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ORIGINAL INVESTIGATION

Diagnostic Utility of Craving in Predicting Nicotine Dependence: Impact of Craving Content and Item Stability

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ABSTRACT

Introduction: Craving is useful in the diagnosis of drug dependence, but it is unclear how various items used to assess craving might influence the diagnostic performance of craving measures. This study determined the diagnostic performance of individual items and item subgroups of the 32-item Questionnaire on Smoking Urges (QSU) as a function of item wording, level of craving intensity, and item stability.

Methods: Nondaily and daily smokers (n = 222) completed the QSU on 6 separate occasions, and item responses were averaged across the administrations. Nicotine dependence was assessed with the Wisconsin Inventory of Smoking Dependence Motives. The discriminative performance of the QSU items was evaluated with receiver-operating characteristic curves and area under the curve statistics.

Results: Although each of the QSU items and selected subgroups of items significantly discriminated dependent from nondependent smokers, certain item subgroups outperformed others. There was no difference in discriminative performance between use of the specific terms *urge* and *crave* or between items assessing *intention to smoke* relative to those assessing *desire to smoke*, but there were significant differences in the two major factors represented on the QSU and in craving items reflecting more intense relative to less intense craving. Stability of the item scores was strongly related to the discriminative performance of craving.

Conclusions: Items indexing stable, high-intensity aspects of craving that reflect the negative reinforcing effects of smoking will likely be most useful for diagnostic purposes. Future directions and implications are discussed.

INTRODUCTION

There is ample evidence for the diagnostic value of craving for distinguishing between dependent and nondependent individuals (Tiffany & Wray, 2012), and *DSM-5* includes craving as a feature of substance-use disorders (American Psychiatric Association, 2013). Most research on the diagnostic utility of craving has focused on alcohol-use disorders—there have been few studies examining craving and diagnoses of nicotine dependence. In a study using nationally representative samples of cigarette smokers, Goedeker and Tiffany (2008) found that nicotine-dependent smokers differed categorically from nondependent smokers. That is, dependent smokers constituted a taxon, and craving was identified as one of the core components of this dependence taxon (see also Piper et al., 2008a). Although there is evidence for the diagnostic utility of craving in general and for nicotine-use disorders more specifically, there is no published research on the extent to which discrimination between dependent and nondependent smokers depends on the specific wording of craving items.

The Questionnaire on Smoking Urges (QSU; Tiffany & Drobes, 1991), which contains 32 items representing a diverse array of craving-related terms, is well suited for exploring the relationship between craving and nicotine dependence. The QSU was developed with four categories of items: desire to smoke, anticipation of positive outcomes from smoking, anticipation of relief from nicotine withdrawal and negative affect, and intention to smoke (Tiffany & Drobes, 1991). Factor analyses have revealed that the QSU has two distinct manifestations of smoking urges with clear discriminant validity (Davies, Willner, & Morgan, 2000): Factor 1 (intention and desire to smoke, and anticipation of pleasure from smoking) and Factor 2 (anticipation of relief from negative affect and nicotine withdrawal, and an overwhelming desire to smoke). The QSU also has a strong general craving factor comprised of all 32 items, which has very high reliability

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(Davies et al., 2000). The comprehensive coverage of craving on the QSU allows for the examination of a variety of questions about the content of craving-related terms and their ability to discriminate nicotine dependence.

One content-related issue is the extent to which various terms reflecting desire, such as *crave*, *urge*, *want*, or *need,* can be used interchangeably to index the same general construct (Tiffany & Wray, 2012). Some researchers have hypothesized that among these terms, urges and cravings represent two distinct states (Kozlowski & Wilkinson, 1987) with craving purportedly representing the more intense state of desire associated with dependence. This argument suggests that the diagnostic performance of an item specifically using the term *crave* may be a better discriminator of nicotine dependence than an item using the term *urge*. More generally, varied item content that extends beyond desire may better assess the multidimensional facets of craving (Sayette et al., 2000). However, it is unknown whether items representing constructs other than desire, such as intention to smoke, also have the ability to discriminate nicotine dependence.

