Task Persistence Predicts Smoking Cessation in Smokers with and without Schizophrenia

Marc L. Steinberg,
Robert Wood Johnson Medical School – UMDNJ

Jill M. Williams,
Robert Wood Johnson Medical School – UMDNJ

Kunal K. Gandhi,
Robert Wood Johnson Medical School – UMDNJ

Jonathan Foulds,
Penn State University, College of Medicine

Elizabeth E. Epstein, and
Rutgers – The State University of New Jersey

Thomas H. Brandon
University of South Florida & H. Lee Moffitt Cancer Center & Research Institute

Abstract

Smokers attempting to quit should benefit from persisting in cognitive and behavioral coping in order to achieve and maintain abstinence. Task persistence, which describes the act of persisting in a difficult or effortful task, is likely to be required in the face of distressing smoking cues, urges to smoke, or other nicotine withdrawal symptoms.

Objective—This study sought to examine whether task persistence (also called distress tolerance) could prospectively predict smoking cessation in a mixed sample of smokers with and without schizophrenia.

Method—Smokers with schizophrenia or schizoaffective disorder (SZ) (N=71) and non-psychiatric smokers (N=78) seeking treatment at state-funded tobacco dependence treatment clinics completed tests of task persistence before their target quit date (QD), and then provided tobacco use data over the 6-months after their QD.

Results—Findings from generalized estimating equations (GEE) support the hypothesis that task persistence as measured by a mirror tracing task predicts smoking cessation while controlling for important covariates such as psychiatric diagnosis, nicotine dependence, and confidence in ability to quit.

Conclusions—These findings add to the literature by corroborating reports suggesting that task persistence may make important contributions to smoking cessation success, and by indicating that the contribution of task persistence to smoking cessation is similar for smokers with schizophrenia and non-psychiatric smokers. These results suggest that efforts to target task persistence in smoking cessation counseling protocols may be warranted.

Correspondence concerning this article should be addressed to Marc L. Steinberg, Ph.D., Department of Psychiatry, Robert Wood Johnson Medical School, 317 George Street, Suite 105, New Brunswick, NJ 08901. marc.steinberg@umdnj.edu.

Keywords

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Tobacco use is the leading preventable cause of death in the United States, responsible for 443,000 annual U.S. deaths (Centers for Disease Control and Prevention, 2010) and for almost 5 million deaths each year throughout the world (World Health Organization, 2009). Cigarette smoking causes heart disease, stroke and multiple cancers (U.S. Department of Health & Human Services, 2004). Despite the devastating effects of tobacco use, 20.6% of U.S. adults continue to smoke (Center for Disease Control and Prevention, 2010), and over the last five years, there has been virtually no change in adult smoking rates (CDC, 2009). In addition, approximately 10 years ago data began to emerge indicating that empirically supported tobacco dependence treatments were becoming less efficacious (Irvin & Brandon, 2000; Irvin, Hendricks, & Brandon, 2003). Although approximately 40% of smokers in the U.S. try to quit each year (CDC, 2008), most relapse within the first eight days (Fiore et al., 2008). Identifying factors that predict outcomes can help identify targets for improved tobacco dependence treatments.

The need to identify predictors of tobacco dependence treatment success may be especially great in smokers with schizophrenia. Individuals with schizophrenia are more likely to be current smokers (58%–88% vs. 20%; CDC, 2008; NIDA, 1999), are highly nicotine dependent, and obtain greater nicotine intake per cigarette (Olincy, Young, & Freedman, 1997; Tidey, Rohsenow, Kaplan, & Swift, 2005; Williams, Ziedonis, Abanyie, Steinberg, Foulds, & Benowitz, 2005; Williams, Gandhi, Lu, Kumar, Shen, Foulds, Kipen, et al., 2010). Smokers with schizophrenia are less likely to quit smoking (Lasser, et al., 2000) as compared to the general population, and even among those motivated to quit, appear to have lower quit rates in tobacco dependence treatment trials (Williams & Hughes, 2003). It is possible that the fact that smokers with schizophrenia and schizoaffective disorder demonstrate reduced persistence as compared to non-psychiatric smokers (Steinberg, Williams, Gandhi, Foulds, and Brandon, 2010) could contribute to the lower quit rates.

One important factor that may contribute to success in quitting smoking in all populations is task persistence, which describes the act of persisting in a difficult or effortful task. For example, those low in task persistence "give up" easily when faced with a challenging task while people high in task persistence keep trying. A similar construct has been referred to as "distress tolerance" (e.g., Brown, Lejuez, Kahler, & Strong, 2002; Brown, Lejuez, Strong, Kahler, Zvolensky, Carpenter, et al.,2009; Sirota, Rohsenow, MacKinnon, Martin, Easton, Kaplan, Monti, Tidey, & Swift, 2010; Zvolensky, Feldner, Eifert, & Brown, 2001). Leyro, Zvolensky, and Bernstein (2010) distinguish "task persistence" from "distress tolerance" by stating that "persistence typically focuses on reward achievement (Cloninger et al., 1991), whereas distress tolerance typically does not (p. 592)." Leyro et al. (2010) note that when distress tolerance has been characterized as the *perception* of one's ability to tolerate distress, it has generally been measured via self-report paper/pencil measures. When measured behaviorally, distress tolerance has been characterized more consistently with Brandon, Vidrine, and Litvin (2007) as the *act* of tolerating – or persisting - in the face of distress. Brandon et al. (2007) suggest that "task persistence" and "distress tolerance" may be overlapping constructs. A comprehensive review of these issues can be found in Leyro et al. (2010).

