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Why Do University Students Smoke Tobacco?

French Validity of Brief Wisconsin Inventory of Smoking Dependence Motives among (non-) Daily Smokers and Associations with Psychological Variables

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Abstract

This study investigates the validity of the Brief Wisconsin Inventory of Smoking Dependence Motives (B-WISDM) among French daily and non-daily university student smokers. Measurement models, measurement invariances, and concurrent and convergent validity with psychosocial and psychopathological variables were tested. Results (1) confirmed the B-WISDM dimensionality in 11 first-order intercorrelated factors; (2) showed its measurement invariance for the types of smokers; (3) showed that tobacco dependence is only and positively predicted by primary dependence motives, which confirm that they are core components of tobacco dependence; and (4) highlighted specific associations between smoking motives and psychological variables, such as smoking identity and perceived behavioral control with some primary dependence motives, social goals with social norms, and weight control with eating disorders. Thus, external validity of the B-WISDM is extended to non-daily smokers. Specific associations of B-WISDM with smoking-related psychological potentially make it a very useful diagnostic tool to support smokers toward quitting.

Keywords: Brief Wisconsin Inventory of Smoking Dependence Motives, University student, Smoking motives, (Non-)Daily smokers, Psychological variables

Introduction

Given the consequences it has on health, tobacco use is considered a global health problem (World Health Organization, 2018). Tobacco dependence, generally defined as the experience of a strong need to smoke (West, 2017), can lead to neuropsychological impairments even among young people (Chamberlain et al., 2012). Therefore, young people, especially university students, constitute a particularly interesting population group for researchers because, they are at risk of developing tobacco dependence in decades to come (Kenford et al., 2005; Schulenberg et al., 2019). In France, 28% of students are smokers (Pasquereau et al., 2017), and among a sample of French student smokers, 15% are already heavily tobacco dependent (Mauduy et al., 2022). Knowing that a basic step for helping people quit smoking consists of identifying their underlying motivations for tobacco dependence, this study focuses on university students' smoking motives.

Drawing on a large body of work suggesting that dependence is a multidimensional and motivational phenomenon (e.g., Colby et al., 2000; Moolchan et al., 2002; Radzius et al., 2001), Piper et al. (2004) assumed that tobacco dependence could be measured based on the different motivations underlying tobacco use. As a result, the Wisconsin Inventory of Smoking Dependence Motives (WISDM, 68-item, Piper et al., 2004), and later on, its 37-item brief version (the B-WISDM, Smith et al., 2010) were developed. Numerous studies have been conducted on heavy and daily tobacco users to test the psychometric qualities of the WISDM (e.g., Piasecki et al., 2010a, 2010b, 2011; Piper et al., 2008; Shenassa et al., 2009) and the B-WISDM (e.g., Ma et al., 2012; Smith et al., 2010; Tombor et al., 2010). Researchers prefer this shorter version for practical purposes, but also because it shows good psychometric qualities. First, its dimensionality on 11 motivational factors was confirmed, namely, loss of control, automaticity, craving, tolerance, affiliative attachment, cognitive enhancement, cue exposure/associative processes, social/environmental goals, affective enhancement, taste, and weight control (Pancani et al., 2015). In their study, Pancani et al. (2015) compared a model with these 11 first-order factors with error covariances to a model with 11 first-order and 2 second-order factors with error covariances. The rationale for testing these two second-order factors lies in the early work of Piper et al. (2008) which highlights two subscales of the WISDM, namely primary dependence motives and

secondary dependence motives. Primary dependence motives represent the core features of advanced tobacco dependence and consist of four scales (loss of control, automaticity, craving, and tolerance). Secondary dependence motives represent instrumental motives for tobacco use and are composed of the seven remaining scales. Pancani et al.'s (2015) results support the 11-factor first-order model. Furthermore, these 11 motivational factors have satisfactory internal consistencies (e.g., Pancani et al., 2015; Smith et al., 2010) and are conceptually similar for men and women (gender measurement invariance, Vajer et al., 2011). Finally, the B-WISDM has good predictive validity with measures of tobacco dependence, such as the Cigarette Dependence Scale (CDS; Pancani et al., 2015), the Tobacco Dependence Screener (Vajer et al., 2011), the Fagerström Test for Nicotine Dependence (Tombor et al., 2010), and biochemical measures (Smith et al., 2010). In sum, B-WISDM is an essential tool with good psychometric properties for understanding the different motivations underlying tobacco dependence. Nevertheless, two elements limit the identification of these motivations among university students with the B-WISDM.