Factor 1 and Factor 2 of the QSU can be conceptualized roughly as capturing the positive and negative reinforcing effects of smoking, respectively. These two factors allow an examination of an additional content-related question—whether Factor 1 differs from Factor 2 in dependence discrimination. Some researchers suggest that once an individual becomes dependent on nicotine, motivation to seek and obtain this drug (associated with the concept of craving) is strongly influenced by a reduction in withdrawal symptoms and an expectation of stress reduction (Baker, Brandon, & Chassin, 2004). This motivation for the dependent smoker reflects negative reinforcement processes, indexed most clearly by Factor 2. In contrast, motivation to smoke for the nondependent smoker may be more strongly influenced by positive reinforcement processes, reflected by items from Factor 1 (Coggins, Murrelle, Carchman, & Heidbreder, 2009).

A final unresolved content issue is the intensity of craving represented in the items utilized in craving measures. Arguably, individuals who experience more intense craving are those who have a higher probability of being dependent. Studies examining the diagnostic utility of craving have generally utilized items reflecting intense levels of craving (Tiffany & Wray, 2012), but no investigation has addressed whether craving items manifesting more intense craving better discriminate between dependent and nondependent individuals compared to items indexing less intense craving. In addition, researchers have not examined the impact of craving stability in dependence discrimination. As nicotine dependence is sometimes considered a stable and enduring characteristic of people who smoke cigarettes, the best predictors of this category should be stable components of craving.

This study examined the impact of craving assessment content and item stability on the discrimination between dependent and nondependent smokers. Craving for cigarettes was assessed by examining the individual items, total score, item categories, and two factors of the 32-item QSU (Tiffany & Drobes, 1991). Nicotine dependence was assessed using the Wisconsin Inventory of Smoking Dependence Motives (WISDM-68; Piper et al., 2004) due to its broad coverage of multiple features of nicotine dependence and high reliability. We utilized receiver-operating characteristic (ROC) analyses to determine associations between craving assessment content and the diagnostic discrimination of smokers. We evaluated the extent to which the following content considerations indicated differential dependence discrimination: (a) use of the term *urge* relative to the term *crave*, (b) items assessing *desire to smoke* relative to those assessing *intention to smoke*, (c) items representing Factor 1 and Factor 2 on the QSU, and (d) craving items reflecting more intense craving relative to items reflecting less intense craving. Additionally, assessments of craving collected on multiple occasions allowed us to calculate a stability index for each item, which was used to evaluate the relationships between stability and area under the curve (AUC) values for discriminations at the item level.

METHODS

Participants

A total of 270 adult smokers (135 males/135 females) were recruited for this study. Nondaily smokers were over-recruited to ensure a wide range of smoking levels in the sample. Participants were between 18 and 45 years old, proficient in reading English, not trying to quit over the past month nor intending to quit over the next 2 months, had not used nicotine or tobacco in any form other than cigarettes in the past 12 months, had smoked at least 25 lifetime cigarettes, and had not been diagnosed with drug dependence (other than nicotine) in the past 12 months. Nondaily smokers were over-recruited to ensure a wide range of smoking levels in the sample and were defined as individuals who smoked 1–29 days over the past 30 days prior to study entry. Study participation occurred across six sessions. Participants were compensated with $30 at the end of Sessions 1, 2, 3, and 4, $70 after Session 5, and up to $110 after Session 6. Participants were recruited as part of a larger study evaluating the validity of various biomarkers and self-report assessments of smoking.

Assessments

Cigarette Craving

Craving was assessed at each session using the 32-item QSU (Tiffany & Drobes, 1991; see Table 1 for individual item content). Participants were instructed to answer each item for how they were "thinking or feeling" during the time they completed the questionnaire ("right now"). In order to eliminate item-position effects, the presentation order of the QSU items was randomized for each participant at each session. The reliability of the QSU total score in this study was $\alpha = .98$.

Smoking History and Current Use

Participants completed a questionnaire about their smoking history. Current cigarette consumption was assessed at Session 1 using a 28-day Timeline Follow Back Interview (Sobell & Sobell, 1996).