With respect to quitting smoking, the act of tolerating – or –persisting in the face of distressing smoking cues, urges to smoke, or other nicotine withdrawal symptoms is likely to be important. Smokers trying to quit would benefit from persisting in behaviors such as

engaging in cognitive and behavioral coping strategies in order to maintain abstinence. In theory, smokers higher in task persistence should be more successful at smoking cessation. We will refer to the concept described above as "persistence" in this manuscript because we are focusing on the behavioral act of persisting in the face of distress, rather than on the perception of one's ability to tolerate distress.

Retrospective / Concurrent designs evaluating task persistence and tobacco use

Retrospective and concurrent designs have examined measures of persistence and their relationship to current smoking and/or past quitting behaviors. Persistence, or distress tolerance, has been measured by an anagram test (Quinn, Brandon, & Copeland, 1996), a mirror-tracing task (Quinn et al., 1996; Steinberg, Williams, Gandhi, Foulds, & Brandon, 2010), breath-holding (Brown et al., 2002, Hajek et al, 1987; Zvolensky et al., 2001), maintained grip (Hajek, 1989), a paced auditory serial addition task (Brown et al., 2002), toleration of inhaled carbon dioxide-enriched air (Brown et al., 2002), a self-report scale measuring ability to tolerate discomfort associated with quitting (Intolerance for Smoking Discomfort Questionnaire (IDQ-S); Sirota et al., 2010), the Persistence scale of the Temperament and Character Inventory (TCI) (Etter, 2010), and a 2-item measure based on the TCI (Steinberg et al., 2010; Steinberg, Krejci, Collett, Brandon, Ziedonis, & Chen, 2007). Higher persistence scores were associated with non-smokers as compared to smokers (Quinn et al., 1996), with former as compared to daily smokers (Etter, 2010), with less dependent smokers as compared to heavier and more dependent smokers (Sirota et al., 2010), and those with a history of abstinence as compared to those unable to quit (Brown et al., 2002; Steinberg et al., 2010). In contrast, Zvolensky et al. (2001) were unable, in a small sample of 22 smokers, to detect a significant difference in breath-holding persistence between smokers who had histories of quit attempts lasting more than seven days as compared to those unable to abstain for at least 7 days. Among adolescents, current smokers scored significantly lower on a 2-item self-report measure than did non-smokers, and higher scores were detected for adolescents planning to quit smoking as compared to those with no plans to quit (Steinberg, et al., 2007). Lastly, in an examination of task persistence differences in smokers with and without schizophrenia, Steinberg et al. (2010) detected significantly greater persistence on a mirror tracing task, and on a 2-item measure based on the TCI, among non-psychiatric smokers as compared to smokers with schizophrenia. In summary, retrospective and concurrent research designs indicate that task persistence, as assessed by a variety of measures, has been associated with multiple smoking-related outcomes in non-psychiatric adults and adolescents. In addition, smokers with schizophrenia appear to demonstrate lower task persistence than non-psychiatric smokers.

Prospective Designs evaluating task persistence and tobacco use

Prospective designs of task persistence and tobacco use examined baseline persistence and its relationship to future quitting behaviors. Prospective designs have used an anagram test (Brandon, et al., 2003), mirror tracing tasks (Brandon et al., 2003), breath-holding endurance (Abrantes, et al., 2008; Brown, et al., 2009; Hajek, Belcher, & Stapleton, 1987), paced auditory serial addition tasks (Abrantes et al., 2008; Brown et al., 2009), CO_2 inhalation (Brown et al., 2009), and the 9-item paper/pencil Persistence scale of the Temperament and Character Inventory (TCI-P; Cloninger, Przybeck, Svrakic, & Wetzel, 1994) (Etter, 2010; Kalman, Hoskinson, Sambamoorthi, & Garvey, 2010).