First, although the psychometric properties of B-WISDM have always been tested on heavy or daily smokers (e.g., Pancani et al., 2015; Vajer et al., 2011), it has never been tested on university students. This limits the B-WISDM external validity to this specific population (Vajer et al., 2011). Indeed, student smokers differ from the general population in two respects. Firstly, the majority of them are not daily smokers, but occasional smokers and are thus considered “light” smokers (Levinson et al., 2007; Moran et al., 2004; Thompson et al., 2007). Second, student smokers also seem to be distinguished according to the reasons that lead them to smoke (Mauduy et al., 2022). For example, we can distinguish between smokers who smoke for coping, for social reasons (e.g., conforming to the social norm, partying), and for pro-smoking attitudes (e.g., Mauduy et al., 2022; Moran et al., 2004; Shiffman et al., 2009; Sutfin et al., 2012). This indicates a diversity of reasons, motivations for smoking among students, a diversity that the B-WISDM scale would make it possible to study if it were validated among daily and non-daily university student smokers. However, while the original version of the WISDM was used with college student smokers (e.g., Piasecki et al., 2011), and the B-WISDM has already been used to study the characteristics of non-daily smokers (e.g., Scheuermann, Mburu, et al., 2015; Scheuermann,

Nollen, et al., 2015) or tested in a nonclinical sample (Adkison et al., 2016), only the primary dependence motives and secondary dependence motives scores were used, and neither the dimensionality nor the measurement invariance of B-WISDM according to the type of smoker (daily vs. non-daily) were pre-tested. Testing the psychometric qualities of B-WISDM with occasional and daily university students' smokers is thus necessary to justify its relevance to this particular smoker population.

Second, although B-WISDM has good psychometric properties in terms of dimensionality, internal consistency, and predictive validity with tobacco dependence, researchers have shown little interest in its convergent validity. Several psychological variables associated with tobacco dependence have been identified among university students: attitude towards smoking (i.e., students' evaluation of smoking, e.g., Mao et al., 2009), perceived smoking social norms (i.e., students' perceptions about how significant others approve of smoking, e.g., Riou França et al., 2009), perceived behavioral control to resist smoking (i.e., students' perception of their ability not to smoke, e.g., Jalilian et al., 2016), smoker identity (i.e., the extent to which students view themselves as smokers, e.g., Levinson et al., 2007; Moran et al., 2004), eating disorders (Eisenberg et al., 2011), anxiety (e.g., Bierhoff et al., 2019), and depression (e.g., Schleicher et al., 2009). Hence, on the one hand, the B-WISDM highlights several motivations for tobacco dependence, and, on the other hand, several psychological variables predict tobacco dependence, but little is known about the associations between these smoking dependence motives and psychological variables. We believe these smoking motives to be associated with specific psychological variables, making these latter the psychological matter of the motivations for tobacco dependence. First, we expect both smoking identity and perceived behavioral control to be two core psychological components of the primary dependence motives (e.g., Falomir-Pichastor et al., 2020; Lee et al., 2014; Mauduy et al., 2022). Second, we expect the other psychological variables to be more related to instrumental motivations to smoke, namely secondary dependence motives. Specifically, attitudes would be primarily associated with taste motives, social norms with social goals motives, eating disorders with weight control motives, and anxiety and depression with coping motives, that is affective and cognitive enhancements, and affiliative attachment. Thus, investigating the associations between the smoking motives and the psychological variables would be of great interest because it would allow

us to (1) provide additional evidence of the good psychometric properties of the B-WISDM, (2) better understand the processes underlying tobacco dependence among university students, and (3) better assist university students to quit smoking by focusing prevention efforts on the psychological processes underlying their motivations for smoking.

Thus, the present study aims to test the validity of the B-WISDM among a French university student population. For this purpose, we test the B-WISDM dimensionality in 11 first-order motivational factors, its measurement invariance for types of smokers, namely daily and non-daily smokers, as well as its concurrent validity with tobacco dependence and convergent validity with several psychosocial variables already identified in the literature as being associated with tobacco dependence.

Methods

Procedure and Participants

This study was carried out on a convenience sample of 687 student smokers from the University of Caen Normandy. The participants were recruited by mail at their institutional address and were asked if they wished to participate in an online survey on tobacco smoking (via the Limesurvey® application, November 2021). No compensation was provided to the participants.

Ethics

All participants were volunteers and gave their consent before starting the survey. The study was notified to and authorized by the “Commission Nationale de l’Informatique et des Libertés” with the registration number [u24- 20171109-01R1]. Besides, the participants’ anonymity was guaranteed by the University Information System Direction (DSI). This survey was conducted in full agreement with the Declaration of Helsinki (World Medical Association, 2008) and the ethical standards set by the Psychology Department, which follows the American Psychological Association Ethical Principles of Psychologists and the Code of Conduct (American Psychological Association, 2017) for the ethical treatment of human participants.

Measures

Details of all measures and items described below are available on the supplemental online material at https://osf.io/2zh6c/?view_only=76269d9b547642d6849a291e3ee24212.

Demographics and Smoking History

We measured gender, age, academic level, age of smoking onset, smoking parents, cigarette consumption per day, recent attempts to quit smoking (Perski et al., 2018), and motivation to quit smoking (MTSS, Kotz et al., 2013).

