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MEASURING CHEMOPHOBIA IN AN ITALIAN SAMPLE TO SUCCESSFULLY IMPLEMENT A SOCIAL MARKETING CAMPAIGN

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Abstract

People often hold a predominantly unfavorable view of chemicals, primarily rooted in misunderstandings and apprehension. Chemophobia is an irrational fear of chemicals, characterized by an excessive concern regarding the potential dangers posed by chemicals and the belief that any concentration and level of exposure to them is harmful. The term "chemicals" is commonly associated with synthetic compounds, hence chemophobia is more prominently linked to the apprehension of exposure to man-made chemicals rather than those of natural origin. People exhibiting chemophobia often express a preference for chemicals derived from natural sources as opposed to synthetic ones in various products (e.g., personal and domestic hygiene, food). Individuals' risk perception may significantly impact their decision-making and behaviors. Consequently, chemophobia has the potential to hinder people from making well-informed choices regarding chemicals and products. For example, individuals with high levels of chemophobia may reject certain chemicals and products, such as pharmaceutical drugs and vaccines, even if they are beneficial, simply because they are artificially produced and therefore are perceived as unsafe. Identifying factors that may mitigate chemophobia would be instrumental in addressing and reducing negative attitudes and behaviors toward chemicals. Within the planning of a social marketing campaign aimed to promote a more positive perception of chemicals, often contrasted with the concept of "natural substances", and to counter chemophobia, the current study presents a first contribution to the evaluation of the psychometric properties of the Chemophobia scale in an Italian sample. The results confirm the single-factor structure of the scale. In line with the original scale, Item 7 shows a lower factor loading than the others; thus, the final version of the scale consists of six items. In general, good psychometric properties are found in terms of Cronbach's alpha (α = .86), average variance extracted (AVE = .55), and composite reliability (CR = .88). The results are promising and future research could focus on the construct and criterion validity of the scale in the Italian context. This self-report scale may be a useful tool in the implementation of a social marketing campaign based on an informative approach. This approach may successfully reduce chemophobia by diminishing the perception of risk and fear associated with chemicals through an enhanced understanding of toxicological principles and awareness of the benefits derived from the use of chemicals.

Keywords: *Social marketing, chemicals, chemophobia, healthy behavior, risk perception.*

1. Introduction

Chemistry is frequently perceived as a complex and challenging science, particularly difficult to be shared effectively. The remarkable human and economic progress witnessed in recent decades has largely been facilitated by an extensive division of labor. However, one potential drawback of this advancement is that consumers may lack an in-depth understanding of the production process of the goods they use in their daily lives. This can lead some individuals to rely on mental shortcuts (e.g., affect heuristic) when assessing associated benefits and risks, such as in the case of chemicals. The perception of risk is not always guided by rational and analytical judgments. While experts tend to evaluate risks based on scientifically proven facts, consumers' risk assessment is more subjective and influenced by personal experience, knowledge, and information obtained from various sources. It is a combination of psychological and cultural forces that lead different groups of individuals to process information differently (Bearth et al., 2014). In Europe, the prevalence of certain unfounded fears triggered by chemicals has led to a desire among many to inhabit a world devoid of such substances.

Similarly, numerous individuals claim to exert maximal efforts to steer clear of chemical substances (Siegrist & Bearth, 2019).

This aversion towards chemistry is referred to as chemophobia. In a recent review (Rollini et al., 2022) numerous definitions of chemophobia are provided. Some authors define it as the fear of chemistry or as the irrational fear of chemical substances, while others describe it as the fear of chemicals and concerns about chemicals and cancer or as the popular belief that all chemicals are toxic and likely carcinogenic. Other definitions propose it as a long-term and persistent irrational fear of chemistry and chemical substances accompanied by a strenuous effort to avoid them, leading to hypersensitivity or even intolerance in this domain, or the irrational tendency to view predominantly synthetic chemical substances as dangerous and something to be avoided at all costs. Among these, the most widespread and accepted definition is "the irrational fear of chemical substances", although it must be noted that chemophobia, despite its potentially misleading name, is clearly distinguished from psychopathological phobias as it does not meet the criteria of a phobia (i.e., psychological strain) (Bearth et al., 2021).

