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Examining differential item functioning of social interaction and performance fears in people with hazardous alcohol consumption and probable alcohol dependence

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ABSTRACT

A growing body of evidence has highlighted the significant relationship between social anxiety disorder and hazardous alcohol consumption, harmful use, and alcohol use disorder. This relationship may influence the reporting of fear and avoidance of social or performance situations on common self-report measures among individuals with hazardous alcohol use or dependence. As such, the current study utilised modern psychometric methods, namely Item Response Theory (IRT) and Differential Item Functioning (DIF), in an online sample of Australian adults (n=1052) to examine the potential under- or over-reporting of items on the Social Interaction Anxiety and Social Phobia Scales (SIAS/SPS) by groups of alcohol users (as measured by the Alcohol Use Disorders Identification Test), while controlling for underlying levels of social anxiety severity. The results indicated that there were no items on the SIAS/SPS that exhibited significant (p<0.01) and meaningful DIF (based on an a priori cut-off of change in pseudo-R^2 across nested models >0.05) attributable to either hazardous consumption or symptoms of alcohol dependence. Moreover, the combined effect of multiple items that demonstrated significant (but non-meaningful) DIF on total SIAS scores relative to scores that assume no DIF between alcohol using groups was minimal. These results suggest that different rates of social anxiety across levels of alcohol consumption and alcohol dependence may not be the result of a systematic under- or over-reporting of certain items on the SIAS and SPS, and as such total social anxiety scores can be compared regardless of the level of alcohol use or dependence symptoms.

Keywords: Social anxiety; alcohol use; alcohol dependence; differential item functioning; item response theory.

Introduction

Social anxiety disorder (or social phobia; SAD) is defined by a chronic and disabling fear of everyday social and/or performance situations where an individual is open to scrutiny or negative evaluation by others (American Psychiatric Association 2013). Relative to other anxiety disorders, SAD is highly prevalent, disabling, and associated with a long latency from first onset to seeking treatment (Chartier et al. 2003; Kessler et al. 2007; Ruscio et al. 2008; McEvoy et al. 2011). SAD often first presents in late childhood and early adolescence, with few cases emerging after the age of 25 years (Kessler et al. 2007). If left untreated, SAD tends to be pervasive across the lifespan with severity fluctuating between sub-clinical and clinical levels (Blanco et al. 2011; Beesdo-Baum et al. 2012). Moreover, there are substantial negative outcomes associated with SAD including poor educational outcomes, impaired workplace functioning, limited social relationships, and increased comorbidity with other mental disorders such as depression, panic disorder, obsessive compulsive disorder, and generalized anxiety disorder (Grant et al. 2005; Stein et al. 2017).

A growing body of evidence has also highlighted the interaction between SAD and hazardous alcohol consumption, harmful use, and alcohol use disorder. Indeed, large scale epidemiological studies have demonstrated a higher proportion of problematic alcohol use and alcohol use disorder among those with a diagnosis of SAD compared to those without SAD (Buckner et al. 2008; Schneier et al. 2010). Those with SAD experience a 53% increase in the speed of transitioning from first alcohol use to alcohol use disorder in comparison to those without SAD (Kushner et al. 2011; Marel et al. 2019). Together, alcohol use and SAD have been shown to perpetuate and worsen each condition in a negative spiral, thus resulting in poorer outcomes compared to those who experience either SAD or alcohol use disorder (AUD) alone (Prior et al. 2017; Oliveira et al. 2018). Moreover, studies examining the temporal sequence of anxiety and alcohol use disorders have demonstrated that SAD

commonly predates AUD unlike panic disorder, major depression, and generalized anxiety disorder, which are often observed as a mix of presenting either first or second relative to AUD (Falk et al. 2008). Despite this, SAD is often under-treated, ignored, or un-recognised among individuals with problematic alcohol use or alcohol use disorder, thus limiting treatment options that could reduce the severity of both conditions simultaneously (Stapinski et al. 2015).

