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Further evidence for the bidimensionality of the components model of addiction: a reply to Amendola (2023)

Loïs Fournier [a,*], Adriano Schimmenti [b], Alessandro Musetti [c], Valentina Boursier [d], Maèva Flayelle [a], Ilaria Cataldo [c], Vladan Starcevic [e], Joël Billieux [a,f]

[a] Institute of Psychology, University of Lausanne, Quartier UNIL-Mouline, Bâtiment Géopolis, CH-1015 Lausanne, Switzerland
[b] Faculty of Human and Social Sciences, UKE – Kore University of Enna, Cittadella Universitaria, 94100 Enna, Italy
[c] Department of Humanities, Social Sciences and Cultural Industries, University of Parma, Borgo Carissimi 10, 43121 Parma, Italy
[d] Department of Humanities, University of Naples "Federico II", Via Porta di Massa, 1, 80133 Naples, Italy
[e] Faculty of Medicine and Health, Sydney Medical School, Nepean Clinical School, University of Sydney, Penrith, NSW 2751, Australia
[f] Center for Excessive Gambling, Addiction Medicine, Lausanne University Hospital (CHUV), Lausanne, Switzerland

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ABSTRACT

In our original research article entitled "Deconstructing the components model of addiction: an illustration through "addictive" use of social media" (Fournier et al., 2023), we showed that the Bergen Social Media Addiction Scale, a six-item psychometric instrument derived from the components model of addiction to assess social media "addiction", did not form a unitary, but a bidimensional construct in which some components (i.e., salience, tolerance) were not associated with psychopathological symptoms, thus conflating central and peripheral features of addiction. Subsequently, in a recent commentary, Amendola (2023) sought to determine whether our findings were driven by the use of data aggregated from multiple independent datasets, i.e., a decision we transparently acknowledged as a limitation in our original research article. Following their reanalysis, Amendola (2023) claimed to have demonstrated that a unidimensional model best fitted the data. However, they only reported results for a partial set of models relevant to this investigation. In the present reply, through a transparent assessment and reporting of all unidimensional and bidimensional models relevant to this investigation, we show that the bidimensionality of the Bergen Social Media Addiction Scale is, in fact, tenable, robust, and consistent across multiple independent datasets. In line with the growing evidence demonstrating that many sets of criteria involved in operationalizing behavioral addictions pathologize involvement in appetitive behaviors, these results highlight the necessity to renew the conceptualization and assessment of behavioral addictions.

In our original research article entitled "Deconstructing the components model of addiction: an illustration through "addictive" use of social media" (Fournier et al., 2023), we examined – using "addictive" use of social media as a representative example – whether the six-component model of addiction (Brown, 1993; Griffiths, 2005) assessed central features of addiction, or whether some components constituted peripheral features not indicative of a disorder. To this end, we aggregated data from four independent samples totaling 4,256 participants from the general population who completed the 6-item Bergen Social Media Addiction Scale (Andreassen et al., 2016), which was and remains, to date, one of the most influential, popular, and cited psychometric instruments derived from the six-component model for screening for social media "addiction" (Cataldo et al., 2022). By performing structural equation modeling and network analyses, we showed that the six components did not form a unitary construct and, crucially, that some components (i.e., salience, tolerance) were not associated with measures assessing psychopathological symptoms. Ultimately, our findings suggest that psychometric instruments based on the components model conflate central and peripheral features of addiction when applied to behavioral addictions, thereby pathologizing involvement in appetitive behaviors (Fournier et al., 2023).

In a recent commentary entitled "Discussing evidence on the

* Corresponding author.
E-mail addresses: lois.fournier@unil.ch (L. Fournier), adriano.schimmenti@unikore.it (A. Schimmenti), alessandro.musetti@unipr.it (A. Musetti), valentina.boursier@unina.it (V. Boursier), maeva.flayelle@unil.ch (M. Flayelle), ilaria.cataldo@unipr.it (I. Cataldo), vladan.starcevic@sydney.edu.au (V. Starcevic), joel.billieux@unil.ch (J. Billieux).

