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The Cannabis Abuse Screening Test (CAST) revisited: examining measurement invariance by age

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Abstract

Defensible use of self-reported cannabis use problem scales in age comparative frameworks requires that measured constructs have equal psychometric properties across age groups. This study compares the psychometric properties of the Cannabis Abuse Screening Test (CAST) across three age groups (18–24, 25–29, 30–40). Data was collected online from an accessible sample of 1316 cannabis users. Factor analysis compared the optimal factor structure and dimensionality diffraction. Multi-group Model Invariance tests examined measurement invariance across the three age groups. CAST was two-dimensional in all age groups with one factor measuring cannabis use problems and the other measuring deviation from a common standard of use. The two-dimensional structure was more pronounced in older age groups. Weak factorial invariance was supported, suggesting that the meaning of the CAST factors is equivalent across age groups. Partial, but not full, strong factorial invariance was supported, indicating that only the cannabis use problem factor can be defensibly used to measure age group mean differences. Results confirm a well-defined two-dimensional CAST structure and factorial invariance across age groups. However, caution is needed when using the two items measuring deviation from a common standard in an age-comparative framework. Replication studies based on a representative sample are needed.

KEYWORDS

age comparison, cannabis, CAST, measurement invariance, psychometrics, scale evaluation

1 | INTRODUCTION

Cannabis is the most commonly used illicit substance worldwide and use is on the rise in many places [United Nations Office on Drugs and Crime (UNODC), 2015]. In Israel 8.9% of adults (aged 18–40) reported use in the last year (Bar-Hamburger, Ezrachi, Roziner, & Nirel, 2009) which is similar to the situation in the United States (Hasin et al., 2015) and similar to the average cannabis use rate in Europe [European Monitoring Centre for Drugs and Drug Addiction (EMCDDA), 2015]. While only a minority of cannabis users experience clinical or social problems (Eisen et al., 2002; von Sydow et al., 2001; Wagner & Anthony, 2002), cannabis consumption carries significant risk of adverse consequences including accidents and poor psychosocial outcomes (Hall, 2009, 2015). Cannabis also constitutes a substantial, and in some places, increasing share of the drugs that people seek addiction treatment for (EMCDDA, 2015; Roxburgh et al., 2010; Rush & Urbanoski, 2007; Sznitman, 2008; UNODC, 2015; Urbanoski, Strike, & Rush, 2005).

One of the most consistent findings in cannabis use research is that patterns of use and associated problems vary greatly by age; the prevalence estimates for cannabis use and related disorders are higher for young adults (aged 18–24) than for older adults (aged 25+) (Crowley, 2006; Hasin et al., 2015; Swift, Hall, & Teesson, 2001; von Sydow et al., 2001) and rates of cannabis use decline sharply after the age of 24 (Chen & Kandel, 1995; von Sydow et al., 2001). In some studies frequent use has been found to be most prevalent in younger populations (Solowij & Grenyer, 2002), whereas in other studies it has been found to be most common in older age groups (Roxburgh et al., 2010).

There is a need for creating appropriate and efficient methods that distinguishes between cannabis users who suffer from cannabis use associated problems and those who do not (Sanchez & Klempova, 2007). It is also important that methodological studies examine whether screening tools are equally valid and reliable across different age groups. Defensible use of self-reported scales for cannabis use problems in age comparative frameworks requires that the measured

constructs have the same dimensionality and meaning across age groups, and that group comparisons of sample estimates are not contaminated by group-specific attributes unrelated to the construct of interest (Gregorich, 2006).

One of the most widely used short cannabis problem screening tools is the Cannabis Abuse Screening Test (CAST), which assesses the frequency of six events or behaviours: smoking alone; smoking before midday; memory disorders; being encouraged to reduce or stop using cannabis; unsuccessful attempts to quit; and problems linked to cannabis use, such as accidents or fights (Legleye, Karila, Beck, & Reynaud, 2007). While various studies have found support for validity and reliability of the CAST, there is little evidence as to whether its psychometric properties are equivalent across age groups (Legleye et al., 2015).