Mirror tracing persistence predicted days until first lapse and showed a statistical trend with days until 7-day relapse when measured over a 12-month follow-up period (Brandon et al., 2003). Higher mirror tracing task persistence was also associated with following through

with smokers' stated intention to begin tobacco dependence treatment and with sustained abstinence (Brandon et al., 2003). In addition, Brown et al. (2009) found that among smokers making an unaided quit attempt, those who scored low on a persistence composite score (e.g., from a paced auditory serial addition task, breath-holding, and CO_2 inhalation endurance) were significantly more likely to lapse on their quit date than were those exhibiting high persistence. When examined separately, greater breath-holding and CO_2 inhalation endurance were significantly related to risk of lapsing, though scores on the paced auditory serial addition task were not (Brown et al., 2009). Two decades earlier, Hajek et al. (1987) also found breath-holding endurance to positively predict seven-day point prevalence abstinence at end of treatment. Unlike breath-holding, mirror tracing, and CO_2 inhalation, neither persistence on an anagram test (Brandon et al., 2003) nor the Persistence scale of the TCI was able to prospectively predict tobacco dependence treatment outcome (Kalman et al., 2010). Similarly, Etter (2010) did not detect a relationship between TCI Persistence scores and cessation (among those identifying as smokers at baseline) or withdrawal (among those identifying as former smokers at baseline) at a 30-day follow-up. In summary, these studies indicate that task persistence, as assessed by a variety of measures (though not all measures), prospectively predict smoking cessation in adult smokers trying to quit.

The current study expands on previous retrospective data on persistence in smokers with schizophrenia (Steinberg et al., 2010) to test whether task persistence (assessed via multiple measures) prospectively predicts smoking cessation within a mixed sample of smokers with and without schizophrenia—the latter being a particularly high risk and underserved group. We used multiple measures to assess task persistence. Measures included a behavioral persistence task that has the greatest empirical support to date (mirror tracing), a physical task with some empirical support (breath holding), and two self-report scales with limited support, but greater potential utility due to ease of administration. Should one or more of these measures of task persistence prove to be a reliable predictor of cessation it would provide greater support for a possible causal role of task persistence, and for the need to develop interventions that either compensate for low task persistence or include components designed to boost persistence. We hypothesized that task persistence would prospectively predict smoking cessation in smokers with and without schizophrenia.

Method

Participants

A total of 203 smokers were recruited from New Jersey state funded tobacco dependence treatment clinics, called "QuitCenters," through clinician referrals or responses to recruitment flyers. Of those, 149 ultimately met all inclusion criteria and were enrolled. Reasons for exclusion from the current study included failing the diagnostic screening, already passing their quit date or using cessation medications (i.e., varenicline, bupropion, FDA approved nicotine replacement therapies, or nortriptyline for cessation), changing their mind about participating, smoking too few cigarettes per day, not planning to quit smoking, transportation issues, lost contact, and inability to provide informed consent. Participants were enrolled before their scheduled Quit Day and before they began taking any cessation medications.

Of the remaining 149 cigarette smokers seeking tobacco dependence treatment, 71 had schizophrenia or schizoaffective disorder (SZ) and 78 were non-psychiatric smokers (NP). While the QuitCenters from which we recruited served many smokers with schizophrenia and schizoaffective disorder, we continued to recruit SZ participants for months after we completed recruitment for NP participants to have a similar number of each group in our sample. We confirmed all diagnoses of schizophrenia or schizoaffective disorder with the Structured Clinical Interview for the DSM-IV (SCID; Spitzer, Williams, Gibbon, & First,

1985). NP smokers were also screened to ensure they did not have any other psychotic disorders, a current major depressive episode, or a current or past manic episode using the SCID-IV (Spitzer, et al., 1985). The specific sections of the SCID-IV were administered by a bachelor's level research assistant with extensive training and supervision in administering the SCID. Inclusion criteria for all participants included age   18, meeting DSM-IV diagnostic criteria for schizophrenia or schizoaffective disorder (for the SZ group), willing to adhere to the study protocol, capable of providing informed consent (Folstein Mini Mental Status Examination (Folstein, Folstein, & McHugh, 1975) score > 23), and stable on their current antipsychotic medication for one month (for the SZ group). Participants were excluded if they smoked fewer than 10 cigarettes per day or were already using any FDA approved smoking cessation medications at assessment. Participants were also excluded if they had made a previous quit attempt within the past 3 months to ensure that this was a new quit attempt, rather than a continuation of a recent, failed attempt. The study protocol was approved by the institutional review board, and all participants provided written informed consent. Additional information regarding the methods utilized in this study can be found in Steinberg et al. (2010).

Measures

We chose four measures of task persistence to ensure that we had measures characterizing the concept behaviorally (i.e., Mirror Tracing Persistence Task and Breath-Holding Task) and as a trait (i.e., The Temperament and Character Inventory – Persistence Scale and Two-Item Persistence Measure). Mirror tracing has the greatest empirical support to date, followed by breath-holding. The two self-report scales have more limited support, but greater potential utility, should they demonstrate predictive validity, due to ease of administration. These are described in detail below.

