Original Papers

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Is the Polythetic Approach Efficient in Identifying Potentially Addicted to Work Individuals? Comparison of the Polythetic Approach With the Item Response Theory Framework

Abstract: *This study included investigation of efficiency of the threshold used to classify symptoms as present, investigation of efficiency of the cut-off point used to identify potentially addicted to work individuals, investigation of magnitude of the problem of class overlap, and investigation of effects of dichotomization of polytomous items on the estimates of the latent trait level. The sample comprised 16,426 working Norwegians (M_{age} = 37.31; SD = 11.36) who filled out the Bergen Work Addiction Scale (BWAS). The results showed that the difficulty/third threshold parameters corresponding to the threshold used to classify symptoms as present were lower than 1.5 for the items corresponding to tolerance and conflict and higher than or equal to 1.5 for the items corresponding to salience, mood modification, relapse, withdrawal, and problems. The cut-off point used to identify individuals as potentially addicted to work identified 411 individuals (31.9% of all individuals classified by the polythetic approach as potentially addicted to work) whose estimates of the latent trait level were lower than 1.5 as potentially addicted to work. The problem of class overlap (being classified by the polythetic approach into different class despite almost the same level of the latent trait) affected 4,686 individuals (28.5% of the whole sample). The dichotomization of polytomous items had a substantial effect on the estimates of the latent trait level. The findings show that the polythetic approach is not efficient in identifying potentially addicted to work individuals and that the prevalence rates of work addiction based on the polythetic approach are not trustworthy.*

Keywords: *IRT, prevalence rate, the Bergen Work Addiction Scale, work addiction, workaholism*

Introduction

In recent years, work addiction has been the subject of heated theoretical discussion. Some researchers criticized it as an example of newly developed behavioural addictions which "have a very limited clinical relevance and none are recognised as disorders by the official diagnostic and classification systems" (Starcevic, Billieux, & Schimmenti, 2018, p. 920; see also Billieux, Schimmenti, Khazaal, Maurage, & Heeren, 2015; Kardefelt--Winther et al., 2017). In response to the critique, the researchers in the area of work addiction argued that work addiction "has substantial clinical relevance as supported by more than 50 years of research including anecdotal data, case studies, cross-sectional data, and longitudinal studies, as well as several decades of Workaholics Anonymous operating in many countries around the world" (Atroszko, 2019, p. 284; see also, Atroszko,

Demetrovics, & Griffiths, 2019; Atroszko & Griffiths, 2017, Griffiths, Demetrovics, & Atroszko, 2018; Robinson, 2014). Additionally, the same researchers (Griffiths et al., 2018) initiated a much-needed debate between researchers in the area of work addiction regarding the current state of the art and directions for future studies of this phenomenon. The researchers agreed that work addiction represents a problematic behaviour; nevertheless, they also pointed out that "more high-quality data are needed to have a better understanding of its symptoms, etiology, epidemiology, course, treatment, and prognosis" (Atroszko et al., 2019, p. 7; see also Andreassen, Schaufeli, & Pallesen, 2018; Griffiths et al., 2018; Kun, 2018; Lior, Abira, & Aviv, 2018; Malinowska, 2018; Quinones, 2018; Sussman, 2018; Tóth-Király, Bőthe, & Orosz, 2018). One of the recommended aims for future studies was to study the prevalence rates of work addiction in different working populations. Hence, it demonstrates

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that there is a demand for an efficient approach to identify potentially addicted to work individuals.

The Aim of This Study

In this study, we aimed to empirically investigate whether the polythetic approach (the most commonly used method to identify individuals as potentially addicted to work) is efficient in identifying potentially addicted to work individuals. Therefore, we compared the polythetic approach with the item response theory (IRT) framework (the "gold standard" of modern psychometrics allowing the most precise estimation of a latent trait level) using a large dataset comprising data from Norwegian employees (Andreassen, Griffiths, Sinha, Hetland, & Pallesen, 2016b).

Taking into account that the polythetic approach is based on a dichotomization of polytomous items we divided the analyses into two sections. The first section includes the comparison of the polythetic approach with IRT for the dichotomized items (each item indicates either presence or absence of a corresponding symptom during the past 12 months). The second section includes the comparison of the polythetic approach with IRT for the polytomous items (each item indicates how often a corresponding symptom was experienced during the past 12 months). Thus, allowing to demonstrate how results and conclusions of a study could be affected by applying different analytical approaches to the same data (the polythetic approach vs. IRT for the dichotomized items) and by dichotomization of polytomous items (IRT for the dichotomized items vs. IRT for the polytomous items).

In both sections we investigated (a) how items corresponding to work addiction symptoms differed from one another in terms of discrimination and difficulty/third threshold parameters, (b) whether a threshold used to classify symptoms as present indicates the level of the latent trait high enough to reason that a symptom is present, (c) whether a cut-off point used to identify individuals as potentially addicted to work identifies individuals whose level of the latent trait is high enough to reason that they are potentially addicted to work, and (d) how many individuals are potentially affected by the problem of class overlap due to the application of the polythetic approach. The remainder of this introduction is structured in the following way. Firstly, we describe the definition, symptoms, and measurement of work addiction. Secondly, we describe the polythetic approach, the threshold used to classify symptoms as present, the cut-off point used to identify individuals as potentially addicted to work, and the problem of class overlap. Thirdly, we describe the IRT framework and its main properties. Finally, we discuss previous studies and formulate hypotheses for this study.

Work Addiction

Definition. Work addiction has been defined as "being overly concerned about work, to be driven by an uncontrollable work motivation, and to spend so much energy and effort into work that it impairs private relationships, spare-time activities and/or health" (Andreassen, Hetland, & Pallesen, 2014, p. 8; for more elaborated definition, see Atroszko et al., 2019). As a behavioural addiction, it has been conceptualized using the seven symptoms of addiction: salience, tolerance, mood modification, relapse, withdrawal, conflict, and problems (Andreassen, Griffiths, Hetland, & Pallesen, 2012; see also Brown, 1993; Griffiths, 2005; Leshner, 1997).

Symptoms. Salience refers to a constant preoccupation with work which manifests itself in the dominance of work in thoughts, feelings, and behaviour of an individual. Tolerance refers to a need to increase the amount of work to achieve the previous mood modification effects and means that an individual gradually increases the amount of time spent every day working. Mood modification refers to a subjective experience that working allows an individual to escape the negative states that he/she is experiencing (e.g., anxiety, guilt, or hopelessness) or to experience the arousal ("high") associated with working. Relapse refers to repeated reversions to earlier patterns of excessive working (which are quickly restored even for the most extreme patterns) after the periods of control. Withdrawal refers to unpleasant feelings (states) and/or physical effects when an individual is unable to work. Conflict refers to conflicts between an individual and those around the individual, to conflicts between work and other activities such as social life and hobbies, and to the intrapsychic conflicts such as contradictory needs. Problems refer to health and/or other problems associated with excessive working (Andreassen et al., 2012; Griffiths, 2011).

The Bergen Work Addiction Scale. These seven symptoms of addiction were used to develop the Bergen Work Addiction Scale (BWAS; Andreassen et al., 2012), one of the most popular instruments to measure work addiction and as far as we are aware, the only instrument rooted in theory and research of addiction. The BWAS consists of seven items, one for each symptom of work addiction. Each item asks respondents how often they experienced a given symptom during the past 12 months. The responses are provided on a 5-point Likert scale ranging from 1 (*never*) through 2 (*rarely*), 3 (*sometimes*), 4 (*often*) to 5 (*always*). To identify potentially addicted to work individuals (we think it is possible with the BWAS) and estimate the prevalence rates of work addiction, based on the responses on the BWAS, researchers use the polythetic approach (Andreassen, Griffiths, et al., 2014; Andreassen, Griffiths, Sinha, Hetland, & Pallesen, 2016a; Andreassen, Nielsen, Pallesen, & Gjerstad, 2019; Atroszko, Pallesen, Griffiths, & Andreassen, 2017; Lichtenstein, Malkenes, Sibbersen, & Hinze, 2019; Orosz, Dombi, Andreassen, Griffiths, & Demetrovics, 2016).

The Polythetic Approach

The polythetic approach is the most commonly used method to identify mentally disordered individuals. Its widespread utilization has been initiated by the creation of the third edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM–III*; American Psychiatric Association, 1980) and nowadays it still is an important part of the most recent fifth edition of this classification (*DSM–5*; American Psychiatric Association, 2013).

The process of classifying individuals based on the polythetic approach comprises two steps. In the first step, the frequency and/or intensity of each symptom is evaluated in order to determine whether a symptom should be classified as either present or absent. In the second step, the number of symptoms that were classified as present is compared with a cut-off point used to determine whether an individual should be classified as mentally disordered. Such a cut-off point might be, for example, the presence of at least five out of nine possible symptoms. Thus, individuals whose number of symptoms present equals five or more are classified as mentally disordered, and individuals whose number of symptoms present equals four or less are classified as not mentally disordered.

In the case of work addiction and the BWAS, a symptom is regarded as present if an individual declared that he/she experienced it *often* (4) or *always* (5) during the past 12 months and as absent if an individual declared that he/she experienced it *never* (1), *rarely* (2), or *sometimes* (3) during the past 12 months. An individual is classified as potentially addicted to work if his/her number of symptoms present equals at least four out of seven (i.e., at least half plus one of all symptoms).

The main advantage of the polythetic approach is its simplicity, whereas its main drawback is that both the threshold used to classify symptoms as present (i.e., responding 4 [*often*] or 5 [*always*] on a corresponding item) as well as the cut-off point used to identify individuals as potentially addicted to work (i.e., presence of at least four out of the seven symptoms of work addiction) are arbitrary and have neither theoretical nor empirical justification. Consequently, the threshold might overestimate (or underestimate) the number of individuals experiencing particular symptoms and the cut-off point might overestimate (or underestimate) the number of individuals potentially addicted to work. Nevertheless, the polythetic approach with the described threshold and cut-off point is widely used by researchers studying work addiction to estimate its prevalence rates (Andreassen, Griffiths, et al., 2014; Andreassen et al., 2016a; Andreassen et al., 2019; Atroszko et al., 2017; Lichtenstein et al., 2019; Orosz et al., 2016).