One potential limitation impacting the recognition and measurement of SAD among hazardous alcohol users or those with an alcohol use disorder is the common reliance on self-report questionnaires to measure SAD (Wong et al. 2016). There are several reasons to expect that hazardous consumption might lead to biased responses that are unrelated to their underlying severity levels of SAD (e.g. systematic under-reporting or over-reporting) when responding to items about the extent of their fear or avoidance when faced with social or performance situations. Primarily, studies have proposed that alcohol might be used as a strategy to reduce anxiety when in certain social situations, particularly situations that commonly involve alcohol consumption such as parties, social gatherings, meeting new people, or in dating situations (Thomas et al. 2003; Buckner & Heimberg 2010). People who rely on alcohol to cope with these social situations might therefore under-report the fear or avoidance that they experience without using alcohol, such that total scores would not accurately reflect the extent of their underlying SAD severity. Instead, their total scores to some extent would be influenced by external factors associated with group membership, in this instance that would reflect differences in responding due to whether the respondent reports high or low alcohol use. As such, any analysis that holds total social anxiety scores constant and compares individual item responses across high and low alcohol using groups may detect differential responses. Similarly, the physiological effects of heavy alcohol use may alter awareness and appraisal processes (e.g. effects on executive function) and could

lead to altered endorsement of specific symptoms that are associated with anxiety (e.g. physiological arousal) such that the relationship between these specific symptoms and a latent dimension of anxiety may differ when AUD is present versus absent (Sinha et al. 2009; Abrams et al. 2018).

Revisions to existing scales or the development of scales that are tailored to alcohol using populations may be required to draw accurate comparisons with non-users or low alcohol users if significant biases are identified. Moreover, the presence of significant levels of reporting bias among specific social and performance situations may provide further insights into the comorbid relationship between alcohol use and SAD, given the expression of one disorder potentially impacts on the expression of another. Researchers and clinicians might need to consider such unique interactions between alcohol use and specific social/performance fears when drawing conclusions about the level of severity and impairment attributed to SAD. Alternatively, if no bias is identified this potentially suggests that the presence of one disorder does not impact on the reporting of symptoms present in another disorder and that comorbidity among AUD and SAD might reflect an additive process.

Alcohol use and associated problems represent highly heterogeneous constructs with differing prevalence and severity. In this paper, alcohol use and associated problems are viewed in the framework of alcohol consumption (light to hazardous), alcohol related harms and consequences (up to harmful drinking), and alcohol dependence consistent with ICD-10 as applied in the Alcohol Use Disorder Identification Test (AUDIT; Saunders et al. 1993). Recent studies have identified differential effects between anxiety and alcohol use depending on the level of alcohol consumption and/or dependence (Dyer et al. 2019). Studies have demonstrated that social anxiety might be protective against lower levels of alcohol consumption and delay first use of alcohol among adolescents, however this association

appears to change direction at higher rates of consumption and among those with dependence symptoms (Stewart et al. 2006). Likewise, at low to moderate levels of consumption, alcohol may be perceived to facilitate some social performance, whereas heavy drinking in social contexts may be perceived to hinder performance and increase fear of embarrassment or social humiliation (Ham et al. 2016). As such, the current study aimed to identify the differential reporting of social interaction and performance fears among a subset of those with hazardous levels of consumption (regardless of alcohol dependence symptoms) and additionally among those with probable alcohol dependence (reflecting a more severe subset of alcohol users).

To our knowledge, no study has investigated the potential for bias among items used to assess the severity of SAD in different alcohol using populations. In line with existing research, we hypothesized that there may be a specific subgroup of people who use alcohol in a hazardous manner to cope with high social anxiety, and that if their social anxiety were consequently reduced in social situations, they may thus report specific social anxiety items differentially in comparison to those with social anxiety without hazardous alcohol use. As such, any analysis controlling for underlying social anxiety scores across groups with high and low alcohol consumption would be expected to find differential reporting of social anxiety items (i.e. differences not due to underlying levels of social anxiety but due to biased reporting in group membership; in this case, alcohol use). To test this hypothesis, the current study utilised modern psychometric methods, namely Item Response Theory (IRT) and Differential Item Functioning (DIF), to examine the potential under- or over-reporting of SAD symptoms among different groups of alcohol users (low/high alcohol consumption, presence/absence of probable alcohol dependence), while controlling for underlying levels of SAD severity. The application of DIF is well-suited to the identification of potential bias in the reporting of questionnaire content: DIF seeks to determine if a specific questionnaire item

is reported at different rates across multiple populations, despite both groups being in terms of their underlying latent severity (Teresi 2006; Teresi & Fleishman 2007).

