negative affect reactivity. Finally, we tested the effect of C-FiTT versions (i.e., the contextual manipulation) on behavioral DI and task responding. There were three specific hypotheses regarding predictive validity: (1) Exposure to the high-difficulty task would produce higher DI (shorter persistence time; greater likelihood self-terminating task) and greater task responding (increases in negative affect and smoking urges), relative to the low-difficulty task; (2) Exposure to the withdrawal content would produce higher DI and greater task responding, relative to the neutral content; and (3) Exposure to the high-difficulty task with withdrawal content would produce the highest DI and greatest task responding, relative to other conditions.

2. Material and methods

2.1. Participants

Participants ($N = 550$; $M_{age} = 44.6$, $SD = 13.5$; 52.2% female) were daily smokers recruited from all 50 states in the United States for an anonymous study on smoking and health. Data were collected online and participants were recruited through the Qualtrics Panels service in July of 2015. Potential participants were targeted based on the following pre-selected eligibility criteria: ≥18 years of age; a qualifying rate of ≥80% (satisfactory completion of ≥80% of surveys in which they participated); and a daily smoker. Interested individuals completed a study screening assessment and were eligible if they met the following criteria: (a) daily smoking for ≥1 year, (b) smoking ≥5 cigarettes/day, and (c) cigarettes were primary tobacco product of use. Participants were excluded if they reported having reduced their smoking rate by more than half in the past 1 month. See Table 1 for sample characteristics.

2.2. Measures

Items from the *Smoking History Questionnaire* (SHQ; Brown et al., 2002) were used to describe the sample in terms of smoking characteristics. Two additional items were used to assess same-day smoking (cigarettes smoked today and minutes since last cigarette). The *Fagerström Test for Cigarette Dependence* (FTCD; Fagerström, 2012) was used to assess level of tobacco dependence, with higher scores reflecting higher dependence (possible range 0–10). Internal consistency was low in the current sample ($\alpha = 0.55$), which is consistently found with this measure (Korte, Capron, Zvolensky, & Schmidt, 2013). The *Patient Health Questionnaire* (PHQ; Spitzer, Kroenke, & Williams, 1999) is a self-report assessment that was used to assess the severity of current depressive ($\alpha = 0.92$) and anxiety symptoms ($\alpha = 0.88$). The 14-item version of the *Distress Tolerance Scale* (DTS; Simons & Gaher, 2005) is a self-report measure used to assess perceived tolerance for emotional distress. Items are rated on a 5-point Likert-type scales ranging from 1

Table 1
Sample demographics.

	Mean/n	SD/%
Sex		
Male	263	47.8
Female	287	52.2
Age	44.6	13.5
Race		
White	490	89.1
Black	25	4.5
Asian	13	2.4
American Indian/Alaska Native	10	1.8
Native Hawaiian or Other Pacific Islander	3	0.5
Other	9	1.6
Ethnicity		
Non-Hispanic	513	93.3
Hispanic	37	6.7
Marital Status		
Married	284	51.6
Never married	141	25.6
Divorced	94	17.1
Widowed	20	3.6
Separated	11	2.0
Educational Attainment		
Less than high school	2	0.4
Part of high school	9	1.6
High school diploma or the equivalent	150	27.3
Some undergraduate college	146	26.5
Associate degree	74	13.5
Bachelor's degree	117	21.3
Master's degree	41	7.5
Professional or Doctoral Degree	11	2.0
Employment Status		
Employed full time	275	50.0
Homemaker	66	12.0
Retired	60	10.9
Employed part time	52	9.5
Unemployed	47	8.5
Disability	40	7.3
Student	10	1.8

(*strongly agree*) to 5 (*strongly disagree*), assessing respondents' perceived ability to experience and endure negative emotional states. A mean score is computed (possible range is 1–5) with higher scores reflecting greater tolerance (lower intolerance) for distress. This scale has good psychometric properties, including high internal consistency and convergent validity (Simons & Gaher, 2005) and has been validated in daily cigarette smokers (Leyro et al., 2011). Internal consistency was $\alpha = 0.95$ in the current sample.

