

ADVANCES IN FACET THEORY RESEARCH: DEVELOPMENTS IN THEORY, APPLICATION AND RELATED APPROACHES

EDITED BY: Paul M. W. Hackett and Yael Fisher
PUBLISHED IN: Frontiers in Psychology





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ISSN 1664-8714

ISBN 978-2-88963-108-7

DOI 10.3389/978-2-88963-108-7

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ADVANCES IN FACET THEORY RESEARCH: DEVELOPMENTS IN THEORY, APPLICATION AND RELATED APPROACHES

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'8055' Paul Hackett, acrylic and graphite on canvass, 60cm x 60cm

In this Research Topic the two editors bring together a series of articles that use facet theory and allied approaches to research. Since its inception in the work of Louis Guttman in the mid twentieth century, facet theory has become an established approach within social science research. In addition, over the past 70 years a wide range of research publications have appeared operating within the theoretical and analytic rubric of facet theory and for the last two decades a biennial international conference has been held devoted to facet theory research.

When using a facet theory approach, an implicit aim of the research within this framework is to bring together in an explicit manner a clear definition of the content area that is being investigated along with data analysis procedures. Integrating the explicit design of research content (for example, attitudes, values, etc) and its subsequent analysis (for example to identify the variables that are influential to respondents in relation to the specific area under investigation) allows for the construction of theory relating to the content area and for the meaningful measurement of complex research areas.

The clear explication of an area of research content, is achieved through the use of a mapping sentence (MS). In a MS all of the pertinent variables (called facets) associated with the specific subject matter of the research study are specified in the form of a natural language sentence where facets (variables) are arranged to demonstrate how these theoretically relate to each other. Sub-levels of facets are defined in such a way as to capture the relationships of research variables (facets) to each other and the overall research domain. Background variables are also stated in the MS along with a specified range over which observations will be made to test the veracity of the structural hypotheses (statements regarding the proposed manner in which variables are related to the study's content) implicit in the MS. Furthermore, by using a MS the researcher is able to select variables that appropriately address the area of content. Traditionally, facet theory has been used in quantitative research but has recently been applied to the analysis of qualitative and philosophical research which incorporates a declarative mapping sentence in such research and which is included in this Research Topic.

In order to interrogate these structural hypotheses, quantitative data analysis procedures are employed, such as Smallest Space Analysis (SSA) and Partial Order Scalogram Analysis by base Coordinates (POSAC). In SSA the structure of the content area of interest (the variables that have been included in the MS) can be interrogated as observations that have been made along the specified outcome range, are represented geometrically (as partitioned regions) in a concept-space related to the specific research domain. Individual respondents may also be investigated in terms of their profile of facet related scores using POSAC. A similar approach is employed when analysing information from qualitative facet theory research, which interrogates the structural hypotheses present in the declarative mapping sentence through approaches such as content and narrative analyses.

This Research Topic presents work from scholars with particular emphasis upon how the approach has developed both theoretically and in terms of its application, new areas of application, and advances in theory development.

Citation: Hackett, P. M. W., Fisher, Y., eds. (2019). *Advances in Facet Theory Research: Developments in Theory, Application and Related Approaches*. Lausanne: Frontiers Media. doi: 10.3389/978-2-88963-108-7

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Editorial: Advances in Facet Theory Research: Developments in Theory and Application and Competing Approaches

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Keywords: facet theory, mapping sentence, qualitative facet theory, declarative mapping sentence, multidimensional statistics

Editorial on the Research Topic

Advances in Facet Theory Research: Developments in Theory and Application and Competing Approaches

When conducting research into human behavior we often discover that multiple independent variables impact several dependent variables. To put this in another way, in complex behavioral research the variables of interest often form an intricate interacting web. In this situation, the researcher has to adopt a research approach that embraces and considers this multiplicity of effects and outcomes: Facet Theory is one such approach. This collection represents a significant updating of Facet Theory scholarship, in which the editors have collected a series of Facet Theory articles along with a chapter that considers multidimensional data visualizations not from a facet perspective. The papers address a wide range of domains of human experience: education, homicide, work life, understanding art, and bird behavior. Multivariate research design procedures and the interpretation of multivariable research findings characterize the papers in the collection.

Facet theory is an approach to theory construction used in the social sciences, which integrates research design with data analysis (Guttman, 1959; Tziner, 1987; Borg and Shye, 1995; Hackett, 2014). A central concept in Facet Theory is the facet, which is a classification of an issue under investigation. Cardinal within Facet Theory is the Mapping Sentence, which is a tool for conceptualizing theoretical structures, planning research designs, selecting the variables for use in a study, and formulating the hypotheses to be investigated.