Mirror Tracing Persistence Task (MTPT)—This procedure has been shown to increase participants' frustration and stress (e.g., Kasprowicz,, Manuck, Malkoff, & Krantz, 1990; Allen, Matthews, & Sherman, 1997), and it has differentiated smokers from nonsmokers (Quinn et al., 1996) and prospectively predicted several short and long-term smoking cessation outcomes (Brandon et al., 2003) with greater persistence associated with nonsmoking and better cessation outcomes, respectively. A computerized version of this test has also been related to multiple substance use behaviors and outcomes (e.g., Daughters, Lejuez, Bornovaolova, Kahler, Strong, and Brown, 2005; MacPherson, Stipelman, Duplinsky, Brown, and Lejuez, 2008). It has been labeled as both a measure of task persistence and distress tolerance. In the current study, participants traced 8 geometric figures by hand while only viewing their hand indirectly through a mirror. Participants were instructed that they could proceed to the next figure if they completed the figure or if they felt unable to complete it. Experimenters told participants to proceed to the next figure if they were still trying after five minutes. Scores were determined by calculating the mean number of seconds spent on incomplete figures. Brandon et al. (2003) found coefficient alpha to be 0.92 for the mirror tracing task in a sample of NP adults.

Breath Holding Task (Hajek et al., 1987)—Participants were asked to hold their breath for as long as they could safely do so as a measure of persistence. This measure has previously been able to differentiate current smokers who had previously been able to remain abstinent for at least 3-months as compared to those unable to remain abstinent for at least 3-months (Brown et al., 2002), was related to risk of lapsing in smokers making an unaided quit attempt (Brown et al., 2009), and predicted seven-day point prevalence abstinence at end of treatment (Hajek et al., 1987). Zvolensky et al. (2001), however, did not find such a relationship.

The Temperament and Character Inventory – Persistence Scale (TCI-9-P; Cloninger, et al., 1994)—The full TCI-9 is a 240-item, true-false, self-report questionnaire that measures seven dimensions of personality, including the original three Tridimensional Personality Questionnaire scales. The present study used only the fourth scale, "Persistence," which comprised 8-items, yielding scores from 0 (low persistence) to 8 (high persistence). Kalman et al. (2010) report cronbach alpha to be 0.72 in their sample of adult smokers.

Two-Item Persistence Measure (Steinberg et al., 2007)—Two items from the Tridimensional Personality Questionnaire (TPQ; Cloninger, 1987) with a modified response format (i.e., True/False changed to 4-point scale) appeared to be consistent with task persistence (Steinberg et al., 2007). The items were: "I will keep trying the same thing over again even when I have not had success the first time" and "I will often continue to work on something, even after other people have given up." Total scores could range from 0 for low persistence to 8 for high persistence. In a sample of adolescents, internal consistency reliability was determined to be 0.73 (Steinberg et al., 2007).

Fagerström Test for Nicotine Dependence (FTND)—A widely used, self–report measure of physical dependence on cigarettes (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). Dependence scores can range from a low of 0 to a high of 10.

Change Questionnaire (Miller, Moyers, & Amrhein, 2005)—This 12-item, theory-driven measure is rated on a 10 point scale—with higher ratings indicating higher motivation to change. The current study used the "Ability" subscale as a measure of confidence in ability to quit smoking with potential scores ranging from a low of 0 to a high of 20.

Procedure

After providing written informed consent, participants completed assessment measures no more than two weeks prior to their target quit date. Participants were paid $30 compensation for their time and then continued with treatment as usual at one of two New Jersey state-funded "QuitCenters" – smoking cessation clinics providing comprehensive, evidence-based (Fiore et al., 2008; Foulds, et al., 2006) treatment. Smoking cessation counselors received at least 42 hours of intensive training in empirically supported tobacco dependence treatments as part of a training program endorsed by the Association for the Treatment of Tobacco Use and Dependence (ATTUD). All participants received individual counseling and were encouraged to utilize at least one of the seven FDA approved smoking cessation medications. Participants completed follow-up assessments at one- and six-months after their quit date (and were paid $30 each time) to determine tobacco use. Individual treatment details for each patient were not recorded, but during the period of the study patients attending one of the clinics attended an average of 4 face-to-face appointments, and 87% used an FDA-approved smoking cessation medication (Foulds et al, 2006). A timeline follow-back procedure (Sobell and Sobell, 1992) was used to collect data from quit-date until the 30-day follow-up appointment. At the six-month follow-up appointment, participants again provided 30 days of tobacco use data. Self-report point prevalence abstinence was verified with CO < 10ppm.

Results

Baseline Characteristics

Participants were approximately 44 years old (M = 44.12, SD = 10.97) and 53% were female. Most (56%) identified as African American and 31% identified as Caucasian. Most

were unemployed (84%) and receiving public assistance (81%). More than a quarter (26%) had obtained less than a high school diploma or GED. We did not detect differences between psychiatric groups (SZ vs. NP) with respect to age, racial categories, or attainment of high school diploma or GED ($p > 0.05$). Chi square analyses detected significant differences between groups with respect to gender, $\chi^2(1) = 4.77$, $p = 0.029$, employment, $\chi^2(1) = 8.25$, $p = 0.004$, and receipt of public financial assistance, $\chi^2(1) = 18.86$, $p = 0.001$. NP smokers were more likely to be women and less likely to be unemployed or receiving public assistance than were those with SZ, though there were very high rates of unemployment (76% for NP and 93% for SZ) and receipt of public assistance (68% for NP and 96% for SZ/) in both groups (Table 1).