Methods

Participants

Data for the current study were from an online survey of community-dwelling, English-speaking, Australian adults (aged 18 years or over) conducted between November 2016 and January 2017. Advertisements for the online survey were placed as a promoted link and paid advertisements on the Facebook website. The advertisements offered participants the opportunity to answer questions to improve the measurement of anxiety disorders, such as social anxiety and panic disorder. A total of 4,147 users clicked on the advertisements and were taken to a participant information and consent form. No compensation was provided for participation in the survey. Of those users who clicked the advertisements, 1,988 (48%) provided informed electronic consent and commenced the online survey (hosted on the SurveyMonkey platform). Only participants who submitted the survey were included in this study, resulting in a final sample size of 1,052 (53% of those who provided consent). The survey was approved by the UNSW Human Research Ethics Committee (HC no. 16428).

Measures

Social and performance fears

Social and performance fears were measured using the Social Interaction Anxiety Scale (SIAS) and the Social Phobia Scale (SPS) (Mattick & Clarke 1998). The scales were designed as companion self-report scales to measure two related, yet distinct, facets of social anxiety. Each scale included 20 items targeting either a range of situations that might involve anxiety related to initiation and maintenance of everyday social interactions or situations related to performance tasks or public scrutiny. Respondents were required to indicate how

characteristic each item is of them on a five-point scale (ranging from 0=not at all characteristic or true of me to 4=extremely characteristic or true of me). The SIAS/SPS have been widely used and possess sound psychometric properties including high internal consistency, test-retest reliability, and discriminant and convergent validity (Peters 2000; Modini et al. 2015). Coefficient alpha for the SIAS and SPS in the current sample were 0.95 and 0.96, respectively.

Alcohol use

The AUDIT was used to determine past-year hazardous levels of drinking and probable alcohol dependence (Babor et al. 2001). The AUDIT is a widely used screening measure endorsed by the World Health Organisation. The alcohol consumption subscale comprising the first three questions of the AUDIT was used to examine hazardous consumption (AUDIT-C; Bradley et al. 2007), with sum scores ranging from 0 to 12. Similarly, the alcohol dependence subscale (comprising items 4, 5, and 6) was used to assess probable alcohol dependence (AUDIT-D; Saunders et al. 1993). Previously determined cut-points (scores ≥4 for males and ≥3 for females for the AUDIT-C and scores ≥4 for the AUDIT-D) were used to categorise respondents into low and high-risk groups (Fleming 1996; Bradley et al. 2007). Finally, given all cases with probable dependence also had hazardous consumption scores, a three-level categorical variable was created that comprised 1=low consumption and no dependence, 2=hazardous consumption and no dependence, and 3 = probable dependence (regardless of consumption).

Statistical analysis

Assumption testing

The specific DIF analysis used in the current study requires the use of the graded response model, suitable for data with ordinal-categorical response options. This model

assumes that the data can be accurately explained by a single latent dimension and that items exhibit local independence - that is, there is no substantial correlation between the items once accounting for covariance via the latent dimension.