In terms of its dimensional structure, some researchers have found CAST to be unidimensional (Gyepesi et al., 2014; Legleye et al., 2007; Legleye, Kraus, Piontek, Phan, & Jouanne, 2012; Legleye, Piontek, & Kraus, 2011; Legleye, Piontek, Kraus, Morand, & Falissard, 2013), while others have found superior fit for a two-factor solution, with the first factor representing cannabis use problems (the last four items mentioned earlier) and the second representing deviation from a common standard of use (the first two items) (Cuenca-Royo et al., 2012; Fernandez-Artamendi, Fernandez-Hermida, Muniz-Fernandez, Secades-Villa, & Garcia-Fernandez, 2012; Legleye et al., 2015).

Notably, the studies that support a unidimensional structure have tended to include larger proportions of adolescents than studies which have found a two-dimensional structure. There are at least four possible reasons for this. First, a unidimensional structure may be more pronounced among adolescents because they are more subject to scrutiny from adults that are likely to disapprove of cannabis use. In this social context, cannabis use before midday and alone may be particularly likely to prompt family members to demand that cannabis use stops which in turn may lead to conflict. Seen from this perspective it is possible that CAST items form a unidimensional structure. In contrast, scrutiny from significant others is likely to be less pronounced in older cannabis users because of greater independence in older age. It is therefore possible that deviance from a common standard of use is more distinct from experiencing problems related to cannabis use which in turn makes it likely that CAST items form a two-dimensional structure in older age groups.

Second, it is possible that different dimensional structures occurs because of so-called extreme response styles (Cheung & Rensvold, 2000) in adolescent and young cannabis users in particular. Indeed, younger users may be particularly likely to lack experience to rate correctly their experiences and problems and, because they are in the beginning of their drug careers, all types of cannabis use patterns are experimented and reported on according to extreme response options.

Third, individual items in the CAST scale may measure different things in younger versus older age groups. For instance, in younger people, failed attempts to quit may be particularly likely to reflect peer pressure to use cannabis rather than the compulsive pattern of use this criterion is intended to capture (Chung & Martin, 2002). A fourth source of age differences arises if age-specific norms for cannabis use (Golub, Johnson, & Dunlap, 2005; Keyes et al., 2011) systematically raise or lower responses to cannabis use problem items in ways that are unrelated to respondents' common factor scores.

If any of these types of age-specific response tendencies exist, it will have implication for the use of CAST in cross-sectional age comparison research efforts (Gregorich, 2006; Millsap, 2011). Against this backdrop, the aim of the present study was to examine whether CAST items have the same dimensionality and meaning across three age groups, and whether age-group comparisons of sample estimates are contaminated by group-specific attributes unrelated to the cannabis problem construct.

2 | MATERIAL AND METHODS

2.1 | Sample

Data were drawn from a sample of 1849 cannabis users (age > 17) recruited via a popular Israeli cannabis internet forum (<http://www.קנאביס.com/>). The study received Institutional Review Board approval, and respondents provided informed consent before filling in the anonymous internet survey. Analyses were restricted to respondents who reported cannabis use during the last six months ($n = 1316$). IP addresses were recorded to identify duplicate records; none were found.

2.2 | Measures

2.2.1 | CAST

The English version of the CAST scale was translated into Hebrew and back-translated following standard procedures (Behling & Law, 2000). Respondents reported the frequency (0 = never, 4 = very often) of the following events within the past six months: smoked cannabis before midday; smoked cannabis when alone; memory problems after smoking cannabis; told by friends or family members to reduce or stop cannabis use; tried without success to reduce or stop cannabis use; had problems because of cannabis use (e.g. arguments, fights, accidents, problems at work).

2.2.2 | Socio-demographics and cannabis use

Five variables were recorded: age group (ages 18–24, 25–29, 30–40); education (high school diploma; professional diploma; BA degree or higher), employment status (in full time employment or not); gender (0 = female, 1 = male); and frequency of cannabis use (frequent use = 4+ days per week).