Relationship Among Persistence Measures

We computed Pearson correlation coefficients to examine the relationship among the four measures of persistence, and did not detect significant relationship between any measures (all $p > .05$). There were, however trends suggesting possible relationships between behavioral persistence measures (i.e., mirror tracing and breath-holding persistence, $r(148) = 0.15$, $p = 0.07$), and between the paper/pencil persistence measures (i.e., TCIP-9 and 2-item persistence measures, $r(133) = 0.17$, $p = 0.06$).

We also computed internal consistency reliability estimates (coefficient alpha) for the persistence measures other than breath-holding endurance. Internal consistency reliability was $\alpha = .94$ for mirror tracing persistence (8 shapes), $\alpha = 0.25$ for the TCIP-9 (8 items), and $\alpha = 0.47$ for the 2-item persistence measure.

Participants' Abstinence Rates

As depicted in Table 2, no differences were detected between smokers with schizophrenia and NP smokers at any of the four time points at which abstinence was assessed (all p-values $> .05$).

Mirror Tracing Persistence

We used SAS 9.2 to analyze generalized estimating equation (GEE) parameter estimates based on empirical standard error estimates, using an exchangeable working correlation structure (SAS Institute Inc., 2009). The dichotomous outcome variable was smoking abstinence and explanatory variables included mirror tracing persistence, assessment time point, diagnosis (SZ vs. NP), confidence in ability to quit, FTND score, and the interaction between diagnosis and persistence. As displayed in Table 3, mirror tracing persistence, Wald $\chi^2(1) = 8.69$, $p = 0.003$, and assessment time point, Wald $\chi^2(3) = 52.77$, $p < .0001$, significantly predicted smoking abstinence. Neither psychiatric diagnosis (SZ vs. NP), confidence in ability to quit, nicotine dependence (FTND score), nor the interaction between persistence and psychiatric diagnosis were associated with significant Wald χ^2 statistics (all p values $> .05$). While we were initially interested in examining both groups (SZ and NP) separately, we were not justified in doing so because of the absence of a significant persistence X diagnosis interaction effect. Figure 1 depicts the results of four planned comparisons (one at each time point) from Analyses of Covariance (ANCOVAs), statistically controlling for nicotine dependence and confidence in ability to quit. Comparisons include 1) Non-abstinent NP smokers, 2) Non-abstinent SZ smokers, 3) Abstinent NP smokers, and 4) Abstinent SZ smokers.

Other Measures of Persistence

We analyzed three additional GEE parameter estimates based on empirical standard error estimates, using an exchangeable working correlation structure. Analyses included the same

dichotomous variable as above (i.e., smoking abstinence) and explanatory variables included task persistence (separate analyses for persistence measured by breath holding, TCIP-9, and the 2-item self-report measure), assessment time point, diagnosis (SZ vs. NP), confidence in ability to quit, FTND score, and the interaction between diagnosis and persistence. Neither breath-holding persistence (Wald $\chi^2(1) = 0.17$, $p = 0.6818$), TCIP-9 (Wald $\chi^2(1) = 0.01$, $p = 0.9151$), nor the 2-item self-report measure of task persistence (Wald $\chi^2(1) = 0.04$, $p = 0.8341$) predicted smoking outcome. Assessment time point was associated with a significant Wald χ^2 statistic for all analyses (all $p < 0.0001$).

Discussion

This manuscript describes the first study to examine the relationship between task persistence and smoking cessation outcome in a sample that includes both smokers with schizophrenia and non-psychiatric smokers receiving evidence-based tobacco dependence treatment. We hypothesized that task persistence would prospectively predict smoking cessation in smokers with and without schizophrenia. Results supported the hypothesis when task persistence was measured with a mirror tracing task (consistent with Bandon et al., 2003), but did not support the hypothesis when persistence was measured via breath-holding, the TCI-P, or the 2-item Persistence measure. As displayed in Table 3, the effect size associated with the relationship between mirror tracing and smoking cessation was small, but significant.

Though smokers with schizophrenia scored lower on measures of task persistence than non-psychiatric smokers (Steinberg et al., 2010), task persistence predicted abstinence similarly in both groups in the current study as suggested by a non-significant Diagnostic Group X Persistence interaction term (see Table 3). The extent to which mirror tracing persistence predicts smoking cessation is therefore similar in SZ and NP, and the overall lower mirror tracing persistence in SZ likely contributes to the lower smoking cessation rates in this group. This relationship is consistent with the suggestion that compared to NP smokers, those with SZ are more sensitive to the negative affective states associated with nicotine withdrawal (Williams, Gandhi, Lu, Kumar, Steinberg, Cottler, & Benowitz, 2011) and that this greater sensitivity may inhibit one's ability to persist through the negative affect, thereby contributing to lower quit rates.