Additionally, the polythetic approach is prone to the problem of class overlap. The overlap occurs when the maximum level of the latent trait for the not addicted class is higher than the minimum level of the latent trait for the potentially addicted class. Consequently, individuals whose levels of the latent trait are within this range are classified into different class based on the polythetic approach even though their levels of the latent trait do not allow to unequivocally classify them into any of the two classes. Taking all of that into account, the latent trait levels should be precisely estimated in order to evaluate the efficiency of the polythetic approach.

The IRT Framework

The IRT framework is the "gold standard" of modern psychometrics, which allows the most precise estimation of a latent trait. IRT models investigate how the probability of responding in a certain way on an item changes depending on the latent trait level of an individual. The most typical are the three-parameter logistic (3PL) model, the two-parameter logistic (2PL) model, and the one-parameter logistic (1PL) model. The 3PL model estimates difficulty, discrimination, and guessing parameters for all items. The 2PL model estimates difficulty and discrimination parameters and fixes guessing parameters for all items to zero. The 1PL model estimates difficulty parameters, constraints discrimination parameters to be equal for all items, and fixes guessing parameters for all items to zero. As the BWAS is an affective test (i.e., a test with items without correct responses) whose items most likely differ in terms of their discriminative power (see Khazaal et al., 2018; Schivinski, Brzozowska-Woś, Buchanan, Griffiths, & Pontes, 2018; see also Dumenci & Achenbach, 2008) we decided that the 2PL model was the most suitable for this study.

To comprehensively evaluate the efficiency of the polythetic approach we decided to compare the polythetic approach with two variants of the 2PL model: the 2PL model for dichotomized items, and the 2PL model for polytomous items (for the polytomous items we used the graded response [GR] model of Samejima, 1969). The difference between the two models is that the former is based on the dichotomized items (indicating either presence or absence of a corresponding symptom during the past 12 months) and the latter is based on the unmodified polytomous items (indicating how often a corresponding symptom was experienced during the past 12 months). Therefore, the estimates of the latent trait level based on the 2PL model for the dichotomized items might be less accurate than estimates of the 2PL model for the polytomous items (as they are based on a smaller amount of information). Consequently, the inclusion of the two variants of the 2PL model allows demonstrating the effect of item dichotomization on the conclusions of this study.

The 2PL Models. Both the 2PL model for the dichotomized items and the 2PL model for the polytomous items estimate one discrimination parameter for each item. Item discrimination (denoted as a) indicates how well an item discriminates between individuals with different levels of the latent trait. The higher the discriminative power, the more precisely the item discriminates whether individuals' levels of the latent trait are above or below the threshold used to classify the corresponding symptom as present. Additionally, the higher the discriminative power, the smaller the chances of false positives (i.e., classifying a symptom as present despite its absence) and false negatives (i.e., classifying a symptom as absent despite its presence). Thus, efficient identification of potentially addicted to work individuals requires items with high discrimination parameters. Baker (2001) proposed the following ranges of values to interpret discrimination parameters for items (please note that these values correspond to a discrimination parameter represented as an item discrimination [a] multiplied by a constant [i.e., $1.7 * a$]; Baker, 2001, p. 43): 0 indicates lack of discriminative value, 0.01–0.34 indicate very low dis-

criminative value, 0.35–0.64 indicate low discriminative value, 0.65–1.34 indicate moderate discriminative value, 1.35–1.69 indicate high discriminative value, and 1.70 and above indicate very high discriminative value.

The two variants of the 2PL model differ in terms of difficulty parameters. The 2PL model for the dichotomized items estimates one difficulty parameter for each item. Item difficulty (denoted as b) indicates the latent trait level at which 50% of individuals are expected to answer an item in a way indicating the presence of a corresponding symptom. Whereas, the 2PL model for the polytomous items estimates $k - 1$ threshold parameters for each item (where k represents a number of response categories; in this study $k = 5$). Each threshold (denoted as b_i) indicates the latent trait level at which equal numbers of individuals are expected to choose category lower than $k + 1$ versus category $k + 1$ or higher. Thus, a third threshold parameter of an item indicates the latent trait level at which an equal number of individuals is expected to choose the response category *never* (1), *rarely* (2), or *sometimes* (3) versus the response category *often* (4) or *always* (5). This corresponds to a difficulty parameter of an item in the 2PL model for dichotomized items. Hence, through the remainder of this paper, we refer to both of these parameters in the following manner: difficulty/third threshold parameters (please note that the exact values of the third threshold parameter might be slightly different from the value of a corresponding difficulty parameter due to the different amount of information used to estimate the two models).

The Latent Trait Level of Potentially Addicted to Work Individuals. Efficient identification of potentially addicted to work individuals requires items with high difficulty/third threshold parameters (but not too high as too high difficulty/third threshold parameters inflate the ratio of false negatives; for a discussion on this topic, see Boness, Lane, & Sher, 2019), which reflect the latent trait level at which symptoms start causing significant impairment in functioning for individuals. The difficulty/third threshold parameters for all items should have similar values in order to maximize measurement reliability at the latent trait level at which work addiction starts causing significant impairment in functioning for individuals. Moreover, efficient identification of potentially addicted to work individuals requires defining a cut-off point which reflects the latent trait level at which work addiction starts causing significant impairment in functioning for individuals. Unfortunately, as far as we are aware the latent trait levels at which work addiction or symptoms of work addiction start causing significant impairment in functioning for individuals have not been determined and reported in the extant literature. However, previous studies consistently showed that work addiction was positively associated with impaired functioning of individuals (for meta-analysis, see Clark, Michel, Zhdanova, Pui, & Baltes 2016; for narrative reviews, see Griffiths et al., 2018; Atroszko, Demetrovics, & Griffiths, 2020) and various mental disorders (Andreassen et al., 2016a; Atroszko et al., 2020). Additionally, Lane and Sher (2015) showed that in the case of alcohol use disorder the latent trait level

of 1.5 could be a quite effective cut-off point for differentiating between disordered and not disordered individuals. Therefore, even though we had to choose the values arbitrarily, we believe that values between 1.5 and 2.0 should be adequate for item difficulty/third threshold parameters and that the value of 1.5 should be an adequate cut-off for identifying individuals as potentially addicted to work based on their levels of the latent trait. Moreover, these values should allow us to identify almost solely individuals with significant impairment of functioning and avoid pitfalls of overpathologization of normal behaviours.

Additionally, we decided that in order to recognize the polythetic approach as efficient in identifying potentially addicted to work individuals less than 5% (a number analogous to the threshold used for testing statistical significance) of individuals classified by the polythetic approach as potentially addicted to work should have the latent trait levels lower than 1.5 and less than 5% of individuals classified by the polythetic approach as not addicted to work should have the latent trait levels higher than or equal to 1.5. Moreover, we decided that the problem of class overlap should concern less than 5% of all individuals in order to recognize the polythetic approach as efficient in identifying potentially addicted to work individuals.

Previous Studies and Theoretical Considerations

To the best of our knowledge, previous studies lacked any form of general or specific investigation whether the polythetic approach is efficient in identifying potentially addicted to work individuals. Moreover, previous studies lacked any form of investigation at which level of the latent trait work addiction and symptoms of work addiction start causing significant impairment in functioning for individuals. Consequently, we had to base our hypotheses for this study on theoretical considerations and empirical research of gaming addiction (frequently referred to as gaming disorder), as gaming addiction was operationalized with the same seven symptoms of addiction as work addiction (see Lemmens, Valkenburg, & Peter, 2009).

Previous studies of gaming addiction showed that relapse, withdrawal, conflict, and problems were more strongly associated with negative outcomes than salience, tolerance, and mood modification (Ferguson, Coulson, & Barnett, 2011; see also Brunborg, Hanss, Mentzoni, & Pallesen, 2015). Moreover, the items corresponding to relapse, withdrawal, conflict, and problems had higher discrimination parameters and third threshold parameters than the items corresponding to salience, tolerance, and mood modification (Khazaal et al., 2018, see also Schivinski et al., 2018). As a result, some of the seven symptoms of addiction (i.e., preoccupation [salience], withdrawal, tolerance, and escape [mood modification]) were excluded from the definition of gaming disorder in a beta draft of the *ICD–11* (Király & Demetrovics, 2017; see also Schivinski et al., 2018) despite its presence in the definition of gaming disorder in the *DSM–5* (see also

Griffiths et al., 2016). Also, previous studies of various substance use disorders showed that items corresponding to their symptoms had varying discrimination parameters and difficulty parameters (e.g., Boness et al., 2019; Hagman, 2017; Kirisci, Tarter, Reynolds, & Vanyukov, 2016; Lane & Sher, 2015; Lane, Steinley, & Sher, 2016). However, we decided not to discuss these studies in detail here as differences in operationalization of the symptoms might substantially influence the results of the IRT analyses (see Lane et al., 2016).

We presumed that symptoms of work addiction would differ in a similar manner as symptoms of gaming addiction (however, please note that it might not be the case; Lane et al., 2016). The items corresponding to relapse, withdrawal, conflict, and problems would have higher discrimination parameters and difficulty/third threshold parameters than the items corresponding to salience, tolerance, and mood modification. Moreover, we presumed that the difficulty/third threshold parameters for the items corresponding to relapse, withdrawal, conflict, and problems would be between 1.5 and 2.0, and the difficulty/third threshold parameter of the items corresponding to salience, tolerance, and mood modification would be lower than 1.5. Therefore, the threshold used to classify symptoms as present (i.e., responding 4 [*often*] or 5 [*always*] on a corresponding item) would overestimate the prevalence rates of salience, tolerance, and mood modification and, consequently, the total number of symptoms present. Due to the overestimated number of symptoms present, the cut-off point used to identify individuals as potentially addicted to work (i.e., presence of at least four out of the seven symptoms of work addiction) would identify as potentially addicted to work

individuals whose actual number of symptoms present is lower than four and whose level of the latent trait is lower than 1.5. Additionally, we presumed that a substantial number of individuals would be affected by the problem of class overlap. Consequently, the polythetic approach would not be efficient in identifying potentially addicted to work individuals and it would overestimate the prevalence rate of work addiction.