The *Positive and Negative Affect Schedule* (PANAS; Watson, Clark, & Tellegen, 1988) was used to assess state negative affect pre-post C-FiTT via the 10-item subscale (possible range 10–50). Internal consistency was $\alpha = 0.96$ (pre) and $\alpha = 0.95$ (post). The *Questionnaire of Smoking Urges-Brief* (QSU-B; Cox, Tiffany, & Christen, 2001) is a 10-item self-report measure of smoking urges that was completed pre-post C-FiTT, where items are rated on 0–100 scale and summed such that higher ratings indicate greater intensity of smoking urges (possible range 0–1000). Internal consistency was $\alpha = 0.96$ (pre) and $\alpha = 0.98$ (post).

2.2.1. C-FiTT task

C-FiTT was programed on Qualtrics. Participants were informed that they were going to complete a typing task to measure how well they "pay attention to details". Administration involved visually presenting individuals with a passage of typed text with instructions to retype the 57-word passage. Participants completed a practice exercise before the real typing trial, and were encouraged to do the best they can without making any mistakes. Individuals were required to correctly retype the passage to complete the task. If an incorrectly re-typed response was submitted, an error message was displayed (*"The passage was incorrectly re-typed. Please try again"*), and individuals were required to re-start the typing. Participants were also instructed that they had the option to self-terminate the task: *"If after several attempts you feel that you are unable to continue, you can type the words 'I Quit' at any point to discontinue this task."* DI was assessed by total trial length (persistence in seconds) and whether the task was self-terminated. Duration of time spent on the C-FiTT was programed to automatically record (in seconds). Participants were unaware that time was being recorded.

2.2.2. C-FiTT context

Two contextual factors were manipulated: task content and difficulty. The *task content* included a passage to read/re-type that was related to mountains (neutral) or tobacco withdrawal (context-specific). The withdrawal content was used to prime respondents to think about distress experienced during a cessation attempt, to increase the salience of the distressing stimuli. To manipulate *task difficulty*, the re-typing instructional set prompted individuals to omit the space bar and certain letters while typing that either occur frequently ("a" and "n", high difficulty) or infrequently ("x" and "z", low difficulty) in the passage. The difficulty associated with omitting typed letters and spaces increases cognitive load, depletes self-regulatory resources and produces negative affect (Muraven et al., 2006). The number of omitted characters were approximately matched for the low difficulty ($n = 3$) and high difficulty condition ($n = 51–53$). See supplemental online materials for additional C-FiTT information.

2.3. Procedures

A 2 × 2 + 1 experimental study design was utilized wherein participants were randomly assigned, stratified by biological sex, that crossed C-FiTT passage content (neutral v context-specific) x task difficulty (low v high difficulty). The combination of these conditions resulted in four experimental groups: (1) Neutral Context + Low-difficulty; (2) Neutral Context + High-difficulty; (3) Withdrawal Context + Low-difficulty; and (4) Withdrawal Context + High-difficulty. The design also included a neutral control condition, in which participants were asked to retype the neutral content without omitting any letters. Ratings of negative affect and smoking urges were completed immediately before and after C-FiTT. All participants were shown a written debriefing statement at the completion of the study. Participants received compensation in the form of Qualtrics credits, which can be used to purchase gift cards or other items through the Qualtrics Panels portal. Researchers are not informed of the specific number of credits that participants receive.

2.4. Data analytic approach

Four attentional check questions were imbedded in the survey (e.g., The correct answer for this question is "strongly agree"). Cases were retained if all four questions were correctly answered. Additional cases were excluded if persistence time was < 10 s given that C-FiTT requires typing a passage of text and spending < 10 s on the task likely reflects an invalid test, and if time spent on the C-FiTT was ≥ 600 s, which was informed by prior task persistence work (Chow & Lau, 2015; Leyro et al., 2010). See Fig. 1 for the CONSORT.

Data were analyzed in SAS 9.4. Preliminary analyses using chi-square analyses and one-way between-subject ANOVAs with post hoc comparisons were used to compare conditions on baseline factors, as a check of randomization. Descriptive statistics were utilized to examine feasibility of the C-FiTT, relative to the control condition. Within-condition mean changes in negative affect and smoking urges resulting from C-FiTT and the control condition were examined as indicators of initial task validity. Next, bivariate correlations between the DTS and persistence time were tested to examine construct validity. Additionally, a multiple regression model was constructed wherein indicators of DI (persistence time from C-FiTT and DTS) were tested as predictors of post-task negative affect, controlling for pre-task negative