French Brief Wisconsin Inventory of Smoking Dependence Motives

The B-WISDM, developed by Smith et al. (2010), was translated into French and then back-translated into English by a professional translation service for verification purposes. The B-WISDM is a questionnaire composed of 37 items rated on a 7-point scale ranging from 1 = *Not true for me at all* to 7 = *Extremely true for me*. It comprised 11 subscales that represent different smoking dependence motivations (Smith et al., 2010; Pancani et al., 2015): loss of control, automaticity, craving, tolerance, affiliative attachment, cognitive enhancement, cue exposure/associative processes, social/environmental goals, affective enhancement, taste, and weight control (see the *supplemental material* for the items translated).

Concurrent Validity Measures

Tobacco dependence was measured using the validated French-language Cigarette Dependence Scale (CDS-5; Etter, 2005). This 5-item (i.e., Item 1 – “*Please rate your addiction to cigarettes on a scale of 0–100: I am NOT addicted to cigarettes at all = 0; I am extremely addicted to cigarettes = 100*”; Item 2 – “*On average, how many cigarettes do you smoke per day?*”; Item 3 – “*Usually, how soon after waking up do you smoke your first cigarette?*”; Item 4 – “*For you, quitting smoking for good would be*”; Item 5 – “*After a few hours without smoking, I feel an irresistible urge to smoke*”) self-report questionnaire provides a continuous score (between 5 and 25) for cigarette addiction. The CDS has shown high internal consistency, good predictive validity, as well as high test-retest reliability (e.g., Etter, 2005, 2008; Etter et al., 2003), thus overcoming the psychometric limitations of the Fagerström Test for Nicotine Dependence.

Convergent Validity Measures

Attitudes, perceived social norms, and perceived behavioral control to resist smoking were assessed based on the Theory of Planned Behavior (TPB, Ajzen, 1991; Jalilian et al., 2016; Mauduy et al., 2022). The assessment included *attitude* towards smoking (4-item, Cronbach $\alpha = .92$), perceived social norms for smoking (3-item, Cronbach $\alpha = .81$), and perceived behavioral control to resist smoking (3-item, Cronbach $\alpha = .75$) rated on Likert-type scale scored from 1 = *do not agree* to 5 = *strongly agree*. This scale measuring three factors of the TPB has acceptable fits in French (Mauduy et al., 2022).

Smoker identity was assessed using the Smoker Self-Concept Scale (SSCS; 5-item Likert-type scale scored from 1 = *do not agree* to 5 = *strongly agree*; Cronbach $\alpha = .85$, Shadel & Mermelstein, 1996). The SSCS assesses the importance of being a smoker for one's self-concept and has shown great predictive and discriminant validities, good internal consistency (Shadel & Mermelstein, 1996), and excellent fits in French (Mauduy et al., 2022).

Eating disorders were assessed with the French version of the SCOFF questionnaire (Parker et al., 2010). It consists of responding to five questions related to food in a yes/no format. Scores can range from 0 to 5 (i.e., answer yes to all 5 questions), with a score of 2 or higher indicating a likely case of an eating disorder.

Anxiety was measured with the French version of the State-Trait Anxiety Inventory (STAI, Spielberger et al., 1983) which is composed of 20 items (Cronbach $\alpha = .91$) on a 4-point scale ranging from no (1) to yes (4). It has shown good validity and acceptable reliability (Barnes et al., 2002).

Depression was measured with the short French version of the Beck Depression Inventory (BDI, Beck et al., 1988). It consists of 13 items, each composed of four statements reflecting various severity degrees of depression-related symptoms. The BDI has shown high internal consistency, good predictive validity, and high test-retest reliability (Beck et al., 1988; Beck & Steer, 1984).

Statistical Analyses

First, the dimensionality and reliability of the B-WISDM have been tested. Three models derived from the literature were tested using a robust confirmatory factor analysis (CFA). Model 1 contained two first-order correlated factors, namely the primary dependence motives and secondary

dependence motives. Model 2 contained 11 first-order correlated factors. Model 3 included 11 first-order correlated factors (as model 2) and 2 second-order factors, namely primary dependence motives and secondary dependence motives. Robust CFAs were used to manage the multivariate non-normality of the data (i.e., Kurtosis test > 20 , Mardia, 1974). As standard maximum likelihood estimation assumes multivariate normality, we used the maximum likelihood estimation with robust (Huber-White) standard errors. Five fit indices were used to evaluate each model. The Satorra-Bentler Chi-square (χ^2) test indicates the fit goodness of the model when the value is statistically significant. The robust comparative fit index (CFI) and robust Tucker-Lewis index must be greater than 0.95 to demonstrate a good model fit, but values above 0.90 are still considered acceptable ((Boateng et al., 2018; Brown, 2006). The robust root mean squared error of approximation (RMSEA) indicates a good model fit when its values are lower than 0.05 and an adequate fit when they are lower than 0.08. The standardized root mean square residual (SRMR) had to be lower than 0.08 (Boateng et al., 2018). To identify whether one more restricted model has a better fit than another, three criteria have to be met. First, we compared the models using the specialized computation for the Satorra-Bentler χ^2 difference (Satorra & Bentler, 2001). The value of the χ^2 difference must be significant (i.e., $p < .05$). However, since the χ^2 test may be sensitive to the sample size, we also used CFI and RMSEA values. The CFI must show an increase higher than .01 ($CFI_{diff} > .01$, Cheung & Rensvold, 2002), and the RMSEA must show a decrease of over 0.015 ($RMSEA_{diff} < .015$). The internal consistencies for the optimal model identified were then calculated using Cronbach's alpha. Values above 0.90 are considered excellent, and values above 0.70 are considered satisfactory (Boateng et al., 2018; Nunnally & Bernstein, 1994).