To examine the dimensionality of each SAD scale we used confirmatory factor analysis (CFA) with all items loading on a single factor and a weighted least square mean and variance adjusted (WLSMV) estimator in Mplus version 8.1 (Muthen & Muthen 2015). To evaluate model fit, a combination of the Comparative Fit Index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA) were inspected. There is no consensus regarding cut-offs associated with fit statistics when informing dimensionality (Lai & Green 2016). Moreover, these statistics have been shown to be influenced by additional features such as sample size or skew (Cook et al. 2009). As such, we used previously reported cut-off values as guidelines only to inform the decision (CFI/TLI >0.95 and RMSEA<0.08) along with additional exploratory bifactor modelling to examine the impact of unmodeled multidimensionality on the estimated item parameters (Hu & Bentler 1999; Reise et al. 2010; Maydeu-Olivares & Joe 2014). The exploratory bifactor analysis involved estimating a series of bifactor models (i.e. items loading on a single general factor as well as additional specific factors that flexibly model multidimensionality) with increasing numbers of specific factors (1 through to 4). The models were estimated in Mplus with a WLSMV estimator and a bi-geomin (orthogonal) rotation. The best fitting exploratory bifactor models were selected based on CFI/TLI>0.95 and RMSEA<0.08 for separate models for both scales. We calculated additional indices, such as explained common variance (ECV) and coefficient OmegaH, associated with the best fitting bifactor model to determine the strength and robustness of a single general factor (Rodriguez et al. 2016). The ECV describes the proportion of all common variance (i.e. both general and group factors) explained by a single general factor, whereas OmegaH describes the proportion of variance in unit-weighted total

scores that is attributable to a single general factor. Higher scores on both statistics are supportive of essential unidimensionality. Finally, local independence of the items was examined by inspection of the residual correlation matrix after fitting a unidimensional IRT graded response model (Samejima 1997). Any residual correlation >0.2 between item pairs was flagged for potential local dependence (Chen & Thissen 1997).

DIF Analysis

A hybrid ordinal logistic regression/IRT-based framework was used to examine whether any SIAS and SPS items showed DIF for low, hazardous consumption, or probable dependence scores. The IRT modelling approach was chosen given it is particularly well suited at examining DIF in item-based scales with categorical/ordinal response options. This approach fits and compares a series of nested ordinal logistic regression models for each item treated as the dependent variable (Choi et al. 2011). The first model, also known as the base or comparison model, assumes that response options are predicted by individual differences on the latent SAD severity dimension only. This model assumes that DIF is not present in the questionnaire items. A second model is then estimated that assumes the response options to each item can be predicted by both latent SAD severity and group membership (e.g. low consumption, hazardous consumption, probable dependence) entered as explanatory variables. If model 2 provides significantly better fit than model 1, it is concluded that significant DIF across AUDIT groups is present in that specific item (DIF across threshold parameters or uniform DIF). A third model is then estimated that includes the interaction term between latent SAD severity and group membership variables (DIF across discrimination parameters or non-uniform DIF). Comparisons between model 3 and model 2 provide some indication of whether the DIF is consistent across latent SAD severity (uniform DIF) or whether it varies depending on underlying SAD severity (non-uniform DIF). DIF is detected over multiple iterations with items that are flagged for DIF treated as unique across

groups and group-specific parameters are obtained. Items that are not flagged for DIF are treated as the anchor set and parameters are constrained to equality across the groups.

Pairwise comparisons between the three models for each item were estimated using Chi-Square log likelihood difference tests with *p*-values indicating significance set at <0.01. Sample size has been shown to substantially impact Chi-square statistics with minor deviations resulting in highly significant results. Therefore, additional tests based on change in pseudo-R^2 have been suggested to differentiate between statistically significant DIF and meaningfully significant DIF. Previous studies have indicated that non-meaningful DIF can be determined by a change in pseudo-R^2 between the models <0.05 (Kim et al. 2007; Cook et al. 2017). The current study used McFadden's pseudo-R^2, which can range from 0 to 1 and represents an approximation of the amount of variance explained by the logistic regression model.

Finally, to determine the overall impact of any identified statistically or meaningfully significant DIF on the final scores on the SIAS and SPS, we estimated two scores for all individuals: 1) correcting for DIF and 2) not correcting for DIF. These two scores were compared using Spearman rank correlations and used to estimate the average mean difference (bias) due to DIF.

Results

Sample characteristics

Overall, the sample was skewed towards participants who were female (77%), younger (45.5% aged 18-35 years), and more educated (77% post-high school education) than what would be expected in a nationally representative sample. The prevalence of hazardous consumption was quite high with approximately 46% (*n*=480) of the sample scoring high (≥4 for males and ≥3 for females) on the AUDIT-C (regardless of dependence

scores). Probable alcohol dependence (score of 4 or more on the AUDIT-D regardless of consumption scores) was evident in approximately 6% (*n*=60) of the sample. The sample characteristics of each AUDIT group are provided in Table 1.