Hypotheses

Based on previous empirical research and theoretical considerations we formulated the following hypotheses. Hypothesis 1: The items corresponding to salience, tolerance, and mood modification would show lower discrimination and difficulty/third threshold parameters than the items corresponding to relapse, withdrawal, conflict, and problems. Hypothesis 2: The difficulty/third threshold parameters corresponding to the threshold used to classify symptoms as present (i.e., responding 4 [*often*] or 5 [*always*] on a corresponding item) would be lower than 1.5 for the items corresponding to salience, tolerance, and mood modification and between 1.5 and 2.0 for the items corresponding to relapse, withdrawal, conflict, and problems. Hypothesis 3: More than 5% of individuals classified by the polythetic approach as potentially addicted to work would have the latent trait levels lower than 1.5 and more than 5% of individuals classified by the polythetic approach as not addicted to work would have the latent trait levels higher than or equal to 1.5. Hypothesis 4: The latent trait levels of more than 5% of all individuals would be between the maximum level of the latent trait for the not addicted class and the minimum level of the latent trait for the potentially addicted class.

Table 1. Estimates of Discrimination and Difficulty Parameters for the Dichotomized BWAS Items and The Prevalence Rates of the Corresponding Symptoms

Symptom	Discrimination [95% CI][a]	Difficulty [95% CI]	Prevalence (%)[b]
Salience	1.641 [1.542, 1.740]	1.965 [1.889, 2.041]	9.0
Tolerance	2.469 [2.339, 2.599]	0.859 [0.829, 0.889]	24.3
Mood modification	1.932 [1.813, 2.051]	1.939 [1.870, 2.008]	7.6
Relapse	3.218 [2.991, 3.446]	1.682 [1.636, 1.728]	7.0
Withdrawal	2.429 [2.288, 2.570]	1.550 [1.504, 1.596]	10.5
Conflict	3.314 [3.111, 3.518]	1.037 [1.008, 1.067]	18.2
Problems	2.449 [2.307, 2.591]	1.559 [1.513, 1.605]	10.3

[a]The discrimination parameters are reported congruently with the output of the mirt package (i.e., 1.702 * *a*).
[b]The percentage of individuals responding 4 (*often*) or 5 (*always*) on an item.

Method

Sample and Procedure

The sample (Andreassen et al., 2016b) comprised 16,426 working Norwegians: 10,487 females (63.8%) and 5,939 males (36.2%). Their mean age was 37.31 years (SD = 11.36), ranging from 16 to 75 years. Data collection was based on convenience sampling and took place during the first half of 2014. A link to the survey was published in the online editions of five national Norwegian newspapers. Participation in the study was completely anonymous and no monetary or other material rewards were offered. A more detailed description of the sample and procedure of the study is presented in Andreassen et al. (2016a).

Instrument

The BWAS (Andreassen et al., 2012) consists of seven items that are based on the seven symptoms of addiction (Brown, 1993; Griffiths, 2005; Leshner, 1997). Each item asks respondents how often they experienced a given symptom during the past 12 months. The responses are provided on a 5-point Likert scale ranging from 1 (*never*) through 2 (*rarely*), 3 (*sometimes*), 4 (*often*) to 5 (*always*). The BWAS showed good validity and reliability in previous studies (Andreassen, Griffiths, et al., 2014; Andreassen et al., 2016a; Andreassen et al., 2019; Atroszko et al., 2017; Lichtenstein et al., 2019; Orosz et al., 2016). In this sample, the Cronbach's alpha reliability coefficient was .86.

Statistical Analyses

All statistical analyses were performed using R 3.5.3 (R Core Team, 2019). The assumptions of IRT (unidimensionality and local independence) were tested using confirmatory factor analysis (CFA) with the lavaan 0.6-3 package (Rosseel, 2012). The weighted least squares estimator (WLS) was used due to non-normality of item distributions and ordinal character of the item response scales (Konarski, 2009). Fit of the model with a single factor of work addiction was evaluated with the following fit indices: Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Squared Error of Approximation (RMSEA). Suggested cut-off points for those indices for acceptable fit are CFI ≥ .95, TLI ≥ .95, RMSEA

≤ .06 to .08 (Hu & Bentler, 1999; Schreiber, Nora, Stage, Barlow, & King, 2006). The IRT models for the dichotomized and the polytomous items (GR model; Samejima, 1969) were estimated using the mirt 1.30 package (Chalmers, 2012). The values of the latent trait were estimated using expected a-posteriori (EAP) estimation. All figures were prepared using the ggplot2 3.1.1 package (Wickham, 2016). The analytic code for all analyses performed in this study is available at https://osf.io/vhx4g (please note that the analytic code might be used to obtain the EAP estimate of the latent trait level for given response patterns).

Results

The Polythetic Approach

The numbers of individuals experiencing a given number of symptoms present as well as the numbers of possible and actual response patterns for a given number of symptoms are presented in Table A1. Zero symptoms were present among 10,360 individuals (63.1%). One symptom was present among 2,436 individuals (14.8%). Two symptoms were present among 1,467 individuals (8.9%). Three symptoms were present among 876 individuals (5.3%). Four symptoms were present among 588 individuals (3.6%). Five symptoms were present among 348 individuals (2.1%). Six symptoms were present among 237 individuals (1.4%). Seven symptoms were present among 114 individuals (0.7%). Based on the polythetic approach 1,287 individuals (7.8%) who had four or more symptoms present were classified as potentially addicted to work.

IRT for the Dichotomized Items

Factor Analysis. The model with a single factor of work addiction showed the following values of the fit indices: $\chi^2(14) = 378.11$, $p < .001$, CFI = .979, TLI = .969, RMSEA = .040, 90% CI [.036, .043]. The standardized factor loadings for the items corresponding to salience, tolerance, mood modification, relapse, withdrawal, conflict, and problems were .68, .83, .75, .88, .84, .90, and .82, respectively. These results indicate a good fit of the model to the data.

Discrimination and Difficulty Parameters. The parameters of the estimated 2PL model for the dichot-

Table 2. Number of Individuals in the Not Addicted and Potentially Addicted Classes Grouped by Their EAP Estimates of the Latent Trait Level Based on the Dichotomized Items

The latent trait level	Class based on the polythetic approach	
	Not addicted	Potentially addicted
Higher than EAP_{NAmax} = 1.315	0	1,258
Lower than or equal to EAP_{NAmax} = 1.315 and higher than or equal to EAP_{PAmin} = 1.256	100	29
Lower than EAP_{PAmin} = 1.256	15,039	0
All levels of the latent trait	15,139	1,287

Note. EAP_{NAmax} = the maximum level of the latent trait for the not addicted class;
EAP_{PAmin} = the minimum level of the latent trait for the potentially addicted class.

Table 3 Estimates of Discrimination and Difficulty Parameters for the Polytomous BWAS Items

Symptom	Discrimination [95% CI][a]	Difficulty (thresholds) [95% CI]				
		b_1	b_2	b_3	b_4	Spread
Salience	1.438 [1.391, 1.485]	−0.355 [−0.386, −0.324]	0.737 [0.703, 0.771]	2.074 [2.009, 2.138]	3.965 [3.812, 4.119]	4.320
Tolerance	2.236 [2.172, 2.300]	−1.208 [−1.242, −1.175]	−0.201 [−0.225, −0.177]	0.867 [0.838, 0.896]	2.368 [2.307, 2.428]	3.576
Mood modification	1.455 [1.402, 1.507]	0.359 [0.329, 0.389]	1.236 [1.192, 1.280]	2.207 [2.137, 2.278]	3.764 [3.621, 3.907]	3.405
Relapse	2.745 [2.655, 2.835]	0.181 [0.159, 0.204]	0.878 [0.851, 0.905]	1.731 [1.689, 1.772]	2.774 [2.695, 2.853]	2.593
Withdrawal	2.192 [2.126, 2.257]	−0.281 [−0.305, −0.256]	0.546 [0.521, 0.572]	1.590 [1.549, 1.631]	2.723 [2.647, 2.799]	3.004
Conflict	2.705 [2.624, 2.786]	−0.462 [−0.486, −0.438]	0.269 [0.247, 0.291]	1.074 [1.045, 1.103]	2.131 [2.080, 2.182]	2.593
Problems	2.001 [1.939, 2.062]	−0.157 [−0.183, −0.132]	0.690 [0.662, 0.718]	1.655 [1.611, 1.699]	2.728 [2.650, 2.805]	2.885

[a]The discrimination parameters are reported congruently with the output of the mirt package (i.e., 1.702 * *a*).

omized items and the prevalence rates of the seven symptoms are presented in Table 1. The item characteristic curves, the item information functions, and the test information function are presented in Figure A1, Figure A2, and Figure A3, respectively. According to Baker's (2001) criteria, all items had high or very high discrimination power. The discrimination parameters were lowest for salience and mood modification (1.641 and 1.932, respectively), average for tolerance, withdrawal, and problems (2.469, 2.429, and 2.449, respectively), and highest for relapse and conflict (3.218 and 3.314, respectively). The difficulty parameters were lowest for tolerance and conflict (0.859 and 1.037, respectively), average for relapse, withdrawal, and problems (1.682, 1.550, and 1.559, respectively), and highest for salience and mood modification (1.965 and 1.939, respectively).