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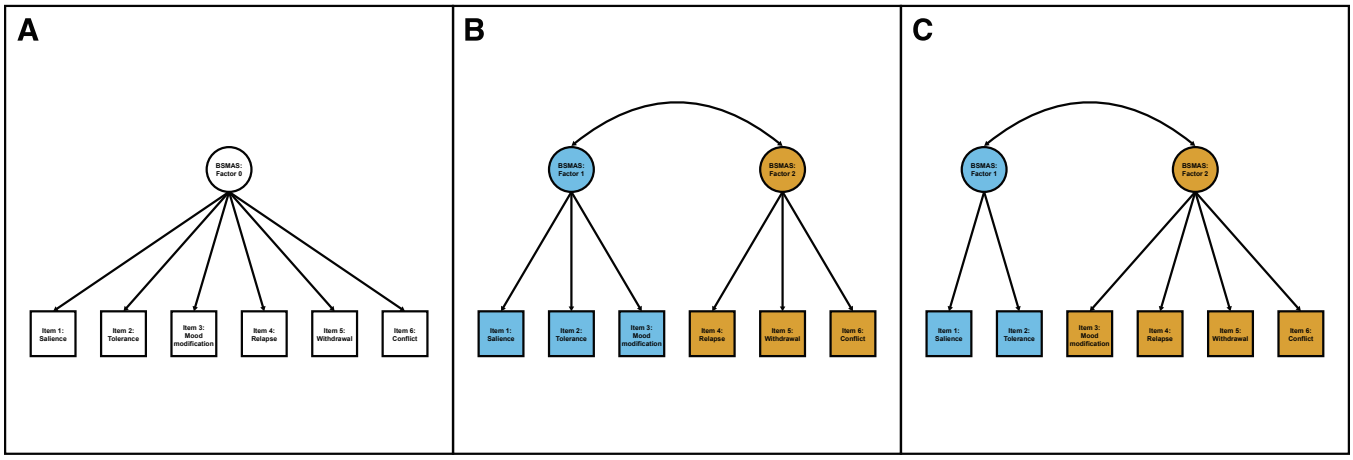

Fig. 1. Confirmatory factor analysis models of the 6-item Bergen Social Media Addiction Scale. BSMAS = 6-item Bergen Social Media Addiction Scale (Andreassen et al., 2016); A = Confirmatory factor analysis unidimensional model derived from Andreassen et al. (2016); B = Confirmatory factor analysis bidimensional model derived from Charlton and Danforth (2007); C = Confirmatory factor analysis bidimensional model derived from Fournier et al. (2023). Circles indicate latent variables (i.e., factors). Squares indicate observed variables (i.e., items). Arrows connecting latent variables to observed variables indicate model-implied non-null λ model parameters (i.e., factor loadings). Lines connecting latent variables indicate model-implied non-null ϕ model parameters (i.e., factor covariances).

components model of addiction: a commentary on Fournier et al. (2023)", Amendola (2023) challenged our findings regarding the bidimensional structure of the 6-item Bergen Social Media Addiction Scale. Based on the premise that "previous studies conducted in different countries consistently proved the one-factor solution of the scale" (Amendola, 2023, p. 1), Amendola (2023) sought to determine whether our findings were driven by the use of data aggregated from multiple independent datasets, i.e., a decision we transparently acknowledged as a limitation in our original research article. Capitalizing on our code and data available from the Open Science Framework (https://osf.io/d39fa/), Amendola (2023) followed the data analytic procedure described in Fournier et al. (2023) to perform factorial structure analyses of the 6-item Bergen Social Media Addiction Scale on each of the four independent datasets rather than on the aggregated database. Following their re-analysis, Amendola (2023) claimed that "this commentary demonstrated a one-factor solution as the best fit for the data" (Amendola, 2023, Highlight No. 4). However, in reviewing the results reported in the commentary of Amendola (2023) and its attached suplementary materials, we can only disagree with their conclusions.

As the commentary of Amendola (2023) focuses on the factorial structure of the 6-item Bergen Social Media Addiction Scale, it would have been necessary to transparently assess and report the quality of adjustment to the data of all structural equation models relevant to this investigation, i.e., 1) the unidimensional model derived from Andreassen et al. (2016) (see Fig. 1A), 2) the bidimensional model derived from Charlton and Danforth (2007) (see Fig. 1B), and 3) the bidimensional model derived from Fournier et al. (2023) (see Fig. 1C). We were therefore disappointed to find that the quality of adjustment to the data of the bidimensional model derived from Fournier et al. (2023) (see Fig. 1C) was only assessed and reported for one of the four independent datasets.

Therefore, to provide a complete account of the results, we extended the data analytic procedure employed in Fournier et al. (2023) and re-employed in Amendola (2023) to assess and report the quality of

Table 1
Confirmatory factor analysis models of the 6-item Bergen Social Media Addiction Scale derived from analyses performed on the aggregated database and the four independent datasets. *n* = Aggregated database / independent dataset subsample size. A = Confirmatory factor analysis unidimensional model derived from Andreassen et al. (2016); B = Confirmatory factor analysis bidimensional model derived from Charlton and Danforth (2007); C = Confirmatory factor analysis bidimensional model derived from Fournier et al. (2023). χ^2 = Model's chi-square. *df* = Model's chi-square's degrees of freedom. *p* = Model's chi-square's probability value. CFI = Model's comparative fit index. TLI = Model's Tucker-Lewis fit index. RMSEA [90 % CI] = Model's root mean square error of approximation along with its corresponding 90 % confidence interval. Asterisks indicate confirmatory factor analysis models whose quality of adjustment to the data was assessed and reported in the suplementary materials attached to the commentary of Amendola (2023). Models in bold indicate confirmatory factor analysis models with acceptable quality of adjustment to the data determined by a CFI ≥ 0.900, a TLI ≥ 0.900, and an RMSEA ≤ 0.080 (Browne & Cudeck, 1992; Chen et al., 2008; Kenny et al., 2015; Marsh et al., 2005; Schermelleh-Engel et al., 2003).