Second, to test the measurement invariance of types of smokers (daily and non-daily), we conducted a series of multigroup CFAs on the previously identified model. Three nested models with increasing constraints were estimated. First, the configural invariance, which corresponds to a model without constraints, tests whether the dimensionality of the FB-WISDM and the item composition of the factors are identical between groups. A configural invariance between groups indicates that the groups (non-daily or daily smokers) have a similar representation of the underlying construct. Second, the metric invariance, which constrained the factor loadings to be identical in all groups, tests whether

the contribution of each item to a factor (as measured by the factor loadings or standardized regression coefficient) is identical in all groups. Metric invariance indicates that the understanding of the content of each item is not influenced by the type of smokers. Third, scalar invariance, which constrained both factor loadings and intercepts to be identical in all groups, tests whether the intercept for each item is not influenced by the groups. Scalar invariance indicates that the differences between groups on the means of measure variables (i.e., items) are due to group differences on the mean of the common latent variable (i.e., factor). Thus, scalar invariance is required to compare groups in terms of latent means. To test measurement invariance, we compared configural to metric invariance, and then, if metric invariance is retained, we compared metric to scalar invariance. To show measurement invariance, at least one of the three following criteria had to be met. First, the specialized computation for the Satorra-Bentler χ^2 difference between the two models has to be not significant, second, the CFI_{diff} between the two models should be less than or equal to .01, and third, the $RMSEA_{diff}$ between the two models should be less than or equal to .015. It should be noted that, since the Satorra-Bentler χ^2 difference test may be sensitive to the sample size, more attention has been given to the CFI_{diff} and $RMSEA_{diff}$ indicators to evaluate the measurement invariance. Furthermore, we also tested the measurement invariance for gender (men and women) to verify that the gender invariance previously shown among adult daily smokers (Vajer et al., 2011) is replicated among university students.

Third, the concurrent and convergent validity were tested using a multivariate regression model that includes all the FB-WISDM dimensions of the identified model as predictors, and tobacco dependence, attitudes, social norms, perceived behavioral control to resist smoking, smoker identity, eating disorders, anxiety, and depression as outcome variables. Estimation of the standardized coefficients of the multivariate model enables us to conclude which FB-WISDM dimensions are significantly or non-significantly associated with which outcomes. The Bootstrap method ($N = 1000$) was used to assess the stability of the results.

All statistical analyses were conducted using the R software (version 4.05; R Core Team). The package *mvn* (Korkmaz et al., 2014) was used to assess the multivariate nonnormality, the package

lavaan (Rosseel, 2012) to test the dimensionality, the measurement invariance, the reliability and concurrent and convergent validities of the FB-WISDM.

Results

Characteristics of the Sample

Table 1 presents the characteristics of the sample. Students were considered current smokers when they indicated that they had already smoked 100 cigarettes in their lifetime and had smoked at least one time in the past 30 days (Adkison et al., 2016; Riou França et al., 2009). Among the 687 smokers ($M_{age} = 20.06$, $SD = 2.39$), 63.5% were female (2.2% did not choose an answer). On average, they started smoking at age 16.1 years ($SD = 2.03$) and currently smoke 6.34 cigarettes per day ($SD = 16.3$). A majority of participants are non-daily smokers (63.5%). Finally, almost half of the participants reported having made one attempt to quit during the past year (41.4%) and are motivated to quit smoking (42.6%).

Tests of FB-WISDM Dimensionality

Among the 687 participants, 29 had at least one missing data on the FB-WISDM. To address the problem of missing data, we used the full-information maximum likelihood estimation (T. Lee & Shi, 2021).

Robust Confirmatory Factor Analyses

The fit indices of the three tested models are depicted in Table 2. Robust CFAs of Model 1 indicated an inadequate fit with the data, while Model 2 and Model 3 displayed acceptable fit indices. The specialized computation for the Satorra–Bentler χ^2 difference, as well as fit indices, indicated that Model 2 fitted significantly better the data than Model 1 ($\chi^2_{diff} = 1721.60$, $df_{diff} = 11$, $p < .001$; $CFI_{diff} = 0.271$; $RMSEA_{diff} = -0.061$), indicating that a two-dimension scale, namely, the composite of four subscales related to the primary dependence motives and the composite of nine subscales related to the secondary dependence motives, is not adequate to account for the data. Model 2 showed a significantly better fit than Model 3 on Satorra–Bentler χ^2 difference ($\chi^2_{diff} = 277.91$, $df_{diff} = 43$, $p < .001$) but not on