It is unclear why our hypothesis that task persistence would prospectively predict smoking cessation would be supported only when task persistence is measured by mirror tracing, but not when measured by breath-holding, by the TCI-P, or by the 2-item Persistence measure. The most parsimonious explanation may be that a behavioral measure of persistence requiring participants to cope with the distress of a frustrating and difficult task (e.g., mirror tracing) may be a better analogue for what is required for quitting smoking than paper and pencil measures designed to assess perceptions about one's tendency to persist (i.e., TCI-P and 2-item Persistence measure) and better than a measure that could potentially be confounded by lung-function or aerobic conditioning (i.e., breath holding). Consistent with previous research (McHugh, Daughters, Lejuez, Murray, Hearon, Gorka, & Otto 2010), our data indicate that behavioral measures of persistence were significantly related to one another and the paper/pencil measures were significantly related to one another, but the behavioral measures were uncorrelated with the paper/pencil measures. Alternatively, the validity of the TCI-P and 2-item persistence scales may have been limited by their low reliability, as indicated by lower than expected coefficient alpha scores ($\alpha = 0.25$ and 0.47, respectively).

Consistent with the current study, the Persistence scale of the Temperament and Character Inventory (TCI) did not prospectively predict tobacco dependence treatment outcome in a

study by Kalman et al. (2010) and did not detect a relationship between TCI Persistence scores and cessation or withdrawal in an internet cohort study by Etter (2010). The low reliability of the TCI Persistence scale may have hampered the ability of Kalman et al. (2010) and Etter (2010) to detect a relationship as well. While the internal consistency reliability of the TCI Persistence scale was more reasonable in their samples, they were still only modest in the Kalman et al (2010) and Etter (2010) samples ($\alpha = 0.72$ and $\alpha = 0.66$ respectively). Although the present data were inconsistent with previous findings relating to the 2-item Persistence measure (Steinberg et al., 2007), the earlier study examined a different sample of smokers (i.e., adolescents) and utilized a concurrent, rather than a prospective study design. It is possible that "persistence" as measured by the TCI-P and 2-item Persistence scale may differ from what is being measured by the mirror tracing task and the construct predicting smoking cessation. The low inter-correlations across measures suggest that they are assessing different variables, although these too may be limited by the poor reliability of the self-report measures in this sample.

Like the 2-item Persistence scale, breath-holding has demonstrated an inconsistent relationship with cessation, though the data have been mostly supportive. Consistent with the current study, Zvolensky et al. (2001) were unable to detect a significant difference in breath-holding persistence between smokers with and without histories of quit attempts lasting more than seven days in a small sample of 22 smokers. In contrast, in a retrospective design, Brown et al. (2002) found that current smokers who had remained abstinent for at least 3-months persisted in breath-holding for longer than those who had been unable to remain abstinent for at least 3-months.

Additionally, it would be worthwhile to start distinguishing between similar concepts. Though we refer to "task persistence" as the behavioral manifestation of "distress tolerance," it is still unclear just how different (if at all) these constructs may be, and whether different measures better represent "distress tolerance" while others better represent "task persistence." Given the nomenclature chosen to describe this phenomenon, it is no surprise that while Steinberg et al., 2010 (who study "task persistence") have suggested that cognitive therapy may be a fruitful strategy for addressing automatic thoughts that may reduce "task persistence," Brown et al. (2005; 2008) (who study "distress tolerance") have suggested that Acceptance and Commitment Therapy would be more appropriate for helping smokers to accept and cope with the distress associated with quitting smoking. In any case, these potential avenues for research highlight the important clinical implications of these data. Most smoking cessation counseling protocols focus on skill building and support (Fiore et al., 2008); yet the current data suggest that efforts to target task persistence and/or distress tolerance in smoking cessation counseling protocols may be warranted – especially in smokers with schizophrenia who have reduced task persistence as compared to NP smokers (Steinberg et al., 2010). It is worth noting that cognitive therapy (Beck and Rector, 2000; Butler, Chapman, Forman, & Beck, 2006) and Acceptance and Commitment Therapy (Bach and Hayes, 2002; Gaudiano and Herbert, 2006) have gained empirical support for individuals with schizophrenia. It is still unknown, however, whether task persistence is, in fact, modifiable via therapy.

Limitations of the current study include a relatively small sample size, the use of measures not yet validated in samples of smokers with schizophrenia, and our inability to generalize to smokers of higher socioeconomic status, or smokers not seeking formal cessation treatment. Because task persistence may be higher in smokers wishing to quit (Steinberg et al., 2007), our sample may be missing smokers with very low persistence. In addition, the lack of a standardized tobacco dependence treatment protocol provided in the smoking cessation clinics may have introduced variability into the study. Participants received treatment at state funded "QuitCenters" providing empirically supported tobacco dependence treatment,

but these treatments were individualized such that participants received different doses of counseling, and different doses and types of pharmacological assistance. However, as the amount of counseling and medication received is itself likely influenced by task persistence, it is unlikely that this could have been meaningfully standardized.