The EAP Estimates of the Latent Trait Level. For individuals classified by the polythetic approach as not addicted to work, the EAP estimates of the latent trait level were varying between −0.527 and 1.315 with a mean equal to −0.147 (see Figure 1). Individuals with zero symptoms present comprised one response pattern which corresponded to the EAP estimate of the latent trait level equal to −0.527. Individuals with one symptom present comprised seven response patterns which corresponded to the EAP estimates of the latent trait level varying between 0.159 and 0.562 with a weighted mean equal to 0.377. Individuals with two symptoms present comprised 21 response patterns which corresponded to the EAP estimates of the latent trait level varying between 0.610 and 1.038 with a weighted mean equal to 0.831. Individuals with three symptoms present comprised 35 response patterns which corresponded to the EAP

estimates of the latent trait level varying between 0.972 and 1.315 with a weighted mean equal to 1.150.

For individuals classified by the polythetic approach as potentially addicted to work, the EAP estimates of the latent trait level were varying between 1.256 and 2.448 with a mean equal to 1.736 (see Figure 1). Individuals with four symptoms present comprised 35 response patterns which corresponded to the EAP estimates of the latent trait level varying between 1.256 and 1.578 with a weighted mean equal to 1.421. Individuals with five symptoms present comprised 21 response patterns which corresponded to the EAP estimates of the latent trait level varying between 1.520 and 1.860 with a weighted mean equal to 1.692. Individuals with six symptoms present comprised seven response patterns which corresponded to the EAP estimates of the latent trait level varying between 1.893 and 2.135 with a weighted mean equal to 2.008. Individuals with seven symptoms present comprised one response pattern which corresponded to the EAP estimate of the latent trait level equal to 2.448.

The Cut-Off Point Used to Identify Individuals as Potentially Addicted to Work. The EAP estimates of the latent trait level were lower than 1.5 for 409 individuals classified by the polythetic approach as potentially addicted to work (this constitutes 31.8% of all the 1,287 individuals classified by the polythetic approach as potentially addicted to work). Furthermore, there were no individuals classified by the polythetic approach as not addicted to work for whom the EAP estimates of the latent trait level were higher than or equal to 1.5.

The Overlap of Classes. The problem of class overlap affected 129 individuals (this constitutes 0.8% of the whole sample; see Table 2 and Figure 1). For

Table 4 Number of Individuals in the Not Addicted and Potentially Addicted Classes Grouped by Their EAP Estimates of the Latent Trait Level Based on the Polytomous Items

The latent trait level	Class based on the polythetic approach	
	Not addicted	Potentially addicted
Higher than $EAP_{NAmax} = 1.792$	0	457
Lower than or equal to $EAP_{NAmax} = 1.792$ and higher than or equal to $EAP_{PAmin} = 0.442$	3,856	830
Lower than $EAP_{PAmin} = 0.442$	11,283	0
All levels of the latent trait	15,139	1,287

Note. EAP_{NAmax} = the maximum level of the latent trait for the not addicted class;
EAP_{PAmin} = the minimum level of the latent trait for the potentially addicted class.

29 individuals classified by the polythetic approach as potentially addicted to work (this constitutes 0.2% of the whole sample) the EAP estimates of the latent trait level were below the maximum level of the latent trait for the not addicted class ($EAP_{NAmax} = 1.315$). Furthermore, for 100 individuals classified by the polythetic approach as not addicted to work (this constitutes 0.6% of the whole sample) the EAP estimates of the latent trait level were above the minimum level of the latent trait for the potentially addicted class ($EAP_{PAmin} = 1.256$).

IRT for the Polytomous Items

Factor Analysis. The model with a single factor of work addiction showed the following values of the fit indices: $\chi^2(14) = 2057.71$, $p < .001$, CFI = .957, TLI = .936, RMSEA = .094, 90% CI [.091, .098]. The standardized factor loadings for the items corresponding to salience, tolerance, mood modification, relapse, withdrawal, conflict, and problems were .68, .82, .69, .85, .82, .86, and .79, respectively. These results indicate an adequate fit of the model to the data.

The value of RMSEA was above the suggested cut-off point, which might indicate some violations of unidimensionality and/or local independence. However, it might be inflated as a result of the large sample size (e.g., Shi, Maydeu-Olivares, & Rosseel, 2019). Moreover, it has been shown that IRT is robust to minor violations of the assumptions (Harrison, 1986). Therefore, we decided that it was justified to proceed with estimating the GR model.

Discrimination and Threshold Parameters. The parameters of the estimated GR model and the spread between the first and the fourth thresholds for the seven symptoms are presented in Table 3. The category response curves, the item information functions, and the test information function are presented in Figure A4, Figure A5, and Figure A6, respectively. According to Baker's (2001) criteria, all items had high or very high discrimination power. The discrimination parameters were lowest for salience and mood modification (1.438 and 1.455, respectively), average for tolerance, withdrawal, and problems (2.236, 2.192, and 2.001, respectively), and highest for relapse and conflict (2.745 and 2.705,

respectively). The third threshold parameters were lowest for tolerance and conflict (0.867 and 1.074, respectively), average for relapse, withdrawal, and problems (1.731, 1.590, and 1.655, respectively), and highest for salience and mood modification (2.074 and 2.207, respectively).

The EAP Estimates of the Latent Trait Level. For individuals classified by the polythetic approach as not addicted to work, the EAP estimates of the latent trait level were varying between −1.645 and 1.792 with a mean equal to −0.148 (see Figure 2). Individuals with zero symptoms present comprised 1,248 response patterns which corresponded to the EAP estimate of the latent trait level varying between −1.645 and 0.931 with a weighted mean equal to 0.016. Individuals with one symptom present comprised 1,323 response patterns which corresponded to the EAP estimates of the latent trait level varying between −1.218 and 1.217 with a weighted mean equal to 0.300. Individuals with two symptoms present comprised 947 response patterns which corresponded to the EAP estimates of the latent trait level varying between −0.664 and 1.604 with a weighted mean equal to 0.669. Individuals with three symptoms present comprised 640 response patterns which corresponded to the EAP estimates of the latent trait level varying between −0.273 and 1.792 with a weighted mean equal to 1.052.

For individuals classified by the polythetic approach as potentially addicted to work, the EAP estimates of the latent trait level were varying between 0.442 and 3.494 with a mean equal to 1.740 (see Figure 2). Individuals with four symptoms present comprised 416 response patterns which corresponded to the EAP estimates of the latent trait level varying between 0.442 and 2.274 with a weighted mean equal to 1.448. Individuals with five symptoms present comprised 241 response patterns which corresponded to the EAP estimates of the latent trait level varying between 1.201 and 2.776 with a weighted mean equal to 1.833. Individuals with six symptoms present comprised 143 response patterns which corresponded to the EAP estimates of the latent trait level varying between 1.519 and 3.101 with a weighted mean equal to 2.222. Individuals with seven symptoms present comprised 40 response patterns which corresponded to the EAP estimate

of the latent trait level varying between 1.919 and 3.494 with a weighted mean equal to 2.539.

The Cut-Off Point Used to Identify Individuals as Potentially Addicted to Work. The EAP estimates of the latent trait level were lower than 1.5 for 411 individuals classified by the polythetic approach as potentially addicted to work (this constitutes 31.9% of all the 1,287 individuals classified by the polythetic approach as potentially addicted to work). Furthermore, the EAP estimates of the latent trait level were higher than or equal to 1.5 for 32 individuals classified by the polythetic approach as not addicted to work (this constitutes 0.2% of all the 15,139 individuals classified by the polythetic approach as not addicted to work).

The Overlap of Classes. The problem of class overlap affected 4,686 individuals (this constitutes 28.5% of the whole sample; see Table 4 and Figure 2). For 830 individuals classified by the polythetic approach as potentially addicted to work (this constitutes 5.1% of the whole sample) the EAP estimates of the latent trait level were below the maximum level of the latent trait for the not addicted class ($EAP_{NAmax} = 1.792$). Furthermore, for 3,856 individuals classified by the polythetic approach as not addicted to work (this constitutes 23.4% of the whole sample) the EAP estimates of the latent trait level were above the minimum level of the latent trait for the potentially addicted class ($EAP_{PAmin} = 0.442$).

IRT for the Dichotomized Items vs. IRT for the Polytomous Items

The EAP estimates of the latent trait level based on the dichotomized items were strongly associated with the number of symptoms present based on the polythetic approach ($r = .96$, $r^2 = 92.2\%$, $p < .001$). The EAP estimates of the latent trait level based on the polytomous items were moderately associated with the number of symptoms present based on the polythetic approach ($r = .76$, $r^2 = 57.8\%$, $p < .001$). Moreover, the 2PL model for the dichotomized items provided a smaller amount of information than the 2PL model for the polytomous items. For example, in the case of the 2PL model for the dichotomized items, the value of the test information function higher than or equal to 5.0 was obtained for the latent trait level between around 0.5 and 2.2, and in the case of the 2PL model for the polytomous items, the value of the test information function higher than or equal to 5.0 was obtained for the latent trait level between around −1.0 and 3.2 (see Figure A3 and Figure A6).

Discussion

Discrimination, Difficulty, and Threshold Parameters

The results showed that the BWAS items differ in terms of their discrimination, difficulty, and threshold parameters (see Table 1, Table 3, Figure A1, Figure A2, Figure A4, and Figure A5). The discrimination parameters varied between 1.641 and 3.314 for the dichotomized items and between 1.438 and 2.745 for the polytomous items, which according to Baker's (2001, p. 43) criteria indicate high or very high discriminative values. The difficulty parameters varied between 0.859 and 1.965 for the dichotomized items, and the corresponding third threshold parameters varied between 0.867 and 2.207 for the polytomous items, which for a diagnostic instrument indicates difficulty ranging from low to high.