Nicotine Dependence

Nicotine dependence was assessed using the WISDM-68 total score (Piper et al., 2004), which was dichotomized into categories of either dependent or nondependent for ROC analyses. The WISDM-68 includes a wide range of

Table 1. QSU Item Content, Stability, Mean Craving Scores, and Discriminative Ability Per Item

QSU item content	Item stability (α)	Item (*M* [*SD*])	AUC	*SE*
1. Smoking would make me feel very good right now.	.88	3.43 (1.42)	.82	.03
2. I would be less irritable now if I could smoke.	.89	3.02 (1.49)	.83	.03
3. Nothing would be better than smoking a cigarette right now.	.88	2.57 (1.35)	.88	.03
4. I am not missing smoking right now.[a]	.85	3.37 (1.43)	.79	.03
5. I will smoke as soon as I get the chance.	.92	3.54 (1.72)	.84	.03
6. I don't want to smoke now.[a]	.86	3.96 (1.51)	.77	.03
7. Smoking would make me less depressed.	.88	2.59 (1.40)	.79	.03
8. Smoking would not help me calm down now.[a]	.76	3.90 (1.35)	.68	.04
9. If I were offered a cigarette, I would smoke it immediately.	.90	4.29 (1.65)	.78	.03
10. Starting now, I could go without smoking for a long time.[a]	.93	3.93 (1.80)	.86	.03
11. Smoking a cigarette would not be pleasant.[a]	.86	4.57 (1.43)	.77	.03
12. If I were smoking this minute, I would feel less bored.	.91	3.82 (1.63)	.74	.04
13. All I want right now is a cigarette.	.88	2.47 (1.37)	.85	.03
14. Smoking right now would make me feel less tired.	.89	2.98 (1.52)	.73	.04
15. Smoking would make me happier now.	.89	3.13 (1.46)	.83	.03
16. Even if it were possible, I probably wouldn't smoke now.[a]	.86	4.22 (1.55)	.75	.03
17. I have no desire for a cigarette right now.[a]	.85	3.99 (1.52)	.78	.03
18. My desire to smoke seems overpowering.	.91	2.33 (1.42)	.82	.03
19. Smoking now would make things seem just perfect.	.90	2.57 (1.34)	.86	.03
20. I crave a cigarette right now.	.87	3.12 (1.46)	.81	.03
21. I would not enjoy a cigarette right now.[a]	.79	4.41 (1.35)	.71	.04
22. A cigarette would not taste good right now.[a]	.88	4.13 (1.52)	.78	.03
23. I have an urge for a cigarette.	.87	3.40 (1.45)	.79	.03
24. I could control things better right now if I could smoke.	.91	2.43 (1.37)	.84	.03
25. I am going to smoke as soon as possible.	.92	3.41 (1.70)	.83	.03
26. I would not feel better physically if I were smoking.[a]	.78	3.19 (1.37)	.75	.04
27. A cigarette would not be very satisfying now.[a]	.82	4.19 (1.37)	.76	.03
28. If I had a lit cigarette in my hand I probably wouldn't smoke it.[a]	.81	5.35 (1.33)	.67	.04
29. If I were smoking now I could think more clearly.	.92	2.65 (1.46)	.83	.03
30. I would do almost anything for a cigarette now.	.87	1.99 (1.11)	.85	.03
31. I need to smoke now.	.89	2.61 (1.45)	.82	.03
32. Right now, I am not making plans to smoke.[a]	.81	3.75 (1.54)	.69	.04

Note. QSU = Questionnaire on Smoking Urges; AUC = area under the curve.
[a]Reverse-keyed items. All p values < .0001 for all AUCs, where p values represent the discriminative ability (AUCs) compared to chance (AUC of .50).

content assessing various motives of nicotine dependence, with items loading onto 13 subscales tapping the potentially multidimensional nature of nicotine dependence. The continuous total score, generated from the WISDM-68's 13 subscales, evidenced high reliability in this study (α = .94). Research has repeatedly confirmed convergent validity of the WISDM-68, with significant correlations found between the WISDM-68 and several other measures of nicotine dependence (Piper, McCarthy, & Baker, 2006; Piper et al., 2008a, 2008b). Analyses of the WISDM-68 subscales have also indicated their significant relations to *DSM-4* dependence criteria (Piper et al., 2004).

Because there is no established dependence cutoff for the WISDM-68 total score, participants were categorized with a selection ratio derived from an empirically validated instrument—the Nicotine Addiction Taxon Scale (NATS)—that has identified an explicit categorization of dependence based on two large sample replications generated from a nationally representative dataset (The National Survey of Drug Use and Health; Goedeker & Tiffany, 2008). The percentage of individuals categorized as dependent according to the NATS (26%) was applied to the WISDM-68 data so that 26% (58 participants) were categorized as dependent on the WISDM-68.