Finally, the relatively small sample size could have inhibited detection of significant effects due to insufficient power. This is particularly relevant given the low quit rates in our sample. We initially suspected that the low quit rates were primarily due to the fact that smokers with schizophrenia typically have more difficulty quitting than do those in the general population (Williams & Hughes, 2003). However, the NP group had similarly poor outcomes, perhaps because they were recruited from tobacco-dependence clinics in low SES areas. Among our non-psychiatric sample, only 23% obtained an education beyond high school diploma / GED, 68% were receiving public assistance, and 76% were unemployed. Foulds et al. (2006) found significant disadvantages in quit rates for those who were less educated and who were unemployed as compared to those with higher educational attainment and full-time employment.

Despite these limitations, an examination of task persistence as a predictor of cessation outcome in a sample of smokers with schizophrenia and without psychiatric diagnosis adds to the literature by corroborating data suggesting that task persistence may make important contributions to tobacco dependence treatment success, and by expanding such research to indicate that the contribution of task persistence is similar for smokers with and without schizophrenia. Nevertheless, many questions remain. We do not yet know the mechanisms through which task persistence is developed, how it influences smoking cessation outcomes, and what other factors may interact with persistence to contribute to smoking cessation success.

One potential explanatory mechanism has been suggested by Quinn, Brandon, and Copeland (1996) when they described task persistence as a measure of Learned Industriousness. Learned Industriousness Theory (Eisenberger, 1992) proposes a learning-based model of motivation whereby people with a history of gaining rewards for effortful behaviors are more likely to persist in behaviors requiring high effort than those without such a learning history. Human (Boyagian & Nation, 1981; Eisenberger, 1992; Eisenberger, Heerdt, Hamdi, Zimet, & Bruckmeier, 1979) and animal (McCuller, Wong, & Amsel, 1976; Wenrich, Eckman, & Moore, 1967) laboratory studies support the hypothesis that organisms receiving rewards for high effort show greater persistence than organisms receiving rewards for low efforts. Once the association has been made between reward and persistence, one is more likely to act with persistence again in the future. If one has not received rewards for effortful behavior, has never persisted in effortful behavior, or has been rewarded only for easy behaviors in the past, one may develop lower task persistence and therefore may not persist in the face of difficulty in the future.

It is important to note that although these data suggest that persistence predicts success in quitting smoking, the smokers in the current study were also receiving empirically supported counseling and using FDA approved pharmacotherapy. We would not wish to imply that successful smoking cessation requires merely persistence or "willpower." Nevertheless, accumulating evidence indicates that individual differences in such constructs as persistence or distress tolerance are reliable predictors of behavior change, and the possibility of a causal contribution cannot be ignored.

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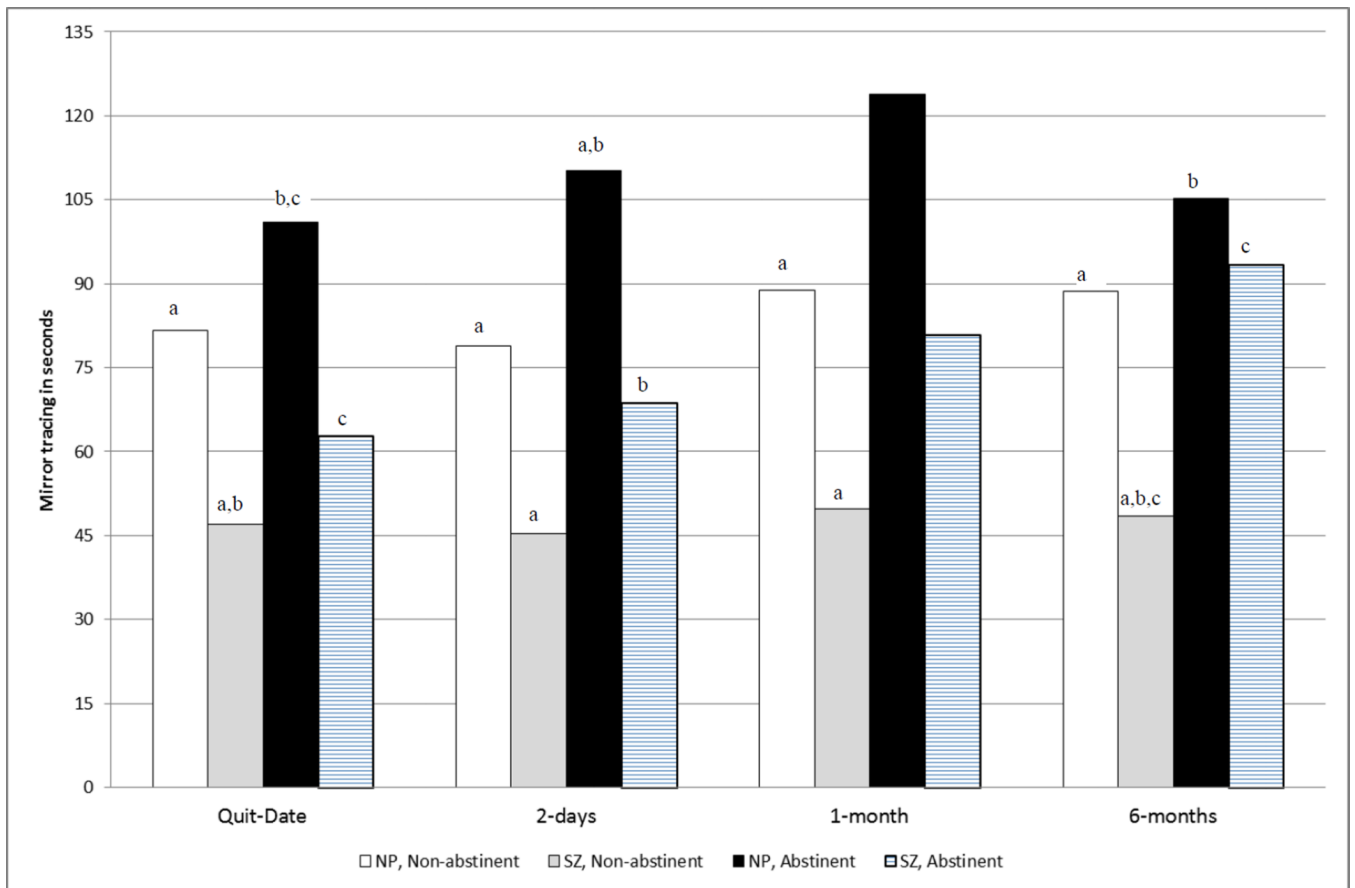**Figure 1.**
Mirror tracing persistence as a function of diagnostic status and abstinence status.
Superscripts represent statistically significant differences (p < .05) between same superscript
within a given time point.