The SIAS and SPS mean scores by AUDIT groups are provided in Table 2. Respondents with hazardous consumption scored significantly lower on the SIAS although the difference was small in magnitude according to Hedges' *g* effect size (0.20). Conversely, respondents with probable dependence scored significantly higher on the SIAS and SPS with small to moderate effect sizes across the two instruments (-0.28, -0.32).

Assumption testing

According to the confirmatory factor analyses, a unidimensional model provided acceptable fit to the SIAS and SPS items fitted separately based on CFI and TLI values greater than 0.95, although the RMSEA values were larger than 0.08 (see Table 3). The ECV and OmegaH values associated with the best fitting exploratory bifactor models were high (ECVs>=0.87 and OmegaHs>=0.96) suggesting that each scale can be regarded as essentially unidimensional and interpreted as such. Inspection of the residual correlation matrices (after fitting the unidimensional model) for the two scales identified only one pairwise combination between items SIAS9 ("I am at ease meeting people at parties") and SIAS11 ("I find it easy to think of things to talk about") with a residual correlation >0.2. The high residual correlation is most likely due to the positive wording and reverse coding shared by the two SIAS items, compared to the otherwise largely negatively worded items on the two measures. Despite the local dependence among these two items, we continued to use IRT-based DIF analysis given the large OmegaH and ECV values (indicating any local dependence and unmodelled multidimensionality will likely have a small impact) and because inspection of the IRT parameters did not provide any indication of inflated discrimination values.

DIF analysis

Both measures were tested for DIF across AUDIT groups separately. Table 4 shows the items with significant DIF. Three items from the SIAS were found to have significant uniform DIF across respondents with low, hazardous consumption, and probable dependence scores based on significant Chi-Square log likelihood difference tests at $p<0.01$. The items were SIAS7 ("When mixing socially, I am uncomfortable"), SIAS9 ("I am at ease meeting people at parties, etc."), and SIAS17 ("I feel I'll say something embarrassing when talking"). The direction of the DIF indicated that the hazardous consumption and probable dependence groups were less likely to feel uncomfortable when mixing in a group, more likely to feel at ease meeting people at parties, and more likely to feel that they will say something embarrassing when talking in comparison to the low consumption group (despite holding underlying SIAS severity scores constant across groups). However, when applying criteria for identifying meaningful levels of DIF (change in pseudo-$R2$ >0.05), there were no items on the SIAS that remained significant. Similarly, there were no items in the SPS that demonstrated statistically or meaningfully significant levels of DIF across the alcohol groups.

Impact of DIF on total scores

Given the potential that multiple items demonstrating non-meaningful but significant levels of DIF could be combined to have a greater impact total severity scores, we conducted additional sensitivity analyses on the impact of overall DIF on the SIAS total scores. Two scores for the SIAS were estimated using IRT parameters generated using the total sample (uncorrected) versus IRT parameters that were specific to the AUDIT groups (corrected) for the items demonstrating significant DIF. The uncorrected and corrected scores for the SIAS were highly correlated (r=0.999, see Figure 1) and resulted in a non-significant mean

difference (bias=0.00, t=0.07, df=1051, p=0.95) and small root mean square error (RMSE = 0.01). As such, the impact of the identified DIF on the total SIAS severity score was minimal.

Discussion

The results of the current study found little evidence to support the hypothesis that reporting of fear or avoidance of specific social or performance situations was different among people with hazardous consumption and probable dependence scores. Indeed, there were no items from the SIAS and the SPS that exhibited meaningful DIF attributable to either hazardous consumption or symptoms of alcohol dependence. Moreover, the combined effect of multiple items that demonstrated statistically (but not meaningfully) significant DIF on total SIAS scores was minimal. These results suggest that different rates of social anxiety across alcohol consumption and dependence are not the result of a systematic under- or over-reporting of specific items on the SIAS and SPS. As such total SAD scores on these measures can be compared and interpreted consistently regardless of the level of alcohol use or presence of dependence symptoms.