DATA	MODEL	χ^2	*df*	*p*	CFI	TLI	RMSEA [90 % CI]
Aggregated database	A	370.064	9	< 0.001	0.945	0.909	0.137 [0.126 – 0.149]
(*n* = 2,128)	B	193.525	8	< 0.001	0.972	0.947	0.104 [0.092 – 0.117]
	C	98.729	8	< 0.001	0.986	0.974	0.073 [0.061 – 0.086]
Independent dataset I	A*	218.796	9	< 0.001	0.935	0.892	0.149 [0.132 – 0.166]
(*n* = 1,052)	B*	108.052	8	< 0.001	0.969	0.942	0.109 [0.091 – 0.128]
	C*	55.433	8	< 0.001	0.985	0.972	0.075 [0.057 – 0.094]
Independent dataset II	A*	71.917	9	< 0.001	0.967	0.945	0.127 [0.101 – 0.155]
(*n* = 432)	B*	39.317	8	< 0.001	0.984	0.969	0.095 [0.067 – 0.126]
	C	23.367	8	0.003	0.992	0.985	0.067 [0.036 – 0.099]
Independent dataset III	A*	95.839	9	< 0.001	0.945	0.908	0.166 [0.137 – 0.196]
(*n* = 353)	B*	59.436	8	< 0.001	0.967	0.939	0.135 [0.104 – 0.168]
	C	20.757	8	0.008	0.992	0.985	0.067 [0.032 – 0.104]
Independent dataset IV	A*	29.841	9	< 0.001	0.961	0.936	0.089 [0.055 – 0.126]
(*n* = 291)	**B***	21.102	8	0.007	0.976	0.955	0.075 [0.037 – 0.115]
	C	20.551	8	0.008	0.977	0.957	0.074 [0.035 – 0.114]

adjustment to the data of all structural equation models relevant to this investigation (see Fig. 1) across all four independent datasets. For this purpose, three conventional model fit indices were employed: the comparative fit index (CFI), the Tucker-Lewis index (TLI), and the root mean square error of approximation (RMSEA) along with its corresponding 90 % confidence interval (Kline, 2016). Acceptable quality of adjustment to the data was determined by a CFI $\geq$ 0.900, a TLI $\geq$ 0.900, and an RMSEA $\leq$ 0.080 (Browne & Cudeck, 1992; Chen et al., 2008; Kenny et al., 2015; Marsh et al., 2005; Schermelleh-Engel et al., 2003). The model-implied fit indices are shown in Table 1.

Through transparent assessment and reporting, the results show that the quality of adjustment to the data of the unidimensional model was lower than that of the two bidimensional models – and below acceptable thresholds for conventional model fit indices – across all four independent datasets. It should be noted, however, that this has already been partially reported in the suplementary materials attached to the commentary of Amendola (2023); the corresponding models are shown in Table 1, indicated by an asterisk. Critically, the quality of adjustment to the data of the bidimensional model derived from Fournier et al. (2023) was higher than that of all other models and across all four independent datasets.

In summary, the present additional results confirm that the bidimensional structure of the 6-item Bergen Social Media Addiction Scale reported in Fournier et al. (2023) (i.e., one dimension comprising the two components of tolerance and salience, and one dimension comprising the four components of mood modification, relapse, withdrawal, and conflict) is, in fact, tenable, robust, and consistent across multiple independent datasets. In light of growing evidence demonstrating that many sets of criteria involved in operationalizing behavioral addictions fail to distinguish central from peripheral features of addiction (Bőthe et al., 2020; Brunborg et al., 2015; Charlton & Danforth, 2007; Deleuze et al., 2018), we encourage the behavioral addictions research community to adopt open science practices (Eben et al., 2023) to transparently examine which criteria are truly valid indicators of a disorder across diverse behaviors, as the necessity to renew the conceptualization and assessment of behavioral addictions is a collaborative duty and effort.

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CRediT authorship contribution statement

Loïs Fournier: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Visualization, Supervision, Project administration, Funding acquisition, Writing – original draft, Writing – review & editing. **Adriano Schimmenti:** Investigation, Resources, Data curation, Writing – review & editing. **Alessandro Musetti:** Investigation, Resources, Data curation, Writing – review & editing. **Valentina Boursier:** Investigation, Resources, Data curation, Writing – review & editing. **Maèva Flayelle:** Writing – review & editing. **Ilaria Cataldo:** Writing – review & editing. **Vladan Starcevic:** Writing – review & editing. **Joël Billieux:** Conceptualization, Methodology, Validation, Investigation, Resources, Data curation, Supervision, Project administration, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Detailed information regarding the analyses, code, data, and materials is available from the Open Science Framework (https://osf.io/d39fa/).

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