Procedures

Participants attended six laboratory sessions over the course of 3 months. Sessions occurred at the same time each week for 5 weeks (Sessions 1–5) and participants returned for a final session (Session 6) 12 weeks after Session 1. Participants completed the QSU on a computer during each study session. The NATS was completed at Session 1 and the WISDM-68 at Session 5.

Data Reduction and Analyses

Craving Scores

The QSU total score was calculated by averaging the 32 items (reverse-scored where appropriate) within each session and then averaging across the six sessions. Scores for each item subgroup and the two factors were calculated by averaging the appropriate items designated to each subgroup and factor and then averaging across the six sessions.

Craving Intensity

Overall rated craving for any given item was used as an index of the intensity of craving captured by that item. We expected that item content reflecting intense states of craving would generate lower average ratings than item content depicting milder forms of craving. For example, an item worded "I would do almost anything for a cigarette now" (item 30) should be, on average, rated lower across smokers than an item worded "I have an urge for a cigarette" (item 23). This approach is consistent with other research directly comparing craving scores generated from items ostensibly varying in craving intensity. For example, Agrawal and colleagues (2011) found that an item presumably reflecting less intense craving was endorsed five times as often as an item reflecting inarguably more intense craving.

Nicotine Dependence

The WISDM-68 total score includes four individual items that load onto a craving subscale, creating overlap between the WISDM-68 and the QSU; we hypothesized that this overlap might contribute to some redundancy between these measures. Analyses involving the WISDM-68 were conducted with the full WISDM-68 total score as well as a total score without the four craving items. There were no differences in any of the findings between these two total scores. Therefore, analyses of the WISDM-68 are reported according to the calculation of the total score using all 68 items.

Analyses

ROC analyses were conducted, and AUC values were interpreted for all questions of interest. ROC curves are designed to measure the performance of classification rules (Krzanowski & Hand, 2009) and are generated by plotting sensitivity relative to a value of one minus specificity for each value of the test. AUC is an effect-size statistic used as a global indicator of diagnostic performance. Differences in AUC values were assessed using z statistics, and statistical significance was defined as $p < .05$. AUC values >.50 were interpreted as having diagnostic performance better than chance.

RESULTS

Participant Characteristics

Data were retained for analyses for participants who completed the WISDM-68 during Session 5 and also completed the QSU on at least three occasions. Of the 270 participants who attended the first session, 222 (108 males/114 females) completed three or more sessions. Of these participants, 216 completed all six sessions, five completed five sessions, and one completed four sessions.

Participants averaged 25.7 years of age (standard deviation [*SD*] = 6.9) and 34% were of minority status (racial categorizations based on the U.S. Census Bureau's racial categorization, 2011; see Supplementary Table 1 for participant demographics). On average, participants had been smoking for 10 years and according to the Timeline Follow Back Interview, smoked 5 cigarettes per day over the past 28 days (*SD* = 7.5; range .1–35). Approximately, 52% had made quit attempts with an average of 2.4 (*SD* = 1.3) quit attempts. On the WISDM-68, 58 participants were categorized as dependent (*M* score of 59.1, *SD* = 8.9), and 164 participants were categorized as non-dependent (*M* score of 29.7, *SD* = 8.7).

Overall Performance of QSU

The AUCs indicated that individual items, item subgroups, factor scores, and the general craving score of the QSU showed significant dependence discrimination, with statistics ranging from .67 to .88, all $p < .0001$ (see Tables 1 and 2). The vast majority of the AUCs were in excess of .71, a value suggested by Rice and Harris (2005) as corresponding to "large" effect sizes.

Urge and Crave Language

ROC analyses were conducted to determine differences in the discriminative performance of the QSU item explicitly assessing craving ("I crave a cigarette right now"; item 20) and the QSU item assessing urge ("I have an urge for a cigarette"; item 23). Both items had significant dependence discrimination ($p < .0001$; Table 1), but there was no significant difference in the discrimination performance of these two items ($p = .23$). A post hoc *t*-test was performed comparing the craving means of the *crave* and *urge* item, indicating that the item referencing *crave* represented a significantly more intense form of desire than the item referencing *urge* (as indexed by a lower craving mean on the *crave* item in comparison to the *urge* item; $t(221) = -6.84$, $p < .0001$).