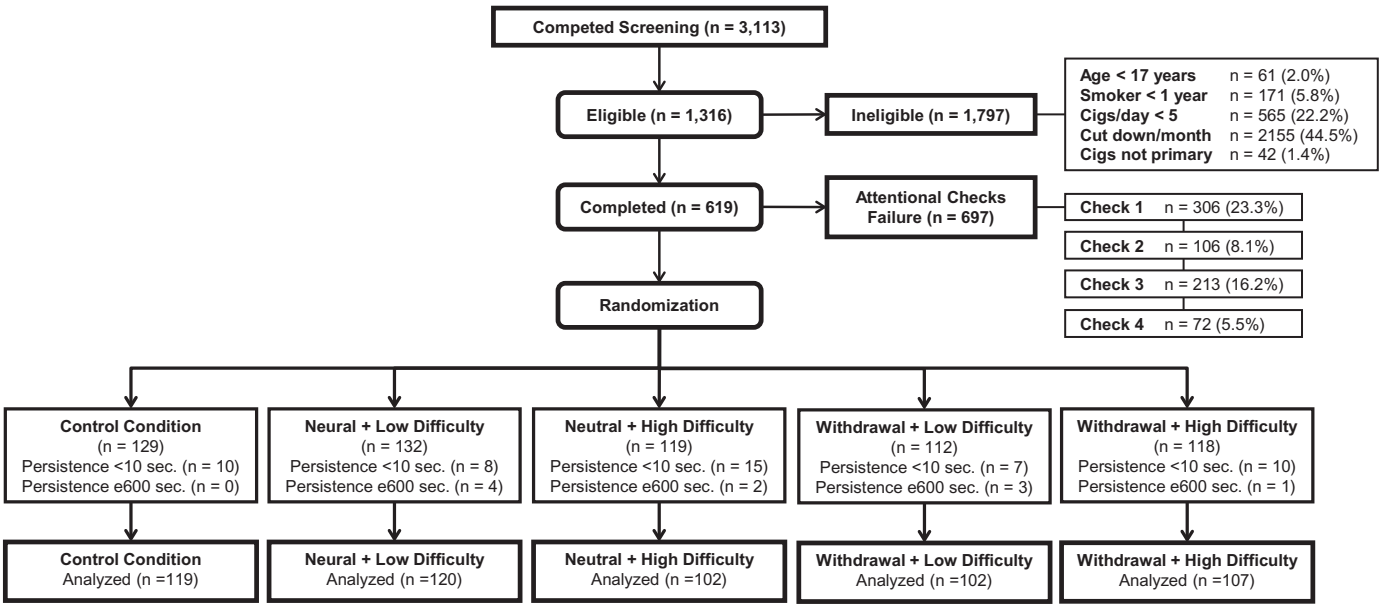

Fig. 1. CONSORT diagram

affect. Subsequent analyses using OLS and logistic regression were conducted to examine the effect of the contextual manipulation on behavioral DI and task responding. Specifically, we tested the main effects of task difficulty and passage context to evaluate between-group differences with respect to: (1) task persistence (seconds), (2) likelihood of self-terminating C-FiTT (0 = completed; 1 = self-terminated), (3) changes in negative affect; and (4) changes in smoking urges. For between-condition comparisons, the main effects of task difficulty were examined using two dummy codes to reflect differences between the high-difficulty condition vs. control condition and low-difficulty condition vs. control condition. Follow-up tests using a third dummy code were used to examine differences between the high-difficulty condition vs. low-difficulty condition. The main effects of passage content were evaluated using one dummy code to reflect the difference between the withdrawal content vs. neutral content. Finally, the effect of the high-difficulty task with withdrawal content was examined using a single dummy code reflecting the difference between that group and the three other experimental groups. Model covariates included participant sex (0 = male; 1 = female), age, number of same-day cigarettes smoked, and tobacco dependence.[1]

3. Results

3.1. Descriptive overview

Descriptive statistics for the sample are presented in Table 1. Mean ± standard deviation is presented. There were no significant differences between groups in terms of any demographic, smoking, or psychological symptoms.

3.2. Initial feasibility and validity of C-FiTT

A descriptive summary of the full sample as well as specific conditions in terms of smoking history, psychological symptom severity, and distress intolerance is presented in Table 2.

[1] Post-hoc analyses revealed that models were unchanged when controlling for symptoms of depressive and anxiety symptoms severity. These results are available upon request and are not presented here given that the incremental validity of C-FiTT beyond psychological symptoms is beyond the scope of this initial validation study.