When comparing the total mean SIAS and SPS scores between the alcohol groups in the current study, the findings suggested that total SIAS scores were significantly *lower* for hazardous alcohol consumers in comparison to low alcohol consumers. A potential interpretation for this finding might be the use of alcohol to cope with anxiety in general (e.g. core feelings of anxiety when faced with potential embarrassment or scrutiny) rather than using alcohol solely in specific social interaction or performance situations, which has received mixed supported in the literature (Dyer et al. 2019). Another possibility is that people with lower social anxiety tend to socialise more, tend not to avoid social interactions or performance situations, and therefore may have on average higher levels of alcohol

consumption related to the increased opportunities to drink at social events or experience increased pressure to drink at social events.

Comparisons of total SIAS and SPS scores indicated that those with probable alcohol dependence scored significantly *higher* than those without probable alcohol dependence—each associated with small to moderate effect sizes. Importantly, the lack of any significant DIF between these groups indicates that these total score comparisons accurately reflect differences in underlying SAD severity, rather than any systematic over- or under-reporting of specific fears by one of the comparison groups. These findings correspond to large scale epidemiological and clinical research that has identified a strong association between alcohol use disorder and social anxiety, perhaps reflecting common factors that result in an additive process among comorbid conditions (Goodwin et al. 2004). Moreover, these findings reflect broader trends in the literature that identified significant correlations between substance use disorders and internalizing disorders (mood and anxiety) more generally (Slade & Watson 2006; Wright et al. 2013).

These findings in the opposite directions for high alcohol consumption versus probable alcohol dependence also reflects previous evidence - for example, that some degree of social anxiety can be protective against milder forms of alcohol consumption and can even delay the first use of alcohol, but this relationship reverses at clinical levels of SAD and alcohol use disorder (Stewart et al. 2006). Notably, the combination of high social anxiety and expectancies about the benefits of alcohol in social situations has been linked to greater negative consequences related to alcohol. Additional research on the inter-relationship between social anxiety, alcohol expectancies, and environmental factors (such as peer influence) at a population level is required to explain the complex relationship between social anxiety and harmful consumption/dependence (Cooper et al. 2016; Ham et al. 2016; Villarosa et al. 2016).

There are limitations associated with the current study that should be noted when interpreting the results. First, the data were obtained using a cross-sectional survey design and therefore preclude the ability to draw causal interpretations between alcohol use and SAD, or to discern any temporal order. However, these results focused on current self-perceptions of SAD symptoms and typical alcohol use in the past 12 months, increasing the confidence that these two constructs could be observed as a co-occurring. Second, the data represented an online convenience sample of Australian adults who responded to an advertisement calling for research participants. As such, although the sample had variability and representation of the symptoms of interest, the generalisability of the results to the population or to clinical sample is not clear. Additional research among various populations is required to replicate the findings demonstrated here. Third, there is some evidence to suggest that the context of alcohol consumption plays a role in the relationship between social anxiety and alcohol consumption/problems, with higher rates of social anxiety associated with greater solitary drinking than social drinking (Keough et al. 2016; Buckner & Terlecki 2016). However, the current study utilised an alcohol consumption measure (e.g. the AUDIT) that did not differentiate between contexts associated with alcohol consumption and therefore precluded our ability to examine this relationship in greater detail.

Taken together, the current study found insufficient evidence for meaningful levels of DIF associated with items from two SAD scales across different groups of hazardous consumption and dependence scores according to the AUDIT. Based on these results, the SIAS and SPS scales can be used to accurately generate SAD severity scores and can be interpreted and compared between groups regardless of the co-occurring level of hazardous consumption or the presence of alcohol dependence symptoms.

Declaration of Interest

The authors report no conflicts of interest.