The items formed three groups with respect to their discrimination parameters, and three groups with respect to their difficulty/third threshold parameters (see Table 1, Table 3, Figure A1, Figure A2, Figure A4, and Figure A5). The low discrimination group of items comprised salience and mood modification, the average discrimination group of items comprised tolerance, withdrawal, and problems, and the high discrimination group of items comprised conflict and relapse. The low difficulty group of items comprised tolerance and conflict, the average difficulty group of items comprised withdrawal, problems, and relapse, and the high difficulty group of items comprised salience and mood modification. These results are not in line with hypothesis 1 and the results of a previous study of gaming addiction reported by Khazaal et al. (2018) as salience and mood modification had lowest discrimination parameters and highest difficulty/third threshold parameters, and tolerance had average discrimination parameter and the lowest difficulty/third threshold parameter.

These results might indicate that even though the seven symptoms of addiction are key to delineating addictions in the first place (Griffiths, 2017), their relative importance in terms of identifying potentially addicted individuals vary between work addiction and gaming addiction. This variation might reflect qualitative differences between behaviours themselves. Work is an everyday activity (usually absorbing 30–40 hours a week) and the source of income for individuals, whereas gaming is a leisure activity (usually absorbing six hours a week; Limelight Networks, 2018) and often associated with spending money on games, electricity bills, and gaming hardware (e.g., computer or console). Consequently, work is regarded as one of the most respectable behaviours and it is socially accepted to neglect other activities (e.g., hobbies) in its favour, whereas the same could not be said about gaming. Therefore, identification of potentially addicted to work individuals might be less dependent on, for example, the symptom of conflict than identification of potentially addicted to gaming individuals.

On the other hand, the differences in relative importance of symptoms in terms of identifying potentially addicted individuals might be associated with differences in symptom measurement as conflict was measured differently in the case of work addiction than in the case of gaming addiction. In the case of work addiction, conflict was measured with a question about conflicts between work and other activities, whereas in the case of gaming addiction, conflict was measured with a question about conflicts between an individual and those around them over time spend on games. Consequently, the results of this study might indicate that some symptoms of work addiction are not measured adequately and that their corresponding items should be revised. If that is the case,

the revision should focus on developing items capturing specificity of work as behaviour and minimising the component of work engagement in item wording (see Atroszko et al., 2017; Di Stefano & Gaudiino, 2019; Griffiths et al., 2018; Griffiths et al., 2016; Kardefelt-Winther et al., 2017). However, please note that in the case of gaming addiction the problems symptom was measured with a question about neglecting other important activities for gaming and its third threshold parameter was above 2.0 (see Khazaal et al., 2018; Lemmens et al., 2009). Thus, supporting our first explanation, but also suggesting that the differences in relative importance of symptoms in terms of identifying potentially addicted individuals might be associated with different question wording for work and gaming (e.g., using deprioritising instead of neglecting; for an additional discussion on this topic, see Boness et al., 2019; Lane et al., 2016).

The Threshold Used to Classify Symptoms as Present

The difficulty/third threshold parameters corresponding to the threshold used to classify symptoms as present (i.e., responding 4 [*often*] or 5 [*always*] on a corresponding item) were lower than 1.5 for the items corresponding to tolerance and conflict (0.859/0.867 and 1.037/1.074, respectively) and above 1.5 for the items corresponding to salience, mood modification, relapse, withdrawal, and problems (1.965/2.074, 1.939/2.207, 1.682/1.731, 1.550/1.590, and 1.559/1.655, respectively). These results do not support hypothesis 2 as the difficulty/third threshold parameters corresponding to the threshold used to classify symptoms as present were higher than or equal to 1.5 for the items corresponding to salience and mood modification and lower than 1.5 for the item corresponding to conflict. Possible explanations for the differences in relative importance of symptoms in terms of identifying potentially addicted to work individuals were discussed above.

In terms of efficient identification of potentially addicted to work individuals, it is worth noting that the difficulty/third threshold parameters corresponding to the threshold used to classify symptoms as present were in the range of 1.5 and 2.0 for five out of the seven symptoms of work addiction (please note that the third threshold parameters for salience and mood modification were above 2.0). These results suggest that the threshold used to classify symptoms as present indicates the level of the latent trait high enough to reason that salience, mood modification, relapse, withdrawal, and problems are present but not high enough to reason that tolerance and conflict are present. Consequently, using the threshold used to classify symptoms as present might often identify the presence of tolerance and/or conflict among individuals who actually do not experience these symptoms (for a discussion on this topic, see Boness et al., 2019).

The Cut-Off Point Used to Identify Individuals as Potentially Addicted to Work

The EAP estimates of the latent trait level were lower than 1.5 for 409/411 individuals (dichotomized/polytomous items) classified by the polythetic approach as

potentially addicted to work (this constitutes 31.8%/31.9% [dichotomized/polytomous items] of all the individuals classified by the polythetic approach as potentially addicted to work) and higher than or equal to 1.5 for 0/32 individuals (dichotomized/polytomous items) classified by the polythetic approach as not addicted to work (this constitutes 0.0%/0.2% [dichotomized/polytomous items] of all the individuals classified by the polythetic approach as not addicted to work; see Figure 1, and Figure 2; in order to compare these results with results for alcohol use disorder, see Lane & Sher, 2015). These results partially support hypothesis 3 as more than 5% of individuals classified by the polythetic approach as potentially addicted to work had the latent trait levels lower than 1.5. Most likely, these results are associated with low difficulty/third threshold parameters for the items corresponding to tolerance and conflict which led to inflated estimates of the prevalence rates of these symptoms (see Table 1 and Table 3). Consequently, the number of symptoms present was overestimated, and the cut-off point used to identify individuals as potentially addicted to work (i.e., presence of at least four out of the seven symptoms of work addiction) was not efficient in differentiating between potentially addicted and not addicted individuals. As a result, the polythetic approach identified 1,287 individuals (this constitutes 7.8% of the whole sample) as potentially addicted to work even though only 878/908 individuals (this constitutes 5.3%/5.5% [dichotomized/polytomous items] of the whole sample) had the latent trait levels higher than or equal to 1.5.

The Overlap of Classes (Dichotomized Items vs. Polytomous Items)

The problem of class overlap affected 129 individuals (this constitutes 0.8% of the whole sample; see Table 2 and Figure 1) in the case of the 2PL model for the dichotomized items and 4,686 individuals (this constitutes 28.5% of the whole sample; see Table 4 and Figure 2) in the case of the 2PL model for the polytomous items. These results indicate that as many as 28.5% of all individuals are classified by the polythetic approach into different class despite the same or almost the same level of the latent trait (in order to compare these results with results for alcohol use disorder, see Lane & Sher, 2015). Consequently, these results support hypothesis 4 and show that the polythetic approach classifies many individuals to a large extent arbitrarily.

Moreover, these results demonstrate how conclusions drawn from this study would have changed if we had estimated only one of the two variants of the 2PL model. If we had estimated only the 2PL model for the dichotomized items, we would have concluded that the problem of class overlap is negligible as it concerns only 0.8% of all individuals. Whereas if we had estimated only the 2PL model for the polytomous items, we would have concluded that the problem of class overlap is a serious issue with respect to the efficiency of the polythetic approach as it concerns as many as 28.5% of all individuals. Thus, these results show that the dichotomization of polytomous items

contributes to substantial reduction in the amount of information provided by the items of the BWAS (the EAP estimates of the latent trait level based on the polytomous items shared less than 60% of variance with the number of symptoms present based on the polythetic approach; $r = .76$, $p < .001$; see Figure 2; also, compare how the amount of information provided by the whole test changes at different levels of the latent trait for the dichotomized items and the polytomous items, see Figure A3 and Figure A6). Whereas application of more complexed analytical approaches to the same data (i.e., IRT) slightly contributes to increase in the amount of information provided by the items of the BWAS (the EAP estimates of the latent trait level based on the dichotomized items shared more than 90% of variance with the number of symptoms present criterion based on the polythetic approach; $r = .96$, $p < .001$; see Figure 1). These results are consistent with the results of Dumenci and Achenbach (2008), who reported a high linear association between a simple sum score and the EAP estimates of the latent trait level for measures of emotional and behavioural problems. Additionally, there seems to be some nonlinearity of the relationship between the EAP estimates of the latent trait level of work addiction and the number of symptoms present based on the polythetic approach (see Figure 1 and Figure 2), which is also consistent with results of Dumenci and Achenbach (2008) as well as with results of Lane and Sher (2015).

Strengths and Limitations

To the best of our knowledge, this is the first study investigating whether the polythetic approach is efficient in identifying potentially addicted to work individuals. This study included comprehensive evaluation of the polythetic approach's efficiency in identifying potentially addicted to work individuals comprising investigation of efficiency of the threshold used to classify symptoms as present, investigation of efficiency of the cut-off point used to identify individuals as potentially addicted to work, investigation of magnitude of the problem of class overlap, and investigation of effects of dichotomization of polytomous items on the estimates of the latent trait level. Consequently, this study significantly adds to the existing literature on work addiction and behavioural addictions in general, and fits well into an ongoing debate about the current status of work addiction and potential over-pathologizing of work (Andreassen et al., 2018; Atroszko, 2019; Atroszko et al., 2019; Billieux et al., 2015; Griffiths et al., 2018; Kardefelt-Winther et al., 2017; Kun, 2018; Lior et al., 2018; Malinowska, 2018; Quinones, 2018; Starcevic et al., 2018; Sussman, 2018; Tóth-Király et al., 2018).

In terms of limitations, we chose the values for the thresholds used in the hypotheses of this study arbitrarily. Therefore, they could not reflect the latent trait level at which work addiction or symptoms of work addiction start causing significant impairment in functioning for individuals. If that had been true, our interpretation of the results regarding efficiency of the threshold used to classify symptoms as present and efficiency of the cut-off point

used to identify individuals as potentially addicted to work would have been incorrect; however, this would not have influenced correctness of our interpretation of the results regarding the polythetic approach's efficiency in identifying potentially addicted to work individuals. Moreover, despite a large sample size, the sample was not representative (which puts restrictions on the generalizability of the results) and the EAP estimates of the latent trait level had high standard errors due to a small number of items of the BWAS.