Intention to Smoke and Desire to Smoke Item Subgroups

ROC analyses comparing the ability of the *intention to smoke* and *desire to smoke* item subgroups indicated that both subgroups had significant dependence discrimination ($p < .0001$; Table 2), but that these two item subgroups did not differ significantly from one another in their ability to discriminate dependence ($p = .56$; Figure 1).

Factors 1 and 2

The Factor 2 subscale on the QSU discriminated nicotine dependence significantly better than the Factor 1 subscale ($z = 2.04$, $p = .04$; Table 2 and Figure 1).

Craving Intensity

WISDM-68 AUC values were significantly and negatively correlated with QSU mean craving scores ($r = -.68$, $p < .0001$), indicating that QSU items with lower mean craving scores (reflecting intense craving items) better discriminated nicotine dependence.

Item Stability

The aggregate scores for individual QSU items across the six sessions were highly stable, with stability estimates (α) ranging from .76 to .93 (*M* = .87; Table 1). The QSU total score was highly stable ($\alpha = .95$) and stability values ranged between .92 and .95 for the four QSU item subgroups and two factors. The association between item stability and dependence discrimination (AUC values) was assessed. AUC values were significantly and positively correlated with QSU individual item stabilities

Table 2. QSU Stability, Mean Craving Scores, and Discriminative Ability Per Total Score, Item Subgroups, and Factors

QSU content	Item stability (α)	Item (*M* [*SD*])	AUC	*SE*
Total score[a]	.95	3.42 (1.19)	.86	.03
Desire to smoke subgroup[b]	.92	3.16 (1.28)	.84	.03
Anticipation of positive outcome subgroup[c]	.93	3.63 (1.23)	.85	.03
Relief of withdrawal or negative affect subgroup[d]	.95	3.07 (1.21)	.82	.03
Intention to smoke subgroup[e]	.94	3.81 (1.29)	.85	.03
Factor 1[f]	.93	3.98 (1.33)	.82	.03
Factor 2[g]	.95	2.67 (1.20)	.87	.03

Note. QSU = Questionnaire on Smoking Urges; AUC = area under the curve.
[a]Total score = average of 32 items across sessions.
[b]Desire to smoke items = average of items 4, 6, 13, 17, 18, 20, 23, and 31 across sessions.
[c]Anticipation of positive outcome items = average of items 1, 3, 11, 15, 19, 21, 22, and 27 across sessions.
[d]Relief of withdrawal or negative affect items = average of items 2, 7, 8, 12, 14, 24, 26, and 29 across sessions.
[e]Intention to smoke items = average of items 5, 9, 10, 16, 25, 28, 30, and 32 across sessions.
[f]Factor 1 = average of items 4, 5, 6, 9, 11, 16, 17, 20, 21, 22, 23, 25, 27, 28, and 32 across sessions.
[g]Factor 2 = average of items 2, 3, 7, 12, 13, 14, 18, 19, 24, 29, and 30 across sessions. All p values < .0001 for all AUCs.