3.2.1. Invalid cases

As indicated in Fig. 1, of the 490 participants who completed a C-FiTT task (which excludes the 129 participants randomized to the control condition), 8.2% of cases demonstrated persistence time < 10 s. An additional 2.0% of cases demonstrated persistence time ≥ 600 s. Thus, the C-FiTT resulted in invalid data for 10.2% of cases, and these cases were excluded. In comparison, the control condition resulted in 7.8% invalid cases. The excluded participants were significantly younger in age, had lower levels of tobacco dependence and smoked fewer cigarettes per day (p's < 0.01) relative to cases that were retained. No other significant differences were observed.

3.2.2. Behavioral persistence

Among participants who completed any version of the C-FiTT (n = 431), the average persistence time was 94.1 ± 114.3 s and 64.7% of participants self-terminated the task. In contrast, average persistence time among participants in the control condition was 75.3 ± 94.7 s, which was not statistically different from the average C-FiTT persistence time ($t = -1.83$, $p = .068$). Approximately half (53.8%) of participants self-terminated the control task, which was significantly lower than the self-termination rate from C-FiTT ($x^2 = 4.77$, $p = .029$).

3.2.3. Construct validity

C-FiTT persistence time was not significantly correlated with the DTS ($r = 0.01$). Regarding the association between DI indices (persistence time and DTS) and emotional reactivity to C-FiTT, pre-task negative affect, and anxiety and depressive symptoms were entered as covarying factors. Persistence time and DTS each accounted for unique predictive variance in negative affect following the task. Shorter persistence time predicted significantly larger increases in negative affect ($b = -0.006$, $t = -3.46$, $p = .001$). Similarly, lower DTS scores predicted significantly larger increases in negative affect ($b = -0.823$, $t = -3.33$, $p = .001$).

3.3. Negative affect and smoking urges

C-FiTT produced increases in negative affect (small-medium effects; Table 3). The largest increases in negative affect were produced by the high-difficulty, withdrawal content, and the combination high-difficulty/withdrawal content versions of C-FiTT. The control condition produced a small-sized increase in negative affect. There were also

Table 2
Descriptive overview.

	Full Sample (n = 550)	Control (*n* = 119)	Neutral + Low Difficulty (*n* = 120)	Neutral + High Difficulty (*n* = 102)	Withdrawal + Low Difficulty (*n* = 102)	Withdrawal + High Difficulty (*n* = 107)
Smoking History						
Tobacco Dependence (FTCD)	5.4 ± 2.0	5.6 ± 2.0	5.4 ± 2.1	5.6 ± 1.9	5.2 ± 2.1	5.3 ± 1.8
Cigarettes/day	17.2 ± 8.5	18.5 ± 9.1	17.3 ± 8.2	17.0 ± 8.5	16.2 ± 8.2	16.8 ± 8.5
Years smoking	26.1 ± 14.2	27.3 ± 12.6	25.3 ± 15.2	24.9 ± 13.6	26.0 ± 14.8	27.1 ± 14.8
Number/cigarettes (same-day)	9.4 ± 6.8	9.7 ± 7.4	9.3 ± 6.5	9.0 ± 6.0	9.2 ± 7.0	9.5 ± 6.9
Time (minutes) since last cigarette[a]	25.5 ± 50.5	26.0 ± 49.9	26.0 ± 35.8	28.5 ± 76.5	24.1 ± 51.7	23.1 ± 29.3
Psychological Symptom Severity						
Depressive symptom severity (PHQ)	7.0 ± 6.9	7.8 ± 7.0	6.3 ± 6.3	6.8 ± 6.6	6.5 ± 7.2	7.6 ± 7.5
Anxiety symptom severity (PHQ)	4.8 ± 3.9	5.3 ± 3.9	4.3 ± 3.7	5.0 ± 4.0	4.3 ± 3.9	5.0 ± 4.0
Distress intolerance						
Distress Tolerance Scale (DTS)	3.3 ± 1.0	3.3 ± 1.0	3.2 ± 1.1	3.2 ± 1.0	3.2 ± 1.	3.3 ± 1.0

Note: One-way between subject ANOVAs, using post hoc Tukey corrections, revealed no significant differences between the groups on any of the baseline variables.
[a] (n = 11 cases reported smoking zero same-day cigarettes thus were not included in average time since last cigarette).

Table 3
Descriptive summary of C-FiTT outcomes.