Conclusions and Future Studies

This study shows that the polythetic approach is not efficient in identifying potentially addicted to work individuals and distinguish two reasons for its inefficiency. Firstly, the threshold used to classify symptoms as present (i.e., responding 4 [*often*] or 5 [*always*] on a corresponding item) classifies tolerance and/or conflict as present for individuals who actually do not experience these symptoms, thus overestimating their number of symptoms present. As a result, the cut-off point used to identify individuals as potentially addicted to work (i.e., presence of at least four out of the seven symptoms of work addiction) is compromised and overestimates the number of potentially addicted to work individuals. Secondly, dichotomization of polytomous items substantially reduces the amount of information provided by the BWAS items and biases the estimates of the latent trait level. Thus, leading to the problem of class overlap where individuals with the same or almost the same levels of the latent trait are arbitrarily classified into different categories based on the polythetic approach. Consequently, this study shows that previously reported estimates of the prevalence rates of work addiction are not trustworthy and that new valid approach to identifying potentially addicted to work individuals should be developed. Additionally, these results emphasize the need for a formal clinical interview before classifying an individual as addicted to work, as many individuals classified as potentially addicted to work based on the polythetic approach had low levels of work addiction (EAP < 1.5) as established by the IRT framework. However, please note that even formal clinical interviews can have different results with different interviewers.

Future studies should aim at developing new valid approach to identifying potentially addicted to work individuals. In order to achieve this goal, future studies should first investigate whether the differences between IRT parameters for items measuring work addiction and IRT parameters for items measuring gaming addiction are associated with differences in the addictive process between work and gaming or are measurement related (i.e., differences in the wording of questions). Then, if these differences turn out to be measurement related, future studies should revise the BWAS with a focus on developing items capturing the specificity of work as behaviour, minimise the component of work engagement in items wording, and use wording indicating the high intensity of symptoms. Finally, future studies should

compare the IRT-based estimates of the latent trait level with clinical diagnoses of work addiction in order to determine at which level of the latent trait work addiction starts causing significant impairment in functioning for individuals, thus allowing to determine which level of the latent trait should be used as the cut-off point to identify individuals as potentially addicted to work. Last but not least, future studies should cross-validate the results of this study in independent samples.

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Appendix

Table A1 The Number of Symptoms Present and the Number of Possible and Actual Combinations of Response Pattern for the Dichotomized and the Polytomous Items