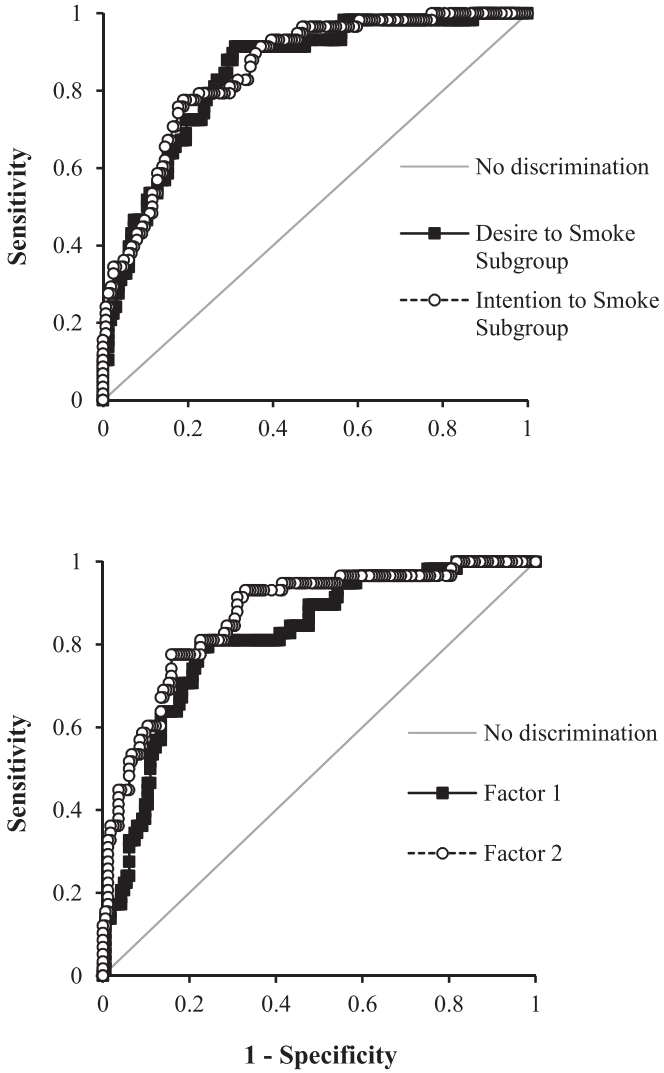

Figure 1. Receiver-operating characteristic curves indicating comparisons of discriminative ability for subgroups and factors. The top and bottom graphs represent the *intention to smoke* subgroup (area under the curve [AUC] = .85) relative to *desire to smoke* subgroup (AUC = .84, p = .56), and Factor 1 (AUC = .82) relative to Factor 2 (AUC = .87, p = .04) in discriminating nicotine dependence, respectively. Diagonal lines indicate chance level of discrimination (AUC = .50).

($r = .73$, $p < .0001$), indicating that dependence discrimination increased as QSU item stability increased. Moreover, the negative correlation between mean craving scores and QSU individual item stability was significant ($r = -.43$, $p = .01$), indicating that QSU item stability decreased with higher mean craving scores (items of less intense craving).

DISCUSSION

The extent to which a person's level of craving discriminated nicotine dependence was clearly influenced by the item content of craving assessment. Though all QSU individual items, the total score, all item subgroups, and the two factors significantly discriminated nicotine dependence, some item subgroups outperformed others in discriminative performance. With regard to the questions specifically addressed by this research, there were no differences in the discriminative ability of the terms *urge* relative to *crave*, or of the *intention to smoke* relative to *desire to smoke* subgroups. There were, however, significant differences in the discriminative ability of craving items across the two factor subscales of the QSU, and of items reflecting more intense craving relative to less intense craving. Additionally, stability was an important factor in the discriminative performance of individual craving items.

Urge and Crave Language

The discriminative performance of craving did not differ depending on use of the term *crave* or *urge*, a finding consistent with factor analyses suggesting that these two terms are used somewhat interchangeably by smokers when they describe their desire to smoke (e.g., Kozlowksi, Pillitteri, Sweeney, Whitfield, & Graham, 1996; Tiffany & Wray, 2012). The absence of a difference across these two items is noteworthy given that the item referencing *crave* represented a significantly more intense form of desire than the item referencing *urge*. Though craving intensity was strongly associated with dependence discrimination, this relationship did not yield a significant difference in the discriminations generated by these two particular items. In general, this finding suggests that researchers and clinicians using craving questionnaires as diagnostic tools can administer items that include the term *crave* or *urge* because they perform similarly in discriminating dependence.

Intention and Desire to Smoke Item Subgroups

There was no significant difference in the discriminative ability of items indicating *intention* to smoke relative to those indicating *desire* to smoke. This is consistent with previous research suggesting that intention and desire items may share the same semantic space (Tiffany & Drobes, 1991; Tiffany, Singleton, Haertzen, & Henningfield, 1993; Tiffany & Wray, 2012), and therefore, would likely not differ in their ability to discriminate dependence. This finding, therefore, suggests that assessing either *intention* or *desire* to smoke is equally useful in discriminating dependence.

Factors 1 and 2

Factor 2 craving items discriminated dependence significantly better than Factor 1 craving items. Factor 2 has been conceptualized as representing the negative reinforcing effects of smoking. The present findings are consistent with theories suggesting that, for nicotine-dependent smokers, smoking may be motivated by attempts to avoid withdrawal symptoms (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). Additional explanations for the higher discriminative ability of Factor 2 include the greater intensity of craving captured by these items, as well as the greater stability of this factor in comparison to Factor 1. In general, this finding suggests that assessing the negative—relative to the positive—reinforcing effects of smoking is most useful for discriminating dependence.