2.3 | Data analysis

CAST dimensionality was investigated by exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) for the combined and age specific groups. Unidimensionality was confirmed if only one eigenvalue was >1 and/or a factor analysis model with one factor showed adequate model fit as indicated by the Comparative Fit Index (CFI) values greater than 0.95, Tucker–Lewis Index (TLI) values greater than 0.90, and root mean square error of approximation (RMSEA) values less than 0.06 (Hu & Bentler, 1999). In the case where two eigenvalues were >1, a two-factor EFA model with promax rotation was performed to determine whether the additional factor provided a coherent and interpretable construct.

To investigate the degree to which CAST measures are invariant across age groups a multi-group measurement invariance comparison strategy was used (Byrne, 2010; Wang & Wang, 2012). The core measurement was the structure found to be optimal in the CFA. The first “configural” step kept all parameter free across the three age groups testing whether each common factor is associated with identical item sets across groups and produced goodness-of-fit values. In the next step the factor loadings were constrained to be identical across the age groups in a weak measurement invariance test (also called metric invariance test). No worsening in model fit when moving from the configural to the weak measurement invariance test indicates that items perform similarly in relation to the latent factors across age groups. In other words, evidence of invariance in the weak measurement invariance test provides evidence that corresponding common factors have the same meaning across groups (Byrne, 2010; Wang & Wang, 2012). Next, the strong measurement invariance test (also called scalar invariance test) further constrained the intercepts between the latent factor and its components to be equal across age groups. The strong measurement invariance test examines whether factors unrelated to the common factors (e.g. cultural norms) systematically cause higher- or lower-valued item response in one group compared with another (Byrne, 2010; Wang & Wang, 2012). No worsening of model fit when moving to the strong measurement invariance provides evidence that comparisons of age group means are meaningful.

The “full” forms of invariance just described can be relaxed to obtain partial factorial invariance (Byrne, Shavelson, & Muthen, 1989). For instance, in a two-factor model with six CAST items, four of the six intercepts may be invariant, whereas two differ across groups. In the current study, when full invariance failed, tests were made for partial invariances by consulting modification indices to determine which cross-group equality constraint most significantly contributed to lack of fit (Gregorich, 2006). Once identified the constraint was freed and the model was re-estimated and if needed the process was reiterated.

To determine and compare model fit the CFI was used. A reduction in CFI indices by no more than 0.02, as long as the index is above 0.90,

indicates general similarity between the models (Byrne et al., 1989; Cheung, 2008). After examining measurement invariance associated with age groups, linear regression was used to investigate the relation between age, gender, frequent cannabis use and cannabis use problems.

3 | RESULTS

3.1 | Description of the sample

The majority (89.5%) were male, and the average age was 25.4 [standard deviation (SD) = 4.78] (see Table 1). Frequent cannabis use was more common in the older groups. In terms of CAST items, the highest means were for using when alone and using before midday, while the problems item had the lowest mean. Older respondents were more likely to report using before midday, using alone, and trying to stop or reduce cannabis use.

3.2 | Dimensionality

EFA showed that goodness-of-fit rose dramatically from below the accepted threshold (CFI > 0.95, TLI > 0.90, RMSEA > 0.06; Hu & Bentler, 1999) for the one-factor solution to a high level of fit for the two-factor solution, and both factors had eigenvalues exceeding 1.0 in all age groups (see Table 2). The best fit was achieved when items 3 to 6 were assigned to one factor (cannabis use problems) and items 1 and 2 to a second factor (deviation from a common standard of use). CFA on the full sample showed acceptable fit for the two-dimensional model (RMSEA = 0.04, CFI = 0.99, TLI = 0.96; see Table 2), and standardized factor loadings ranged from 0.412 for memory problems to 0.712 for using before midday. The two factors had a correlation of 0.44 ($p < 0.001$).