Number of symptoms	Number of individuals	Dichotomized items		Polytomous items	
		Possible combinations	Actual combinations	Possible combinations	Actual combinations
0	10,360	1	1	2,187	1,248
1	2,436	7	7	10,206	1,323
2	1,467	21	21	20,412	947
3	876	35	33	22,680	640
4	588	35	34	15,120	416
5	348	21	21	6,048	241
6	237	7	7	1,344	143
7	114	1	1	128	40
Total	16,426	128	125	78,125	4,998
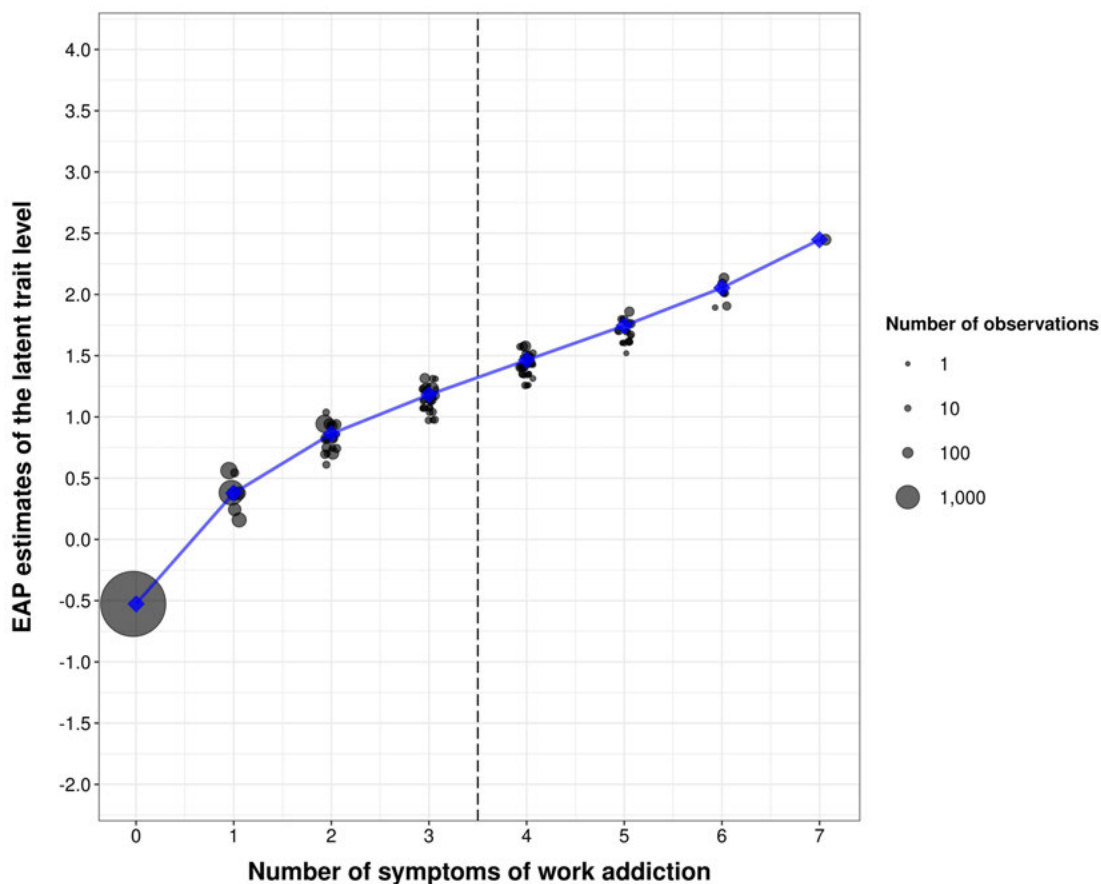
Figure 1. The relationship between the number of symptoms present and the EAP estimates of the latent trait level based on the dichotomized items. The circles represent unique response patterns and are jittered for ease of presentation. The blue rhombuses connected with the blue lines represent weighted mean values of the latent trait level for a given number of declared symptoms of work addiction. The dashed line depicts the cut-off point used by the polythetic approach.
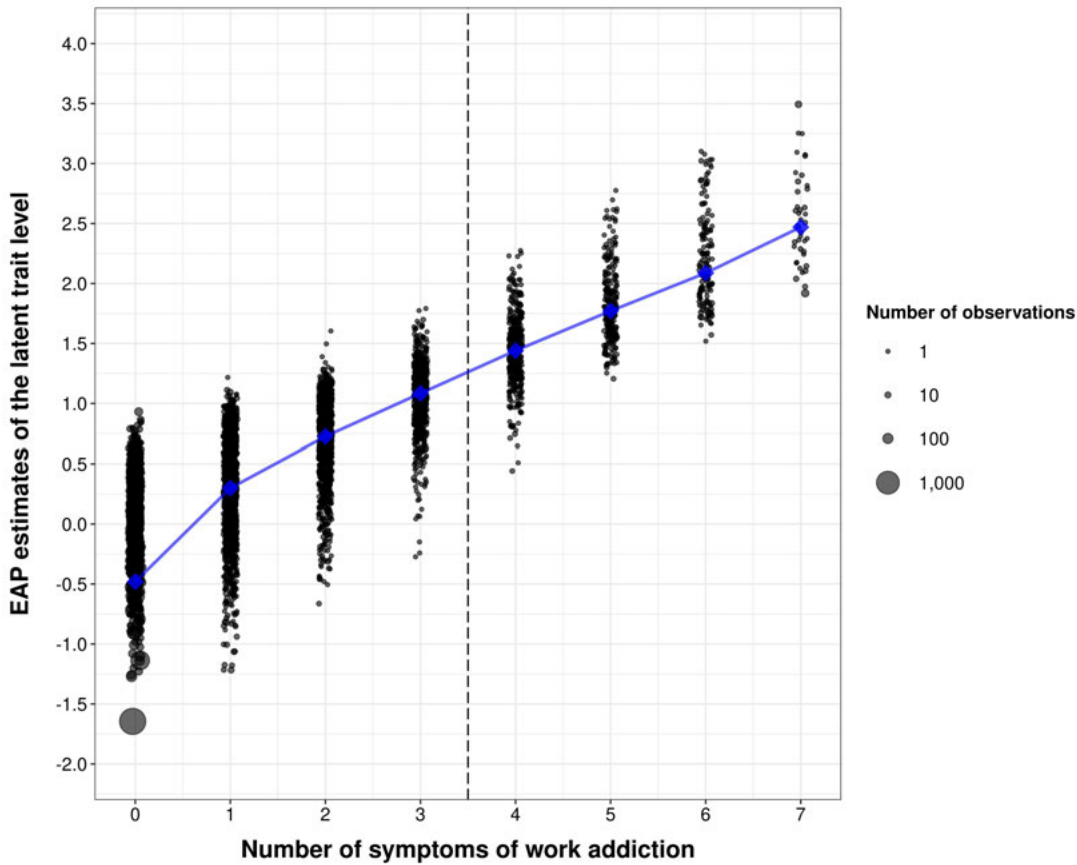
Figure 2. The relationship between the number of symptoms present and the EAP estimates of the latent trait level based on the polytomous items. The circles represent unique response patterns and are jittered for ease of presentation. The blue rhombuses connected with the blue lines represent weighted mean values of the latent trait level for a given number of declared symptoms of work addiction. The dashed line depicts the cut-off point used by the polythetic approach
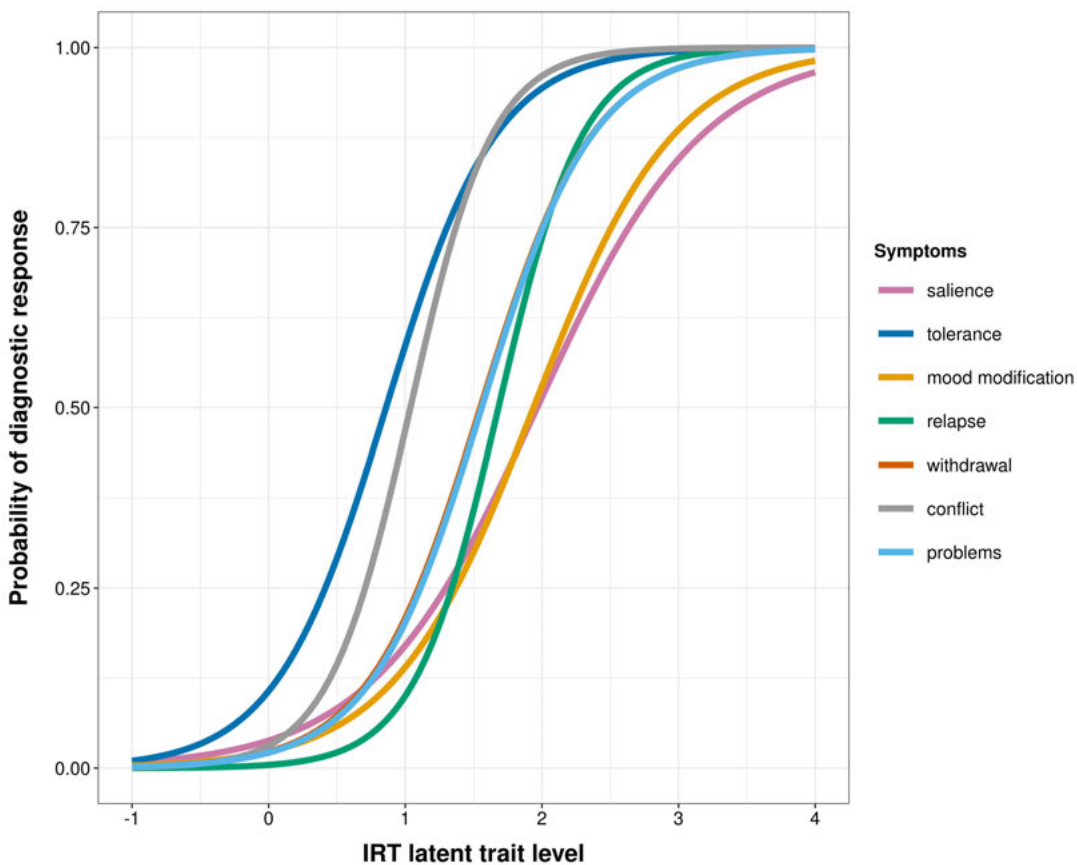
Figure 1A. The item characteristic curves for the dichotomized BWAS items
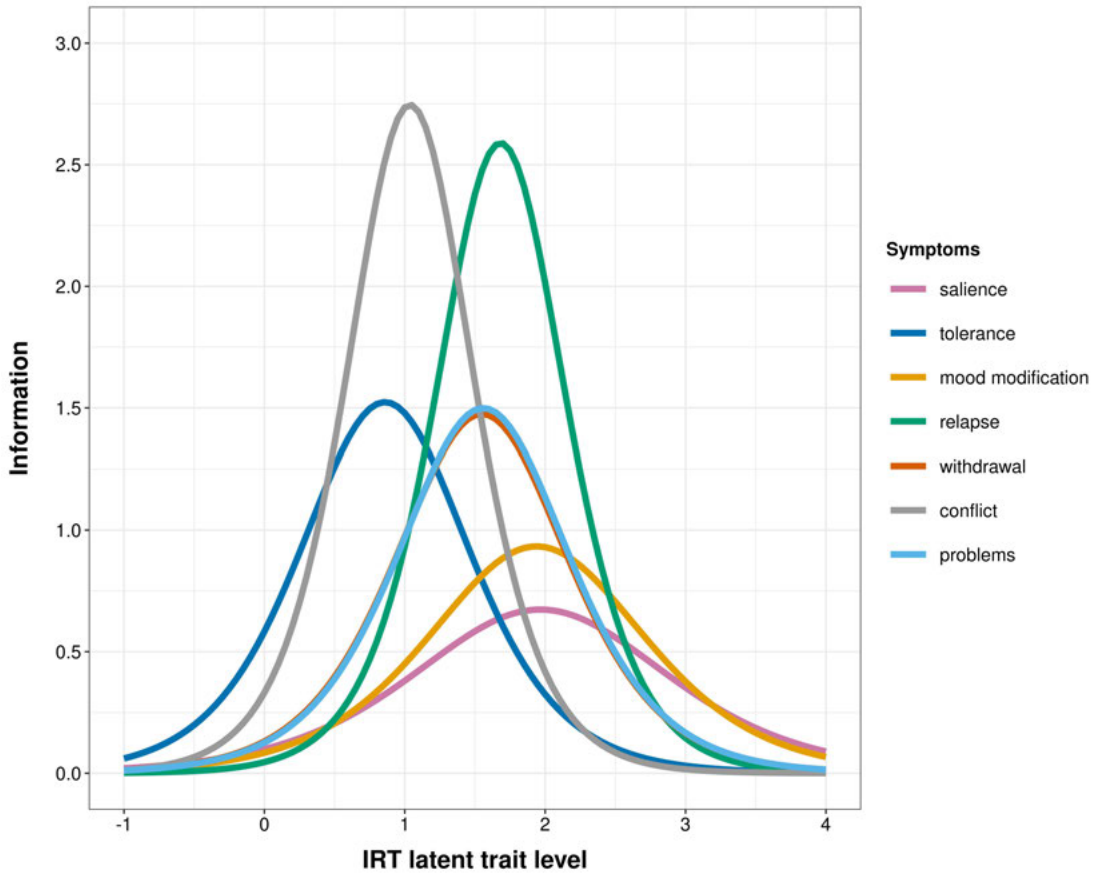
Figure A2. The item information functions for the dichotomized BWAS items
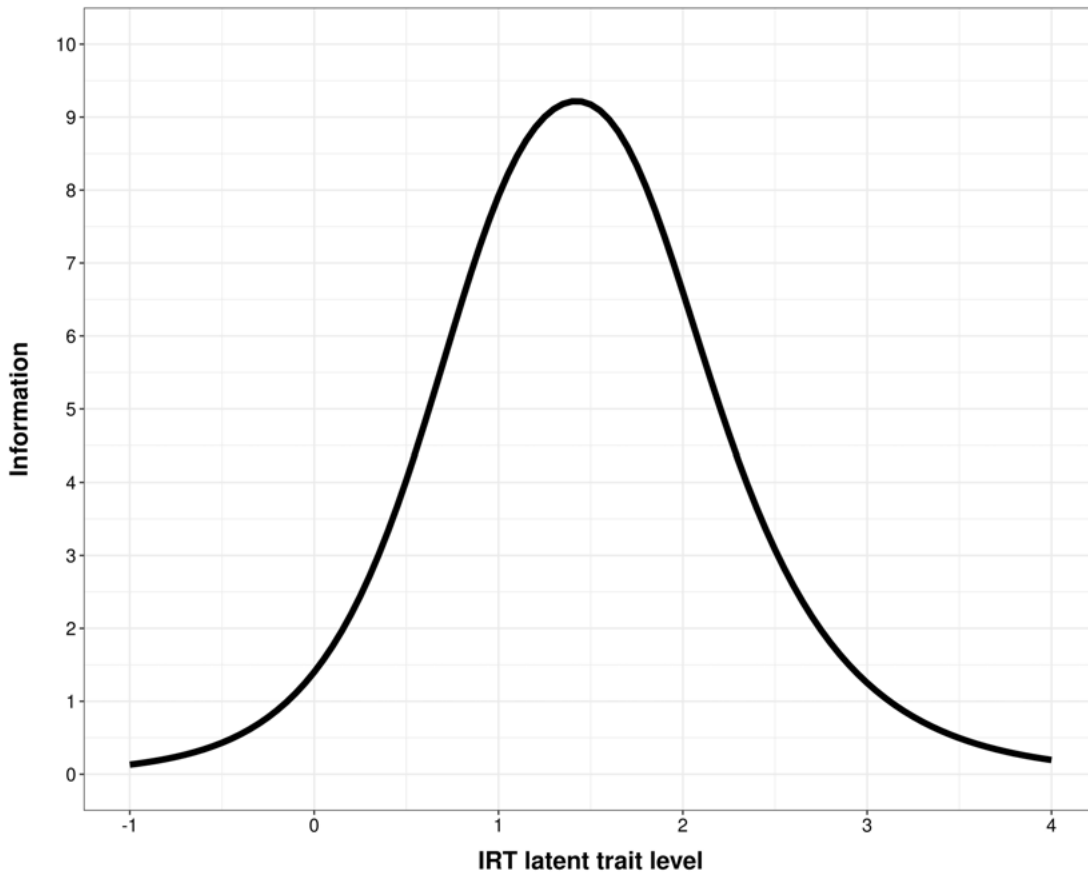
Figure A3. The test information function for the dichotomized BWAS items
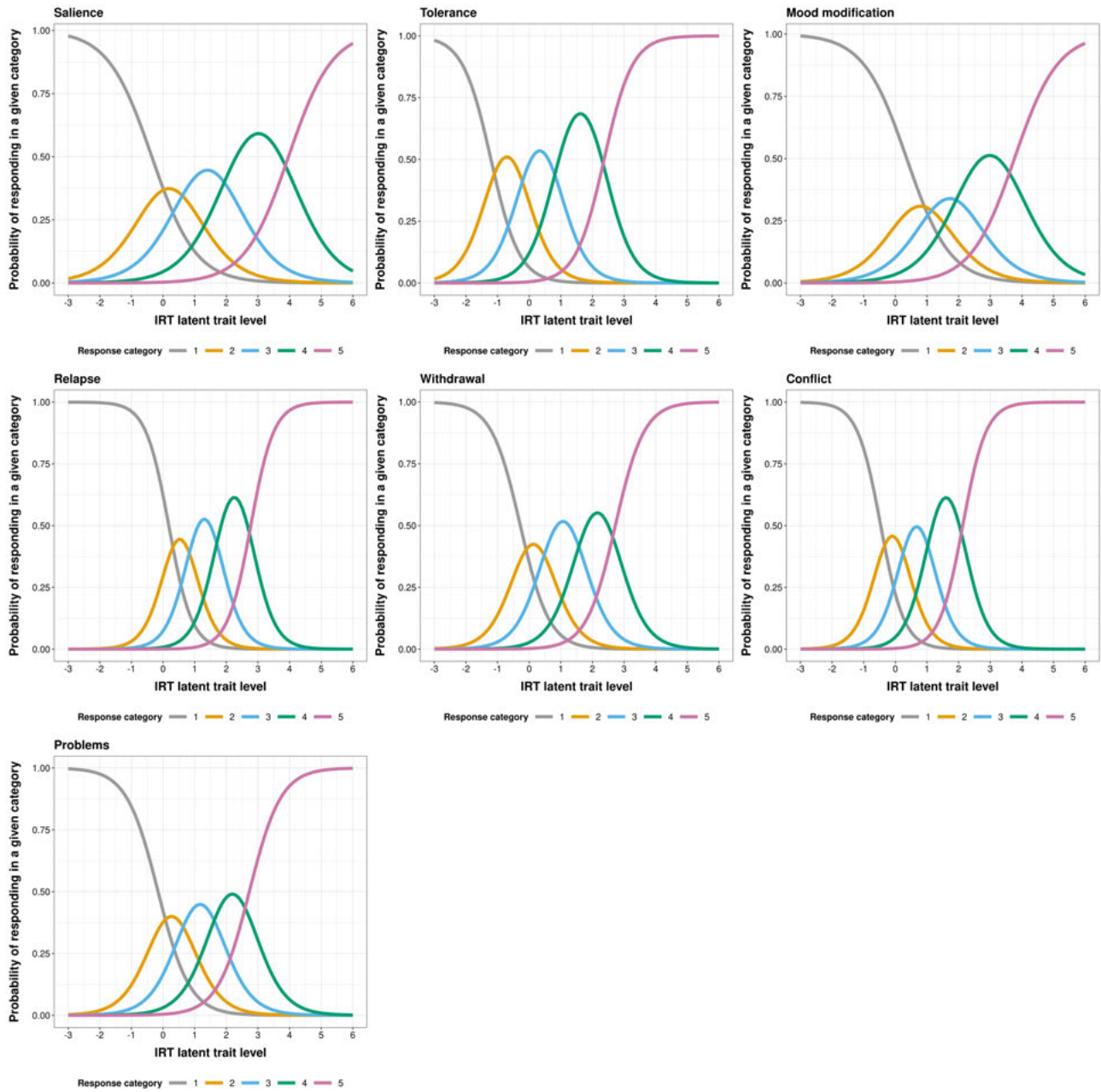
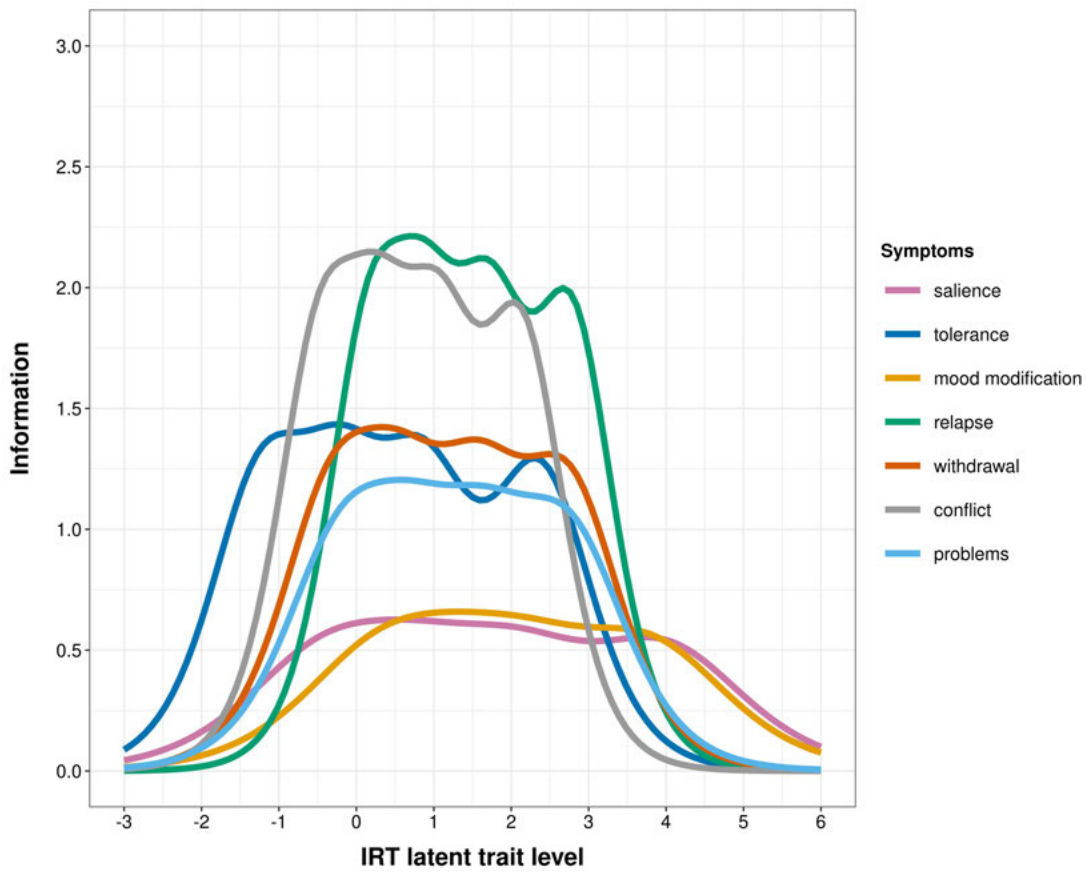**Figure A4. The category response curves for the polytomous BWAS items**