CFI and RMSEA indices ($CFI_{diff} = 0.015$; $RMSEA_{diff} = 0.004$). These results suggest that the 11 first-order dimensions of the FB-WISDM (Model 2) represent the optimal solution, although we cannot reject Model 3. We further compared models 2 and 3 by examining the factor loadings and correlations between factors. No differences were found between the two models for the first-order factors: they displayed standardized factor loadings that are all above 0.60 as well as positive and significant correlations between all factors. However, two elements weaken the relevance of Model 3. First, the loadings of the second-order factors are different, with primary dependence motives values ranging from 0.77 to 0.98 and secondary dependence motives ranging from 0.27 to 0.86. The dimensionality of the secondary dependence motives is challenged by the three following sub-scales: social/environmental goals, taste, and weight control. Second, discriminant validity is also challenged by the high correlations between the primary dependence motives and secondary dependence motives factors ($r = 0.86$). Thus, we consider Model 2 as the optimal solution to fit the data. The results of the robust CFA for Model 2 are displayed in Table 3.

Cronbach's Alpha

All Cronbach's alpha values of the 11 first-order factors were higher than 0.70 (see Table 3), indicating an excellent internal consistency of the FB-WISDM.

Tests of Measurement Invariances through Multiple Group Robust CFA

Multiple group CFAs were used to test the measurement invariance (configural, metric, scalar) of the FB-WISDM for types of smokers (daily and non-daily smokers) and gender (men and women).

Measurement Invariance for Types of Smokers

For all three invariance levels of types of smokers, the models have good fit indices (see Table 4). The Satorra–Bentler χ^2 difference between the first model (configural invariance) and the second one (metric invariance) is significant ($\chi^2_{diff} = 137.80$, $df_{diff} = 37$, $p < .001$) but CFI and RMSEA values do not differ ($CFI_{diff} = .005$; $RMSEA_{diff} = .001$). Then, the Satorra–Bentler χ^2 difference between the second and the third model (scalar invariance) is significant ($\chi^2_{diff} = 92.62$, $df_{diff} = 26$, $p < .001$), but there was no significant change in fit indices ($CFI_{diff} = .005$; $RMSEA_{diff} = .001$). Thus, scalar invariance is not rejected, which means that the factor loadings and intercepts of the 11 first-order factors are invariant

between types of smokers. Concretely, daily and non-daily smokers have a similar understanding of the different smoking motivations measured by the FB-WISDM.

Measurement Invariance for Gender

For all three gender invariance levels, the models have good fit indices (see Table 4). The Satorra–Bentler χ^2 difference between the first model (configural invariance) and the second one (metric invariance) is significant ($\chi^2_{\text{diff}} = 55.11$, $df_{\text{diff}} = 37$, $p = .028$) but the CFI and RMSEA values do not differ. Then, fit indices did not change between the second and the third model (scalar invariance, $\chi^2_{\text{diff}} = 29.96$, $df_{\text{diff}} = 26$, $p = .27$; $CFI_{\text{diff}} = 0.0$; $RMSEA_{\text{diff}} = 0.001$). Thus, scalar invariance is not rejected, which means that the factor loadings and intercepts of the 11 first-order factors are gender invariant. Men and women have a similar understanding of the different motivations for smoking.

Tests of FB-WISDM Concurrent and Convergent Validity

The results, displayed in Table 5, support both concurrent and convergent validity of the FB-WISDM. First, tobacco dependence is mainly and positively predicted by primary dependence motives, namely, lack of control, craving, and tolerance, and is also predicted by associative processes. Second, attitudes are mainly and positively associated with taste and affective enhancement, and, to a lesser extent, negatively associated with lack of control. Social norms are only positively associated with social goals. Perceived behavioral control is mainly and negatively associated with craving and associative processes. Smoker identity is mainly associated with lack of control and affiliative attachment, and, to a lesser extent, associative processes and tolerance. Eating disorders are only associated with weight control. Anxiety is mainly associated with affective enhancement, and, to a lesser extent, with affiliative attachment and weight control, and is negatively associated with tolerance. Finally, depression is mainly associated with affective enhancement, weight control and affiliative attachment, and, to a lesser extent, negatively associated with taste.

Discussion

This study aimed to test the psychometric qualities of B-WISDM on a sample of daily and non-daily university student smokers. The questionnaire had already been validated but only on heavy or daily adult smokers. Overall, the results highlight the good psychometric qualities of the FB-WISDM

among university students. In line with previous studies, our results confirm the dimensionality in 11 first-order motivational factors, their satisfactory internal consistencies (Ma et al., 2012; Pancani et al., 2015; Smith et al., 2010; Vajer et al., 2011), and gender invariance (Vajer et al., 2011). On the other hand, and beyond having carried out the first study to test the validity of the B-WISDM on university students, we have also contributed to the literature by highlighting two new findings that we will discuss.