When consumers express concerns about chemicals used in products, they may avoid using them or reduce their exposure especially to synthetic chemicals such as artificial additives in food. Therefore, chemophobia may lead people to avoid products containing chemicals that could prove beneficial (e.g., medicines, vaccines) or support groups that advocate for the removal of various chemicals from the market without considering scientific evidence of their safety. On the flip side is the danger of neglecting the risk associated with natural chemicals, perceived as less threatening than their synthetic counterparts (Saleh et al., 2019, 2021). Therefore, understanding elements that may reduce chemophobia could aid in tackling laypeople's adverse perceptions and responses to chemicals.

2. Objectives

Within a social marketing initiative aimed to foster a more favorable view of chemicals, often juxtaposed to "natural substances", and to counteract chemophobia, this study aims to offer an initial exploration of the psychometric characteristics of the Chemophobia scale proposed by Saleh et al. (2019, 2020) within the Italian context.

3. Methods

3.1. Participants

Participants were 150 Italian women (60%) and men (40%), with a mean age of 32.38 years (*SD* = 13.55). Half of the participants held a university degree (50.7%); 38% had a high school diploma; 7.3% had post-graduate education; 4% had an elementary/middle school diploma. The majority did not have a Science, Technology, Engineering, and Mathematics (STEM) education (75.3%), while nearly one-third of the participants did (24.7%). More than half of the participants worked (58%); 34.6% were students; 4.7% were unemployed; 2.7% were retired.

3.2. Measures

Chemophobia was assessed with an Italian translation of the Chemophobia scale (Saleh et al., 2019, 2020). The original scale was unidimensional and composed of five items (Saleh et al., 2019). Subsequently, the authors added two items while maintaining unidimensionality (Saleh et al., 2020). The original scale items were translated into Italian by the authors. An English native-speaker translator performed a back-translation, to guarantee semantic correspondence between the English and Italian versions of the scale. The final version produced a one-factor scale with six items (e.g., "*I do everything I can to avoid in my daily life contact with chemical substances*"). The response scale ranged from 1 (strongly disagree) to 6 (strongly agree). The Cronbach's alpha for the scale was .86.

The participants' socio-demographics (e.g., age, gender, level of education) were included in the questionnaire.

3.3. Data analyses

The psychometric properties of the Italian Chemophobia scale were evaluated through a confirmatory approach. We conducted two confirmatory factor analyses (CFAs) (i.e., a one-factor seven-item model, and a one-factor six-item model) by means of the Lisrel 8.80 software (Jöreksog & Sörbom, 2006). To assess the adequacy of fit for the CFA models, the χ^2 test was utilized. A model exhibits satisfactory fit if χ^2 is nonsignificant. However, due to the influence of sample size on χ^2, additional fit indices were considered (Schermelleh-Engel et al., 2003): the comparative fit index (CFI) and the nonnormed fit index (NNFI), both indicating good fit if values are $\geq .97$ and acceptable fit if

values range between .95 and .97; the root-mean-square error of approximation (RMSEA), with values ≤ .05 indicating good fit and values between .05 and .08 indicating acceptable fit; and the standardized root-mean-square residual (SRMR), with values ≤ .05 considered good and values between .05 and .10 considered acceptable. Additionally, composite reliability (CR) and average variance extracted (AVE) indices were calculated, with values ≥ .70 and ≥ .50, respectively, considered satisfactory (Bagozzi & Yi, 2012; Fornell & Larcker, 1981). The Chi-square difference ($\Delta\chi^2$) test was used to compare the fit of competing nested models (Hu & Bentler, 1999).

4. Results

Regarding the one-factor model with seven items, the fit indices showed an acceptable fit to the data, except for RMSEA, which indicates poor fit – χ^2 (14) = 35.80, p = .001; CFI = .97; NNFI = .95; RMSEA = .11; SRMR = .06. Table 1 shows standardized factor loadings, CR, and AVE. Standardized factor loadings were all significant and greater than .50 except for item 7. Furthermore, CR reached satisfying values, while AVE did not (Table 1). Therefore, in line with the original scale, item 7 appears to reduce the psychometric quality of the scale.

To have a measurement scale with adequate psychometric properties, we next performed a CFA of the one-factor model with six items. The fit indices showed a good fit to data, except for RMSEA, which indicates an acceptable fit – χ^2 (9) = 18.64, p = .028; CFI = .99; NNFI = .98; RMSEA = .08; SRMR = .04. Standardized factor loadings are all significant and greater than .50. Moreover, CR and AVE reach satisfying values (Table 1).