	Persistence		Self-Termination	Negative Affect		Smoking Urges	
				Pre	Post	Pre	Post
Condition	**M ± SD**	**Skew (Kurtosis)**	**n (%)**	**M ± SD**	**M ± SD**	**M ± SD**	**M ± SD**
Control (n = 119)	75.3 ± 94.7	2.41 (5.75)	64 (53.8)	14.2 ± 7.3	15.3 ± 8.2	442.6 ± 312.7	424.8 ± 345.3
Neutral + Low Difficulty (n = 120)	125.4 ± 128.3	1.21 (0.611)	49 (40.8)	14.6 ± 8.4	15.6 ± 8.8	417.0 ± 301.7	404.5 ± 345.7
Neutral + High Difficulty (n = 102)	69.9 ± 85.3	2.15 (4.19)	71 (69.6)	14.7 ± 7.9	16.7 ± 9.1	447.1 ± 312.4	495.8 ± 362.1
Withdrawal + Low Difficulty (n = 102)	128.7 ± 140.9	1.52 (1.76)	52 (51.0)	15.3 ± 8.9	16.1 ± 9.1	431.4 ± 303.2	428.6 ± 338.1
Withdrawal + High Difficulty (n = 107)	49.1 ± 61.4	2.96 (9.34)	107 (100.0)	15.3 ± 8.2	18.3 ± 9.6	418.4 ± 298.0	473.9 ± 345.0

small increases in smoking urges following C-FiTT, though these effects were evident only from the high-difficulty and combination high-difficulty/withdrawal content C-FiTT. The control condition did not produce changes in smoking urges.

3.4. Effects of contextual manipulation on C-FiTT responding

Between-condition differences were examined to determine the extent to which the contextual manipulation influenced behavioral DI, negative affect and smoking urges. Within-condition effect sizes are presented in Table 4. Between-condition effect sizes are presented in Table 5.

3.4.1. Behavioral persistence

Compared to the low-difficulty C-FiTT, the high-difficulty C-FiTT resulted in significantly shorter persistence time and a significantly greater likelihood of self-termination of C-FiTT. The combination high-difficulty/withdrawal content C-FiTT, compared to other C-FiTT conditions, also resulted in significantly shorter task persistence and a significantly higher self-termination rate. There were no significant differences in task persistence for the neutral versus withdrawal content C-FiTT, although the withdrawal content C-FiTT resulted in a significantly greater likelihood of self-termination.

3.4.2. Negative affect

The high-difficulty C-FiTT produced significantly greater increases in negative affect compared the control condition and low-difficulty C-FiTT. The combination high-difficulty/withdrawal content C-FiTT compared to other C-FiTT versions produced significantly greater increases in negative affect. The content manipulation alone did not produce significant differences in negative affect change.

3.4.3. Smoking urges

The high-difficulty C-FiTT produced significantly greater increases in smoking urges compared to the control and low-difficulty C-FiTT conditions. The combination high-difficulty/withdrawal content C-FiTT compared to other C-FiTT versions, produced significantly greater increases in smoking urges. The content manipulation alone did not

Table 4
Acute changes in negative affect and smoking urges from C-FiTT (Within-Condition Effects).

	Negative Affect			Smoking Urges		
Condition	***t***	***p***	***d***	***t***	***p***	***d***
Control	2.62	0.01	0.25	−1.20	0.233	−0.11
Low Difficulty	3.55	0.001	0.24	−0.76	0.446	−0.05
High Difficulty	6.40	< 0.001	0.45	4.29	< 0.001	0.30
Neutral Text	4.90	< 0.001	0.33	1.53	0.129	0.10
Withdrawal Text	5.28	< 0.001	0.40	2.10	0.036	0.15
High Difficulty + Withdrawal	4.95	< 0.001	0.49	3.18	0.002	0.32

Table 5
Between-condition effects.

Condition comparisons	Task persistence			Self-termination			Negative affect			Smoking urges		
	t	*p*	*d*	OR	*p*	*V*	*t*	*p*	*d*	t	p	*d*
Control vs. Low Difficulty	4.28	< 0.001	0.45	1.39	0.145	−0.13	−0.28	0.780	0.07	0.51	0.610	0.03
Control vs. High Difficulty	1.31	0.190	0.19	4.93	< 0.001	0.16	2.78	< 0.001	0.26	3.70	< 0.001	0.17
Low Difficulty vs. High Difficulty	6.62	< 0.001	0.65	6.88	< 0.001	0.42	3.51	< 0.001	0.19	3.67	< 0.001	0.20
Neutral vs. Withdrawal Content	1.13	0.261	0.03	4.08	< 0.001	0.23	1.20	0.232	0.13	1.20	0.233	0.08
High Difficultly/Withdrawal vs. Others	−4.71	< 0.001	0.65	77.55[a]	< 0.001	0.43	3.53	< 0.001	0.24	2.37	0.018	0.10

[a] Denotes value is Chi-square.

produce significant differences in smoking urge change.