Model fit was also acceptable when running CFA separately for each age group (see Table 2) and factor loadings were in the same range as for the full sample. Notably, the correlation between the factors was high and significant in the youngest ($r = 0.53$, $p < 0.001$) and

TABLE 1 Distribution of socio-demographic characteristics, patterns of consumption and CAST

	Age 18–24 (n = 651)		Age 25–29 (n = 458)		Age 30–40 (n = 207)		P value	Total (n = 1316)	
Male (n, %)	583	89.3	415	90.4	182	87.9	0.616	1180	89.5
Use 4+ days per week (n, %)	317	48.7	283	61.8	148	71.5	<0.001	748	56.8
Education level									
High school diploma (n, %)	461	70.8	166	36.2	63	30.4		690	52.4
Professional diploma (n, %)	113	17.4	109	23.8	49	23.7	<0.001	271	20.6
BA or higher (n, %)	77	11.8	183	40.0	95	45.9		355	27.0
Full time employment (n, %)	399	61.3	287	62.7	176	85.0	<0.001	862	65.5
CAST criteria									
1. Cannabis before midday (M, SD)	1.56	1.11	1.65	1.11	1.85	1.30	0.001	1.65	1.15
2. Cannabis when alone (M, SD)	2.10	1.23	2.47	1.02	2.74	1.05	<0.001	2.35	1.15
3. Memory problems (M, SD)	1.20	1.06	1.20	0.95	1.12	0.99	0.470	1.20	1.01
4. Friends or family (M, SD)	1.01	1.13	0.92	1.00	0.91	1.07	0.194	0.97	1.07
5. Tried to stop or reduce (M, SD)	0.32	0.71	0.38	0.78	0.47	0.81	0.019	0.38	0.76
6. Problems (M, SD)	0.24	0.63	0.20	0.52	0.17	0.46	0.125	0.22	0.57

Note: n = number, M = mean, SD = Standard Deviation, P = P-value for Chi-square test (%) or for ANOVA (mean) when comparing age groups. P-Values signifies any difference between groups.

TABLE 2 Eigenvalues and model fit indices for the six CAST items, one versus two factor options

Age groups	N	Eigenvalues factor 1: cannabis use problems	Eigenvalues factor 2: deviance from a common standard of use	Determinacy		One factor			Two factors			Correlation between factor 1 and 2
				Factor 1	Factor 2	CFI	TLI	RMSEA	CFI	TLI	RMSEA	
All ages	1316	2.08	1.21	0.83	0.77	0.71	0.52	0.15	0.99	0.96	0.04	0.44 ($p < 0.001$)
18–24	651	2.21	1.13	1.00	0.79	0.78	0.64	0.14	0.91	0.97	0.04	0.53 ($p < 0.001$)
25–29	458	2.07	1.22	1.00	0.79	0.72	0.53	0.15	1.00	0.99	0.02	0.43 ($p < 0.001$)
30–40	207	1.81	1.42	0.82	0.77	0.57	0.28	0.16	0.97	0.90	0.06	0.19 ($p = 0.064$)

Note: CFI, Comparative Fit Index; RMSEA, root mean square error of approximation; TLI, Tucker–Lewis Index

weak and not significant in the oldest age group ($r = 0.19$, $p = 0.064$). The percentage of total variance accounted for by the second factor increased with age from 18.8% explained variance in the youngest group to 23.7% in the oldest. In other words, cannabis use problems and deviation from a common standard grew more distinct with age.

3.3 | Measurement invariance

The weak measurement invariance test, which constrained the factor loadings to be equal across the age groups, showed acceptable model fit and no significant difference compared to the baseline configural model ($\Delta\text{CFI} = 0.005$, Table 3). These results indicate that the factor loadings are similar across the three groups.

The strong measurement invariance test further constrained the model to have equal intercepts across the age groups. Here, the fit quality fell significantly ($\Delta\text{CFI} = 0.037$, Table 3). Since intercept invariance was not supported, we tested for partial strong measurement invariance by consulting modification indices. Partial strong measurement invariance was achieved when the intercepts were constrained to be equal for the first factor (cannabis use problems) but allowed to vary for the second factor (deviation from a common standard). The CFI indices fell by no more than 0.02 between the constrained and unconstrained models, indicating general similarity between them (Cheung, 2008).