First, this study highlights the applicability of the B-WISDM to a non-daily, occasional smoking population. Tested only among heavy or daily smokers (e.g., Pancani et al., 2015; Smith et al., 2010; Vajer et al., 2011), the validity of the B-WISDM among occasional smokers was lacking. Based on measurement invariance by types of smokers, this study is the first one to show that motivations underlying tobacco dependence are conceptually identical for daily and non-daily university student smokers. This result, beyond extending the applicability of the B-WISDM to different types of smokers, is of great interest because it would allow us to investigate motivational changes explaining the development of daily smoking in occasional smokers (Kenford et al., 2005; Schulenberg et al., 2019), using the B-WISDM. Measurement invariance by type of smokers is a necessary condition for using the B-WISDM to compare daily and non-daily student smokers according to their motivations to smoke. Since it is thus possible to study and compare the smoking motivations of daily and non-daily student smokers using the B-WISDM, it would be possible in future longitudinal research to use it to track the trajectories of student smokers and student smoking motivations. Existing data on the trajectories of cigarette smoking suggest that 25-50% of non-daily youth smokers quit smoking, 35-50% maintain non-daily smoking, and 10-25% switch to daily smoking (Dutra et al., 2017; Kenford et al., 2005; Kvaavik et al., 2014; Robertson et al., 2016; Wetter et al., 2004; White et al., 2009). Thus, by using the B-WISDM in future longitudinal studies, it would be possible to identify whether certain motivations to smoke are likely to cause a student who initially smokes non-daily to switch to daily smoking. In the same way, it would be possible to identify smoking motivations that are less likely to cause students who are non-daily smokers to develop smoking habits in the future.

Second, this study highlights the convergent validity of the B-WISDM with psychological variables, well-known to be associated with tobacco use and dependence. This result is particularly interesting for prevention purposes, as it potentially makes the B-WISDM a very useful diagnostic tool

to identify the underlying psychological reasons for an individual's smoking, in the first stage of prevention. Then, in the second stage, the B-WISDM would be able to guide prevention actions targeting the psychological variables that are specifically associated with people's reasons for smoking through the use of adapted strategies. In our results, two categories of psychological variables seem to emerge, depending on whether they are more associated with primary dependence motives or with secondary dependence motives. On the one hand, smoker identity and perceived behavioral control to resist smoking are mainly associated with motivations related to lack of control, tolerance, and craving, thus accounting for three out of four primary dependence motives. These findings are not surprising considering that perceived behavioral control (Lee et al., 2014; Mauduy et al., 2022) and smoker identity (Falomir-Pichastor et al., 2020; Mauduy et al., 2022) are key determinants of tobacco dependence and cessation success. As primary dependence motives are the core components of tobacco dependence (Piper et al., 2008), it seems essential for any tobacco dependence prevention program to target these two psychological variables. The development of new prevention strategies, such as the social modeling technique (Burn, 1991; see Webb & Sheeran, 2006 for a meta-analysis) for increasing people's confidence to resist smoking, or the multi-categorization technique (Kang & Bodenhausen, 2015) for encouraging people who smoke to define themselves not only as smokers but also as members of other social groups and then reduce the potential role of the problematic identity in driving behaviors, could be considered for this purpose. On the other hand, attitudes towards smoking, perceived smoking social norms, eating disorders, anxiety, and depression are uniquely associated with specific secondary dependence motives. Thus, our results would suggest targeting positive smoking attitudes among student smokers because of taste and affective enhancement, with for instance the framing technique (Gallagher & Updegraff, 2012), the perceived smoking social norms because of social goals, with the personalized normative feedback technique (Vallentin-Holbech et al., 2018), eating disorders because of weigh control, with dissonance-based prevention programs (see Stice et al., 2019 for a meta-analytic review), and anxiety and depression because of affiliative attachment and affective enhancement, with mindfulness-based interventions (Hofmann & Gómez, 2017).

This study, however, has limitations that we must highlight. First, a biochemical measure of tobacco dependence (Bize et al., 2009) or a combination of measures (Hughes et al., 2004) would have

allowed us to ensure that the participants were smokers. Second, we have not collected information on the use of other nicotine products. People who use nicotine products other than cigarettes likely have higher levels of primary dependence motives (e.g., loss of control, craving) than those who do not use other nicotine products. This could have influenced our results if differences in the use or non-use of other nicotine products were observed between daily and non-daily smokers. Third, given that our study was conducted with French students and that it is a correlational study, further research could attempt to replicate our results. For this reason, caution must be taken about the prevention recommendations we have made. The sample does not allow us for generalizability across age groups and non-student populations.

In conclusion, after having been validated on heavy smokers or daily smokers in English, Italian, and Hungarian participants, this study shows that the B-WISDM has also good psychometric qualities among French daily and non-daily university student smokers. Examining its convergent validity with different psychological variables (attitude, social norms, perceived behavioral control, smoker identity, and eating disorders) has provided a better understanding of the underlying motivations for tobacco dependence and a guide for smoking reduction efforts among university students. Future research must now extend the external validity of the B-WISDM to other populations of non-daily smokers, and investigate the involvement of other psychological variables in understanding motivations underlying tobacco dependence.