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Tables

Table 1: Sample descriptive in total and by AUDIT groups

		Total sample (n=1052)		AUDIT (Low; n=572))		AUDIT (Hazardous consumption no dependence; n=420)		AUDIT (Probable dependence; n=60)	
		N	%	N	%	N	%	N	%
Age	**18-25**	245	23.3	133	23.3	102	24.3	10	16.7
	26-35	233	22.2	128	22.4	99	23.6	6	10.0
	36-45	153	14.5	76	13.2	62	14.8	15	25.0
	46-55	186	17.7	102	17.8	65	15.5	19	31.7
	56-65	173	16.4	97	16.9	68	16.2	8	13.3
	65+	62	5.9	36	6.3	24	5.7	2	3.3
Gender	**Male**	208	19.8	100	17.5	93	22.1	15	25.0
	Female	813	77.3	451	78.8	318	75.8	44	73.3
	Other	23	2.2	17	3.0	5	1.2	1	1.7
	Prefer not to answer	5	0.5	2	0.4	3	0.7	0	0.0
	Missing	3	0.3	2	0.4	1	0.2	0	0.0
Education level	**Some secondary school**	25	2.4	17	3.0	5	1.2	3	5.0
	Year 10 or equivalent	39	3.7	20	3.5	16	3.8	3	5.0
	Year 12 or equivalent	169	16.1	94	16.4	65	15.5	10	16.7
	Certificate level I-IV	167	15.9	96	16.8	59	14.1	12	20.0
	Diploma/Associate degree	114	10.8	72	12.6	35	8.3	7	11.7
	Bachelor's degree	257	24.4	134	23.4	112	26.7	11	18.3
	Graduate diploma/Graduate certificate	112	10.7	61	10.7	48	11.4	3	5.0
	Master's degree	115	10.9	50	8.7	57	13.6	8	13.3

	Doctoral degree	47	4.5	24	4.2	20	4.8	3	5.0
	Prefer not to answer	7	0.7	4	0.7	3	0.7	0	0.0
Area	**Metropolitan**	508	48.3	284	49.7	192	45.7	32	53.3
	Regional	447	42.5	243	42.5	183	43.6	21	35.0
	Rural	92	8.7	43	7.5	42	10.0	7	11.7
	Missing	5	0.5	2	0.4	3	0.7	0	0.0

Table 2: Social anxiety disorder scores by AUDIT groups

		AUDIT groups			Pairwise comparisons		
	Total M (SD)	**Low (n=572) M (SD)**	**Hazardous consumption no dependence (n=420) M (SD)**	**Probable dependence (n=60) M (SD)**	**Low vs Hazardous p (Hedge's g)**	**Low Vs Dependence p (Hedge's g)**	**Hazardous vs Dependence p (Hedge's g)**
SIAS	38.4 (18.9)	39.6 (18.9)	35.9 (18.4)	45.1 (19.5)	<0.01 (0.20)	0.03 (-0.28)	<0.01 (-0.49)
SPS	24.5 (19.3)	25.0 (19.4)	22.9 (18.6)	31.3 (20.7)	0.08 (0.11)	0.02 (-0.32)	<0.01 (-0.44)

Table 3: Confirmatory factor analysis and exploratory bifactor analysis of the SIAS and SPS

	Unidimensional CFA			Exploratory Bifactor analysis*				
	CFI	**TLI**	**RMSEA**	**CFI**	**TLI**	**RMSEA**	**ECV**	**OmegaH**
SIAS	0.96	0.95	0.11	0.99	0.98	0.07	0.87	0.94
SPS	0.97	0.97	0.09	0.99	0.98	0.07	0.91	0.97

Notes: * The best fitting exploratory bifactor model comprised one general factor and 2 specific factors.

Table 4: Logistic regression/IRT DIF results for SIAS and SPS

		AUDIT groups	
Item	**Wording**	**U DIF**	**N DIF**
SIAS7	When mixing socially, I am uncomfortable	x	
SIAS9	I am at ease meeting people at parties, etc.	x	
SIAS17	I feel I'll say something embarrassing when talking	x	

Notes: Only items with statistically significant DIF were presented in the table. Full results are provided in the supplementary material. x indicates DIF was significant based on chi-square loglikelihood difference test $p<0.01$. Bold x indicates DIF was significant based on difference in McFadden's pseudo-R^2 >0.05 between nested models. U DIF = uniform differential item function. N DIF = nonuniform differential item functioning.