Table 1. Standardized factor loadings, CR, and AVE for the seven-item and six-item models.

	Seven-item model Factor loading	**Six-item model** Factor loading
Item 1	.66	.66
Item 2	.82	.83
Item 3	.81	.81
Item 4	.74	.73
Item 5	.74	.73
Item 6	.68	.67
Item 7	*.25*	-
CR	.86	.88
AVE	*.48*	.55

Note. Non-statistically significant values are in italics.

Even the $\Delta\chi2$ test suggests accepting the six-item model (Table 2). Therefore, the instrument exhibits good psychometric characteristics.

Table 2. Fit indices and Chi-square difference.

Model	**χ^2**	***df***	**CFI**	**NNFI**	**RMSEA**	**SRMS**	**$\Delta\chi^2$**	**Δdf**
Seven-item model	35.80***	14	.97	.95	.11	.06		
Six-item model	18.64*	9	.99	.98	.08	.04	17.16**	5

*Note. * p < .05; ** p < .01; *** p < .001.*

5. Discussion and conclusion

The current study aimed to provide an initial contribution to the evaluation of the psychometric properties of the Chemophobia scale proposed by Saleh et al. (2019, 2020) in the Italian context. The results confirmed the single-factor structure of the scale. Consistent with the original scale, Item 7 exhibited a lower factor loading compared to the others, thus leading to the reduction of the final scale to six items. Overall, good psychometric properties were observed, with a high Cronbach's alpha coefficient (α = .86), an AVE of .55, and a CR of .88. Therefore, the instrument exhibits good psychometric characteristics. Future research is needed to evaluate the validity of the scale, exploring possible relationships with other relevant dimensions (e.g., knowledge of chemical principles, attitudes towards chemical products, behavioral intentions, health concerns).

How can we counteract chemophobia? Dealing with chemophobia is a challenging task that requires collaboration across various sectors and involves professionals (e.g., chemists, psychologists). Trust in experts is crucial for the acceptance of the messages they convey. Product certifications can also play a significant role in ensuring access to safe and eco-friendly products. Enhancing communication about responsible handling of chemical products in daily life may serve as a potential strategy to mitigate chemophobia. Furthermore, the chemical industry has undergone substantial restructuring, embracing the principles of green chemistry, which offers a solution to the fear of chemicals within the chemical community (Rollini et al., 2022). Green chemistry provides a pathway to explore innovative methods of producing molecules with desirable properties while minimizing waste and pollution. Implementing green chemistry principles in laboratory settings may also aid students in overcoming apprehensions associated with handling chemical substances (Tarasova & Makarova, 2020). Additionally, when considering the negative correlation between chemophobia and understanding of basic toxicological principles and chemicals (both natural and synthetic), and the perceived lack of knowledge about chemicals among people (Bearth et al., 2019; Saleh et al., 2019; Siegrist & Bearth, 2019), promoting education on these topics is hypothesized to be one of the most effective strategies to combat chemophobia (Rulev, 2021). Indeed, a foundational understanding of chemistry enables individuals to critically assess pseudo-scientific and conspiratorial information. Recent research supports the notion that an informational approach, focusing on basic toxicological principles, is more effective than one based solely on emotional appeal in addressing chemophobia (Saleh et al., 2020).

As is known, common themes across various definitions of social marketing include "*(a) influencing behavior change, (b) utilizing a systematic planning process that applies marketing principles and techniques, (c) focusing on priority audience segments, and (d) delivering a positive benefit for individuals and society*" (Lee et al., 2023, p. 7). Therefore, measuring the personal disposition to chemophobia may help researchers and practitioners identify individuals and/or groups needing targeted efforts in terms of social marketing and educational communication (Falco et al., 2013). The results of this study highlight the good psychometric characteristics of a scale aimed to measure chemophobia in the Italian context, representing a further development in terms of operationalizing the construct. This tool proves to be particularly useful for the initiation of a social marketing campaign, currently underway in a research project with a scientific museum in northern Italy, aimed to modify some aspects of people's behavior associated with the use of chemical products by promoting a greater understanding of chemistry.

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