We next conducted a linear regression examining age, gender and frequency of cannabis use in relation to CAST scores. Since mean group differences can only be calculated for items fulfilling invariance criteria (Byrne et al., 1989), only the summed scores for the cannabis use problem items were used in this analysis. No age or gender differences in cannabis use problems were found ($p > 0.05$). Frequent cannabis use was associated with more cannabis use problems (coefficient = 0.237, $p < 0.001$).

4 | DISCUSSION

The current study contributes to our understanding of how CAST performs in an age-comparative framework. The results show that the CAST items have equal factor loadings on the underlying constructs across the age groups, implying that the items share similar meanings across the groups. However, since only partial strong measurement invariance was found, caution is needed when using CAST to compare mean problematic cannabis use across different age groups. Specifically,

the current findings suggest that only the cannabis use problem factor can be used to compare means across age groups. This finding may have significant implications beyond the use of CAST, because researchers have suggested that the CAST item on smoking cannabis when alone is a promising new Diagnostic and Statistical Manual of Mental Disorders (DSM) diagnostic criterion for cannabis use disorders (Piontek, Kraus, Legleye, & Buhringer, 2011). The current results suggest that this addition may impair use of the DSM in an age-comparative framework.

The results showing superior fit for the two-factor solution and increasing factor diffraction with age have implications for the interpretation of CAST data. Specifically, the current results suggest that age-related shifts in cannabis users' social environment have implication for the psychometric properties of the screening tool. Indeed, it is possible that greater CAST diffraction by age is caused by processes in which use before midday and alone prompt greater reproaches from relatives in younger than in older users due to greater social disapproval of young people's cannabis use. It has previously been pointed out that existing screening tools for problematic cannabis use neglect the role of context (Asbridge, Duff, Marsh, & Erickson, 2014). The current results provide further indication that additional research is needed to examine the role of age-related social contexts when screening for cannabis use problems.

While previous studies have used lifetime (Legleye et al., 2007) and 12 month (Cuenca-Royo et al., 2012; Legleye et al., 2015; Legleye et al., 2011) reference periods for CAST items, the current study assesses the frequency of CAST items within the past six months. The shorter time frame is a strength of this study as it should reduce the potential for memory and recall bias. Nevertheless, the shorter time frame limits the ability to directly compare the current results to other (past or future) studies using 12 months or lifetime time frames. Furthermore, if the stability of use have not yet been established in the younger age group, the short time frame may be one reason for the finding of partial rather than strong measurement invariance. More research is needed with different time frames in order to examine this further.

Besides the sample's restricted age range and exclusion of adolescents, other study limitations include the use of a self-selected sample of visitors to a single Israeli online discussion forum. This design limits our ability to assess the representativeness of the sample among cannabis users in Israel. We chose this method because of its advantages *vis-à-vis* ease of access, broader reach, anonymity, and reduced response bias on sensitive topics such as drug use (Ramo, Liu, & Prochaska, 2012). We found no double entries based on IP addresses, meaning that we can discount the likelihood of organized multiple