Table 1

Baseline characteristics for total sample, smokers with schizophrenia, and non-psychiatric smokers.

	Total Sample			Schizophrenia (n=71)			Non-Psychiatric (n=78)			t(148)	χ^2 (1)
	M	SD	%	M	SD	%	M	SD	%		
Serious quit attempts	2.76	2.68		2.89	2.41		2.64	2.91		−0.56	
Cigarettes per day	19.43	9.76		19.63	10.22		19.24	9.39		−0.19	
FTND	5.69	1.94		6.04	1.97		5.37	1.86		−2.13[*]	
Confidence in ability to quit	16.84	3.73		16.47	4.43		17.19	2.92		1.11[a]	
Age	44.12	10.97		42.75	9.91		45.37	11.78		1.46	
Female			53.02			43.66			61.54		4.77[*]
African American			56.38			53.52			58.97		0.45
Caucasian			31.54			29.58			33.33		0.24
Less than high school diploma / GED			26.17			29.58			23.08		0.81
Unemployed			83.89			92.96			75.64		8.25[*]
Receiving public assistance			81.21			95.77			67.95		18.86[**]

Note: Table 1 includes data from Steinberg et al. (2010) and adds Total Sample data.

[*]
p < .05,

[**]
p < .0001,

[a]
df = 130.

Table 2

Abstinence rates for smokers with schizophrenia and for non-psychiatric smokers at four time points.

	Smokers with Schizophrenia N = 78	Non-Psychiatric Smokers N = 71	
	% Abstinent	% Abstinent	Test Value
On Target Quit Date	46.48%	42.31%	$\chi^2(1) = 0.262$, $p = 0.609$
48 hours post QD	39.44%	35.90%	$\chi^2(1) = 0.199$, $p = 0.656$
One-month post QD[a]	15.49%	6.41%	$\chi^2(1) = 3.199$, $p = 0.074$
6-months post QD[a]	12.68%	10.26%	$\chi^2(1) = 0.215$, $p = 0.643$

Note:

[a] 7-day point prevalence abstinence CO < 10ppm verified

Table 3

Analysis of GEE parameter estimates based on empirical standard error estimates, using an exchangeable working correlation structure, with smoking abstinence as outcome variable, and task persistence, time, diagnosis, ability, FTND score, and the interaction between disorder and persistence as explanatory variables.

Parameter	Estimate	Standard Error	Wald χ^2 (df=1)[a]	p-value	OR	95% CI
Intercept	−4.319	1.207				
Mirror Tracing Persistence *	0.014	0.006	8.69	0.003	1.014	1.014 – 1.017
Time **	2.083	0.327	52.77	<0.001	8.029	2.114 – 237.81
Diagnostic Group	0.188	0.557	0.11	0.740	1.207	0.991 – 1.019
Confidence in ability to quit	0.051	0.053	0.93	0.334	1.052	1.047 – 1.176
FTND Score	0.077	0.092	0.70	0.401	1.080	1.065 – 1.332
Persistence X Diagnostic Group	−0.009	0.006	2.15	0.143	0.991	0.991 – 1.019

*
p < .05,

**
p < .0001,

[a] df=3 for variable Time