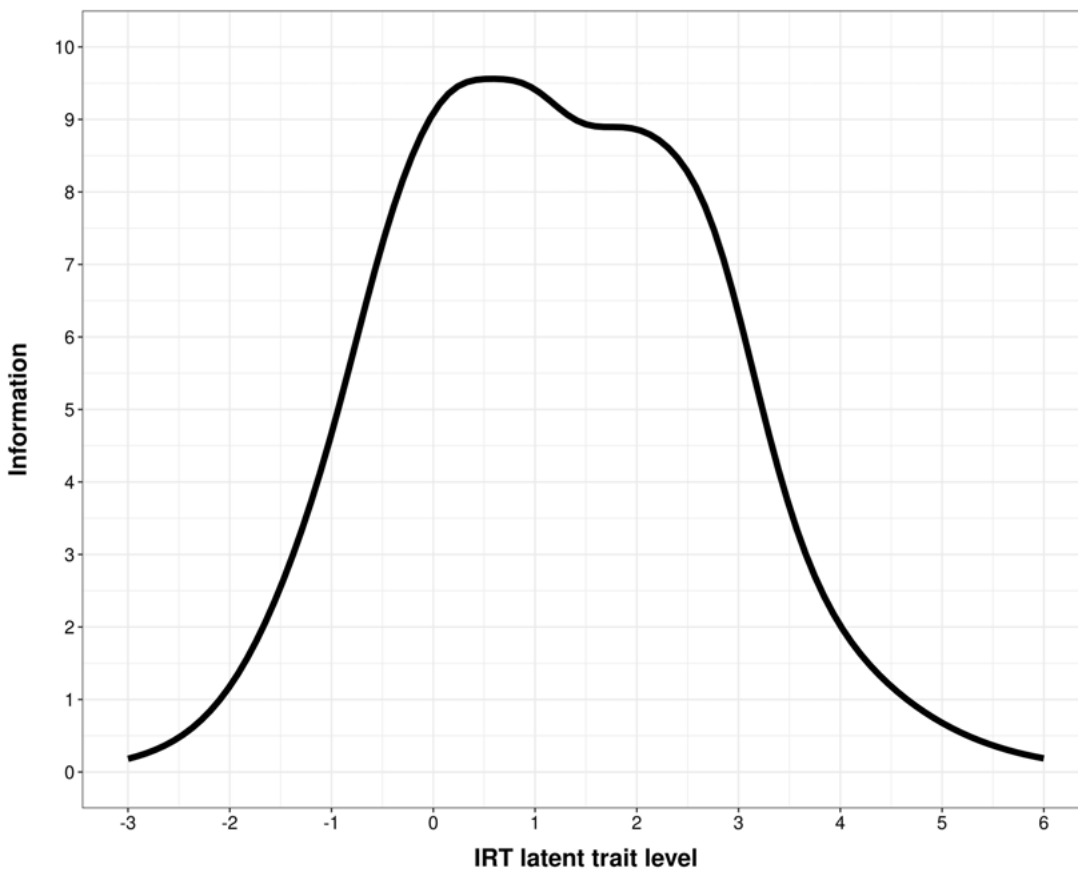**Figure A5. The item information functions for the polytomous BWAS items**

Figure A6. The test information function for the polytomous BWAS items.