TABLE 3 Measurement invariance results, unstandardized loadings and intercepts

		Age group N	Loadings			Intercepts		
			18–24 655	25–29 460	30–40 269	18–24 655	25–29 460	30–40 269
Configural	Factor 1	Memory problems	0.44	0.40	0.42	1.21	1.20	1.13
		Friends or family	0.69	0.58	0.44	1.02	0.92	0.94
		Tried to stop or reduce	0.38	0.45	0.50	0.33	0.38	0.51
		Problems	0.32	0.21	0.26	0.25	0.20	0.19
	Factor 2	Cannabis before midday	0.79	0.81	0.78	1.56	1.65	1.84
		Cannabis when alone	0.84	0.74	0.73	2.10	2.47	2.74
		CFI	0.97					
		TLI	0.94					
		RMSEA	0.05					
		χ^2	54.77					
		DF	24					
		P	<0.001					
Weak measurement invariance	Factor 1	Memory problems	0.42	0.42	0.42	1.21	1.20	1.13
		Friends or family	0.60	0.60	0.60	1.02	0.92	0.94
		Tried to stop or reduce	0.41	0.41	0.41	0.33	0.38	0.51
		Problems	0.27	0.27	0.27	0.25	0.20	0.19
	Factor 2	Cannabis before midday	0.78	0.78	0.78	1.56	1.65	1.84
		Cannabis when alone	0.80	0.80	0.80	2.10	2.47	2.74
		CFI	0.96					
		TLI	0.95					
		RMSEA	0.05					
		χ^2	71.97					
		DF	36					
		p	<0.001					
		Δ CFI	0.005					
Strong measurement invariance	Factor 1	Memory problems	0.43	0.43	0.43	1.20	1.20	1.20
		Friends or family	0.60	0.60	0.60	0.97	0.97	0.97
		Tried to stop or reduce	0.41	0.41	0.41	0.37	0.37	0.37
		Problems	0.27	0.27	0.27	0.22	0.22	0.22
	Factor 2	Cannabis before midday	0.67	0.67	0.67	1.49	1.49	1.49
		Cannabis when alone	0.91	0.91	0.91	2.15	2.15	2.15
		CFI	0.93					
		TLI	0.93					
		RMSEA	0.06					
		χ^2	110.61					
		DF	44					
		p	<0.001					
		Δ CFI	0.037					
Partial strong measurement invariance	Factor 1	Memory problems	0.42	0.42	0.42	1.19	1.19	1.19
		Friends or family	0.61	0.61	0.61	0.97	0.97	0.97
		Tried to stop or reduce	0.41	0.41	0.41	0.37	0.37	0.37
		Problems	0.27	0.27	0.27	0.22	0.22	0.22
	Factor 2	Cannabis before midday	0.76	0.76	0.76	1.56	1.66	1.84
		Cannabis when alone	0.80	0.80	0.80	2.10	2.48	2.74
		CFI	0.95					
		TLI	0.95					
		RMSEA	0.05					

(Continues)

TABLE 3 (Continued)

	Age group N	Loadings			Intercepts		
		18–24 655	25–29 460	30–40 269	18–24 655	25–29 460	30–40 269
χ^2		94.5					
DF		44					
p		<0.001					
Δ CFI		0.020					

Note: CFI, Comparative Fit Index; DF, degrees of freedom; RMSEA, root mean square error of approximation; TLI, Tucker–Lewis Index.

responses. Nevertheless, it is clear that the sample is unlikely to be representative of the general Israeli cannabis population. In particular, and while no representative study from Israel has examined the age distribution of regular cannabis use, research from other places has generally found that rates of frequent cannabis use are highest in young adults (mid-twenties) and that it declines steadily with age (Solowij & Grenyer, 2002). However, research from Australia has found frequent use to be highest in older age groups (Roxburgh et al., 2010). This is similar to the age distribution of frequent cannabis use found in the current study. We do, however, not have the ability to test how representative this age pattern is among cannabis users in Israel. Furthermore, the sample consists of 89.5% male. While Israeli males are much more likely to use cannabis than their female counterparts (Bar-Hamburger et al., 2009) the gender difference has been found to be smaller in more representative samples than what we found in the current sample. The unbalanced gender proportions in the current sample means that the current analyses is mostly assessing invariance in males and it would be valuable for future research to explicitly test the invariance of the CAST by gender. Given the limitations of the study design, especially its lack of representativeness, the results may be considered preliminary.

5 | CONCLUSION

Comparative research of cannabis use problems in different age groups requires that instruments measure constructs with the same dimensionality and meaning across age-groups and allow defensible quantitative age-group comparisons. The study confirms a well-defined two-dimensional CAST structure and factorial invariance across age groups. However, the finding of diffraction by age and partial (rather than full) strong invariance suggest that caution is needed when using the two items measuring deviation from a common standard in an age-comparative framework. Because of the convenience sampling method used in the current study, replication studies with representative samples are needed. Further research is also needed to explore the role of age-related social contexts in screening for problem cannabis use.

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