Declaration of Interest Statement

The authors report no conflict of interest.

Data Availability Statement

Data from this study will be provided by the first author upon request.

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Tables**Table 1***Sample Characteristics*

	Overall sample (<i>N</i> = 669)		Non-daily smokers' sample (<i>n</i> = 436; 63.5%)	Daily smokers' sample (<i>n</i> = 251; 36.5%)
	<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)
Socio demographics				
Females, <i>N</i> (%)	434 (63.17%)		272 (63.55%)	162 (62.55%)
Males, <i>N</i> (%)	235 (34.21%)		146 (34.11%)	89 (34.36%)
No answer sex, <i>N</i> (%)	18 (2.62%)		10 (2.33%)	8 (3.09%)
Age, years	20.06 (2.39)	18 - 35	20.00 (2.25)	20.19 (2.65)
Smoking-related variables				
First use, year	16.12 (2.03)	10 - 31	16.39 (2.09)	15.61 (1.81)
Cigarettes per day	6.34 (16.3)	0 - 60	4.25 (4.94)	9.70 (25.47)
Days of use per month	20.52 (10.38)	1 - 30	15.05 (9.46)	30.00 (0)
CDS –Tobacco dependence	11.72 (4.50)	1 - 24	9.62 (3.52)	15.15 (3.78)
MTSS – Motivation to quit smoking	2.85 (1.69)	1 - 7	2.92 (1.80)	2.81 (1.53)
Recent attempts to quit smoking, <i>N</i> (%)	214 (41.39%)		135 (44.41%)	74 (36.81%)
Psychological variables				
Attitude related to smoking	3.70 (1.08)	1 - 7	3.55 (1.03)	3.89 (1.12)
Social norms related to smoking	3.86 (1.17)	1 - 7	3.72 (1.11)	4.11 (1.23)
Perceived behavioral control to resist smoking	3.51 (1.60)	1 - 7	3.96 (1.60)	2.83 (1.36)
Smoker identity	2.69 (1.64)	1 - 7	2.11 (1.32)	3.58 (1.69)
SCOFF – Eating disorders	1.02 (1.18)	1 - 5	0.94 (1.13)	1.15 (1.23)
STAI-T – Anxiety	50.90 (14.35)	20 - 80	50.37 (13.63)	51.21 (15.18)
BDI – Depression	9.40 (8.35)	0 - 36	8.81 (7.21)	9.78 (9.41)

Note. Except for gender, recent attempts to quit, and smokers' status, data show means (standard deviations); CDS: Cigarette Dependence Scale; MTSS: Motivation to stop smoking; SCOFF: Sick Control One Fat Food; STAI-T: State-Trait Anxiety Inventory; BDI: Beck Depression Inventory

Table 2*The Fit Indices for the Three Confirmatory Factor Analysis Models of FB-WISDM*

	Model description	Satorra-Bentler χ^2	df	CFI	TLI	RMSEA	90% Confidence Interval		SRMR
							Lower	Upper	
Model 1	2 first-order factors with error covariances	7291.134	628	0.655	0.634	0.126	0.123	0.129	0.089
Model 2	11 first-order factors with error covariances	2087.628	563	0.926	0.913	0.061	0.058	0.065	0.043
Model 3	11 first-order and 2 second-order factors with error covariances	2442.526	617	0.911	0.903	0.065	0.061	0.068	0.057

Note. CFI = comparative fit index; RMSEA = root mean squared error of approximation; SRMR = standardized root mean square residual; TLI = Tucker-Lewis index.

Table 3*Factor Loadings and Internal Consistencies of the French B-WISDM*

Factor	Estimate	SE	Standard Estimate	Z	p	α
Affiliative Attachment						
Item 11	1.821	0.268	0.821	6.794	< .001	.86
Item 22	1.336	0.191	0.830	6.982	< .001	
Item 26	1.498	0.221	0.844	6.766	< .001	
Automaticity						
Item 1	1.628	0.109	0.776	14.975	< .001	.89
Item 10	1.612	0.103	0.774	15.648	< .001	
Item 14	1.732	0.118	0.900	14.698	< .001	
Item 25	1.519	0.118	0.827	12.845	< .001	
Loss of Control						
Item 2	1.513	0.285	0.872	5.318	< .001	.91
Item 16	1.338	0.258	0.783	5.185	< .001	
Item 21	1.883	0.346	0.911	5.439	< .001	
Item 35	1.547	0.290	0.835	5.342	< .001	
Cognitive Enhancement						
Item 6	1.786	0.066	0.896	27.128	< .001	.92
Item 13	1.818	0.069	0.917	26.205	< .001	
Item 32	1.566	0.067	0.855	23.237	< .001	
Craving						
Item 4	1.678	0.242	0.855	6.928	< .001	.91
Item 17	1.665	0.243	0.851	6.862	< .001	
Item 23	1.723	0.253	0.840	6.823	< .001	
Item 29	1.490	0.217	0.841	6.855	< .001	
Cue Exposure / Associative Processes						
Item 8	1.555	0.173	0.612	8.973	< .001	.73
Item 12	2.022	0.155	0.692	13.022	< .001	
Item 24	2.079	0.167	0.793	12.435	< .001	
Taste						
Item 5	1.505	0.116	0.790	12.956	< .001	.84
Item 15	1.706	0.136	0.857	12.575	< .001	
Item 20	1.519	0.110	0.747	13.771	< .001	
Tolerance						
Item 3	1.433	0.141	0.718	10.176	< .001	.87
Item 28	1.732	0.146	0.863	11.821	< .001	
Item 31	1.555	0.158	0.676	9.841	< .001	
Item 36	1.803	0.148	0.894	12.182	< .001	
Weight Control						
Item 7	1.665	0.095	0.867	17.566	< .001	.88
Item 19	1.073	0.092	0.752	11.615	< .001	
Item 34	1.755	0.100	0.912	17.534	< .001	