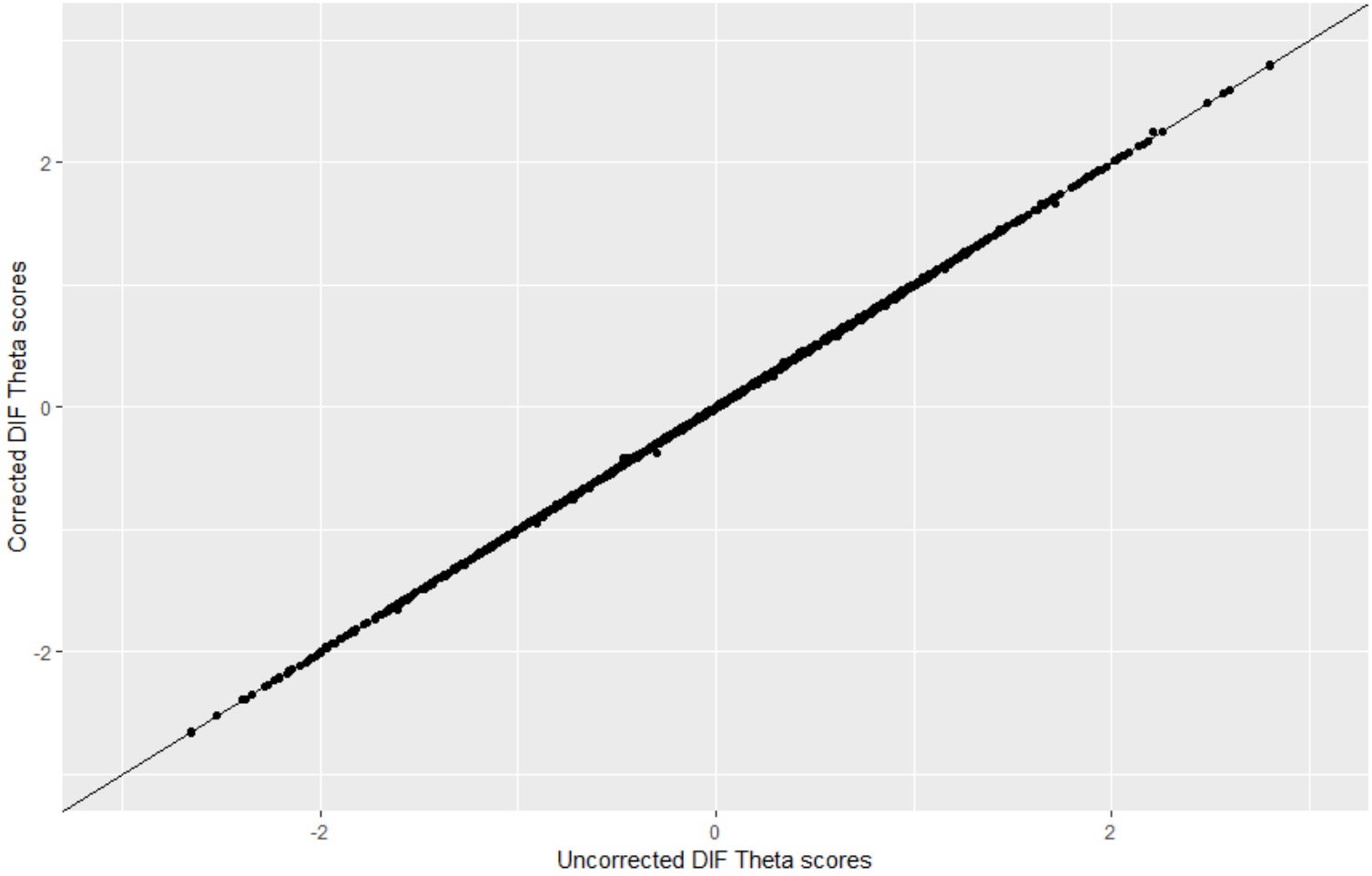

Figure 1: Comparison of IRT Theta scores generated using parameters that were corrected and uncorrected for meaningful DIF across AUDIT groups in the SIAS scale.