Craving Intensity

Craving items reflecting more intense craving had higher discriminative performance than items reflecting less intense craving. In general, many diagnostic instruments used in epidemiological studies of substance-use disorders assess craving with items reflecting a high intensity of desire (Tiffany & Wray, 2012). *DSM-5* includes craving in the diagnosis of substance-use disorders and describes this feature as "craving or a strong desire or urge to use" (American Psychiatric Association, 2013). Findings from this study bolster the rationale for operationalizing craving as a *strong* desire or urge in order to capture the full diagnostic import of craving.

Item Stability

Item stability was strongly associated with the ability of items to discriminate between dependent and nondependent smokers. Although the importance of item stability may be self-evident, this issue is rarely considered and even less often explicitly evaluated in studies of the predictors of dependence or other clinically relevant outcomes. Lower mean craving scores (conceptualized as reflecting items of higher intensity craving) were associated significantly with higher item stability. Therefore, items reflecting more intense craving might be most useful for dependence discrimination because these items have enhanced stability.

Implications and Future Directions

In this research, stable estimates of craving were generated by examining scores averaged across six sessions of assessment. This approach is not viable for most diagnostic situations, which often require the selection of a single item that can capture stable aspects of craving with only one administration. For example, the item "My desire to smoke seems overpowering" (QSU item 25), which displayed high stability and a strong AUC, might be considered a good candidate for diagnostic purposes. But, this item, if used for conventional diagnosis, would have to be rewritten to measure a more enduring craving experience (e.g., "My desire to smoke *often* seems overpowering"). Whether attempts to capture the enduring aspects of craving experiences in a single item administered once can yield adequate discriminative efficiency requires confirmation in future research.

For practical diagnostic purposes, response to a single craving item will likely be dichotomous (e.g., yes/no, present/absent), which may further compromise the diagnostic efficiency of that item. Dichotomous scales are often less reliable than continuous scales, and any reduction in reliability would degrade the discriminative efficiency of the item (Tiffany & Wray, 2012). Future research should address the diagnostic

utility of single craving items when dichotomous responses are utilized and/or establish optimal cut-offs for continuous measures of craving. Research should also address the diagnostic utility of craving when discriminating nicotine dependence using measures other than the WISDM-68. Using *DSM* criteria as a measure of nicotine dependence may be particularly useful when considering the clinical utility of craving for categorizing nicotine-dependent individuals. Given that many of the smokers in this study were nondaily smokers, a strict application of *DSM* criteria would have proven difficult.

Research may also focus on assessing the diagnostic utility of craving in a sample with a larger proportion of putatively dependent smokers. However, ROC analyses are generally robust even when the target group is a relatively small proportion of the total sample (Inácio et al., 2012). Researchers might also consider examining the diagnostic utility of craving among individuals experiencing a quit attempt, as these individuals may be more sensitive to particular craving item content. In addition, our sample was relatively young compared, for example, to participants in clinical trials, and future research should include a broader age range of smokers. Finally, future research might also focus on longitudinal study designs to determine the emergence of dependence as a function of smoking experience; this would evaluate the hypothesis that strong, stable craving is characteristic of nicotine dependence.

Although craving continues to be a controversial topic in the addictions field, there is accumulating evidence on the clinical utility of craving across multiple domains. In this research, craving indexed through any of the 32 QSU individual items or groups of items significantly discriminated dependent from nondependent smokers. These findings suggest that craving is generally a diagnostically useful feature of nicotine dependence and provide clear support for the decision to include craving in the *DSM-5* diagnosis of substance-use disorders. Although the diagnostic performance of craving was evident across many ways of asking about craving, this research also identified particular aspects of craving assessment that enhanced its diagnostic utility. Most importantly, the data suggest that, when using craving to inform diagnoses of nicotine dependence, clinicians should assess the presence of strong craving that reliably occurs across multiple occasions. Additionally, clinicians and researchers would benefit from asking about craving that reflects the negative reinforcing effects of smoking when identifying nicotine dependence.

SUPPLEMENTARY MATERIAL

Supplementary Table 1 can be found online at http://www.ntr.oxfordjournals.org

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DECLARATION OF INTERESTS

None declared.

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