4. Discussion

We found evidence for the initial feasibility and validity of C-FiTT. Four versions of the C-FiTT were administered and yielded sufficient variability in behavioral DI indicated by persistence time (in seconds) and self-termination of the task. Shorter task persistence was significantly related to greater emotional reactivity to the task. Of note, persistence time was not significantly correlated with the DTS, which is often the case when mixed-method approaches are used to measure of DI (McHugh et al., 2011) and is consistent with the multidimensional conceptualization of DI (Zvolensky et al., 2010). C-FiTT also produced small to medium sized-increases in negative affect and smoking urges. Findings also suggest that behavioral DI is influenced by contextual factors, particularly in the context of task difficultly manipulation. The high-difficulty C-FiTT produced significantly shorter task persistence and greater likelihood of self-terminating the task compared to the low-difficulty version. The self-termination rate in the high-difficulty condition was nearly double that of the low-difficulty condition (85.2% versus 45.5%). In addition, the high-difficulty version of C-FiTT resulted in significantly greater increases in negative affect and smoking urges relative to the low-difficulty and control conditions.

Contrary to expectation, the contextual priming for nicotine withdrawal yielded minimal independent effects on behavioral DI, negative affect, or smoking urges. This finding is surprising given that task salience influences physical distress intolerance (e.g., Branstetter-Rost, Cushing, & Douleh, 2009) and intolerance for *withdrawal* would theoretically be more salient in smokers, relative to general non-specific distress (Sirota, Rohsenow, Dolan, Martin, & Kahler, 2013). It is possible that the withdrawal text was not a sufficiently "potent" provocation. It also is possible that nicotine withdrawal priming was less salient to participants in the study given that they were not recruited on the basis of motivation for smoking cessation. Future refinement and/or modification to the C-FiTT content would be useful.

Interestingly, as hypothesized, the combination high-difficulty/withdrawal version of C-FiTT produced significantly higher DI, a 100% self-termination rate, and greater task responding (increases in negative affect and smoking urges) relative to the other experimental conditions. Given that tobacco withdrawal produces acute physiological and emotional distress that is most severe during early phases of a quit attempt (Hughes, 2007), the combination high-difficulty/withdrawal version of C-FiTT may most closely resemble the context of a quit attempt in that the task requires persistence in an effortful task while being presented with withdrawal-relevant information.

Findings should be viewed in terms of their limitations, particularly of relevance for internet-based studies. This study relied largely on self-reported assessments, and participants were not monitored during their completion of the C-FiTT which could introduce bias due to effort and attention. The C-FiTT was also not programed to require a minimum or maximum time duration, although this is easily programmable and should be considered in future work to minimize occurrence of invalid data. We also did not provide reward for successful completion of the task, which could influence effort, although use of rewards has a potentially confounding effect on construct validity (Leyro et al., 2010) which was avoided in our study design. Additionally, the control condition had a high rate of self-termination perhaps reflecting low effort, thus the utility of this condition as a control was limited. Finally, the sample was primarily white and well-educated, thus generalizability of these findings to more heterogeneous sample of smokers may be limited.

Overall, there are several innovative features of the C-FiTT that enhance the contextual utility of this task: it is (a) theoretically-based; (b) the first smoking-specific behavioral DI task and can be used to model contextual factors relevant to smoking cessation; (c) easily accessible through an online, web-based platform which increases feasibility for use and dissemination; and (d) highly flexible, in that there are multiple versions of the task and the task can be modified with alternative clinically-relevant content (e.g., other substance use cues, specific emotional states). These are design features that enable researchers to administer a specific task version that meets the unique needs of the target sample or research focus. The concurrent validity of the C-FiTT in relation to other behavioral measures of DI and self-report smoking-specific DI (e.g., Intolerance for Smoking Abstinence Questiionnaire; Sirota et al., 2010) is needed, in addition to the evaluation of additional validity indices (i.e., discriminant, known-groups, predictive, incremental validity). If future work further strengthens and supports the validity of this task, the C-FiTT could enhance future assessment and monitoring of DI across changing contexts.

Declarations of interest

None

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.addbeh.2018.07.020.

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