Affective Enhancement						
Item 9	1.595	0.251	0.774	6.345	< .001	.82
Item 33	1.690	0.273	0.753	6.199	< .001	
Item 37	1.656	0.263	0.795	6.301	< .001	
Social / Environmental Goals						
Item 18	1.622	0.091	0.866	17.829	< .001	.92
Item 27	1.560	0.092	0.848	17.001	< .001	
Item 30	1.812	0.083	0.965	21.788	< .001	

Note. $N = 687$. The table shows the results of the CFA and internal consistency for Model 2.

SMOKING MOTIVES AMONG UNIVERSITY STUDENTS

Table 4

The Fit Indices for the Three Multigroups Confirmatory Factor Analysis Models of FB-WISDM for Type of Smokers and Gender

Model description		Satorra-Bentler χ^2	<i>df</i>	CFI	TLI	RMSEA	90% Confidence Interval		SRMR
						Lower Upper			
Type of smokers (daily vs. non-daily)									
Model 1	Configural Invariance	2644.08	1126	0.919	0.905	0.059	0.056	0.063	0.052
Model 2	Metric Invariance	2766.83	1163	0.914	0.901	0.060	0.057	0.064	0.063
Model 3	Scalar Invariance	2875.13	1189	0.914	0.901	0.060	0.057	0.064	0.063
Gender (men vs. women)									
Model 1	Configural Invariance	2916.475	1126	0.917	0.902	0.065	0.062	0.069	0.049
Model 2	Metric Invariance	2972.161	1163	0.916	0.904	0.065	0.061	0.068	0.054
Model 3	Scalar Invariance	3002.432	1189	0.916	0.906	0.064	0.061	0.067	0.054

Note. CFI = comparative fit index; RMSEA = root mean squared error of approximation; SRMR = standardized root mean square residual; TLI = Tucker–Lewis index.

SMOKING MOTIVES AMONG UNIVERSITY STUDENTS

Table 5

Standardized Coefficients from a Multivariate Linear Regression Model Describing the Association between the French B-WISDM and Tobacco Dependence and Psychological Variables

	Tobacco dependence	Attitudes	Social norms	PBC	Smoker identity	Eating disorders	Anxiety	Depression
Adjusted R^2	.761	.319	.317	.520	.447	.211	.247	.282
Loss of Control	.252***	-.199*	.046	-.050	.252***	-.081	-.108	-.113
Craving	.342***	.023	-.004	-.319***	-.013	-.005	.215	.169
Automaticity	.044	-.002	.025	-.048	-.010	.056	-.002	.006
Tolerance	.376***	.045	-.047	.015	.156*	-.030	-.212*	-.123
Affiliative Attachment	-.058*	.047	.025	-.008	.192***	.071	.182*	.234**
Associative Processes	.017	-.003	-.051	-.387***	.123*	.038	.043	-.044
Social Goals	-.004	.001	.538***	.046	-.009	-.019	.028	.057
Taste	.024	.481***	.053	.009	.082	-.049	-.119	-.143*
Weight Control	.035	-.015	.064	.025	-.024	.332***	.129*	.226***
Affective Enhancement	-.082	.181***	.008	-.067	.009	.047	.305***	.269***
Cognitive Enhancement	-.012	.049	.026	.003	.059	-.002	.024	.029

Note. PBC: Perceived Behavioral Control.

Tobacco dependence was assessed with the French version of the CDS-5 (Etter et al., 2003). Attitudes, social norms, and PBC were assessed based on the theory of planned behavior (Mauduy et al., 2022). Smoker identity was assessed using the Smoker Self-Concept Scale (Shadel & Mermelstein, 1996; Mauduy et al., 2022). Eating disorders were assessed with the French version of the SCOFF questionnaire (Parker et al., 2010). Anxiety was measured with the French version of the State-Trait Anxiety Inventory (Spielberger et al., 1983). Depression was measured with the short French version of the Beck Depression Inventory (Beck et al., 1988).

Statistically significant at *** $p < .001$; ** $p < .01$; * $p < .05$