The mapping sentence is a tool that exists within Facet Theory that allows the design and interpretation of the output from multivariate statistical plots. The mapping sentence is an approach that is both unique to Facet Theory and unique in that it is employed from design to research interpretation stages. In all the Facet Theory articles in this Research Topic, the authors present mapping sentences for their specific research domains. In most of the articles, the mapping sentences that have been used to design the research are analyzed psychometrically using smallest space analysis (SSA), a multi-dimensional non-metric data visualization technique. In her paper, Fisher used a mapping sentence approach coupled with SSA to analyze motives for joining a parent-teacher association and compared her results with factor analysis (FA) that have previously been undertaken on the measuring instrument¹. Fisher's SSA yielded a polarized facet of self-serving altruistic ideological motives, self-serving altruistic pedagogical motives, and egoistic motive, along with a radial form facet with elements of concealed motives and politically correct-driven motives in a Radex configuration.

¹The facet approach is often used to analyze an existing domain.

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Edited and reviewed by:

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Specialty section:

This article was submitted to
Theoretical and Philosophical
Psychology,
a section of the journal
Frontiers in Psychology

Received: 07 June 2019

Accepted: 28 June 2019

Published: 18 July 2019

Citation:

Hackett PMW and Fisher Y (2019)
Editorial: Advances in Facet Theory
Research: Developments in Theory
and Application and Competing
Approaches. *Front. Psychol.* 10:1642.
doi: 10.3389/fpsyg.2019.01642

Moreover, Shkoler et al. noted that several definitions and measures of workaholism existed and investigated this also using SSA and FA. They developed a questionnaire based upon a two-facet definition of workaholism and proposed a definitional model incorporating a modality facet with cognitive, emotional, and instrumental elements and a facet of resources that had two elements (time and effort). Also, in a work-related context, Tziner and Levy studied the personality, attitudes, beliefs, etc., of managers and military officers toward performance appraisal. They examined connections between raters' appraisal ratings along with measures of performance and discrimination measures. They designed a mapping sentence and their findings confirmed the presence of a polarizing facet with elements of rater, ratee, and organization/system. The structure led to them concluding that this indicated these three considerations may have been "equally proximal in determining rater behavior."

A similar domain (workplace and personality) is the subject of de Souza and Roazzi's chapter. However, they root their understanding of personality in a fictitious model developed in sci-fi writing by Veronica Roth. In her dystopian and post-apocalyptic society, she posits five psychological traits. The authors claim that the fictional typology may provide an important contribution to personality studies. They investigate the typology's utility for understanding work life choices and within organizations' experiences. SSA supported the five-part division of personality. They concluded that the five traits were psychologically valid and predicted work life choices and experiences. In a second paper by de Souza and Roazzi, the authors (with Monica Souza) looked at possible psycho-cultural underpinnings for some murders. They investigated the Culture of Honor and how this supports ideas that men should never show weakness and how this may be associated with homicide. SSA was used to analyze Brazilian men's attitudes and discovered aspects of culture were linked to traditional masculinity, anger, and other negative personality traits which increased a propensity toward committing homicide. They claim that their approach supported a new scientific framework that clarifies psycho-cultural processes and mechanisms.

There are three chapters that present Facet Theory as a qualitative research approach. Capobianco philosophically reflects upon the book by Paul Hackett that presents the possibilities of using the mapping sentence in a qualitative and philosophical manner. Capobianco concludes that there are difficulties associated with the extra time and effort that a researcher must expend when using a Facet Theory approach. However, he concludes that these efforts are worthwhile, and that Facet Theory is valuable in both qualitative and quantitative research. The first of Hackett's two papers takes a philosophical Facet Theory perspective and uses a mapping sentence to explore and talk about

abstract fine art practice. He employs characteristics of artwork suggested by Crowther's and reduces these using a Facet Theory approach and presents these in a mapping sentence with facets of resemblances, novel environments, visual suggestions, and spatiality/structure. In his second article Hackett considers both quantitative and qualitative facet approaches and applies these to investigate birds' cognitive performance in the wild. Through SSA and partial order scalogram analysis (POSA) he claims Facet Theory can be used to design research into avian cognition research and that the structure of avian intelligence may be understood using a mapping sentence.

Payton Jones and colleagues take a non-Facet Theory approach to multivariate research. Their paper claims multidimensional data visualizations may be misunderstood. In Jones et al., researchers consider their aims when they evaluate the strengths and weaknesses of different visualization approaches. They note how whilst many methods exist that produce interpretable visualizations of highly complex data in two dimensions, two-dimensional representations of high-dimensional data are never able to fully depict its complexity. They suggest researchers should give the reasons for their choice of approach and also provide details as to how their particular visualizations can be understood. In another non-Facet Theory article, Segalowitz et al. investigate the use of multidimensional scaling approaches (MDS) in neoteric combinations with other techniques. They focused upon looking at the comprehension of language that expresses doubt and uncertainty in clinically located health communications. MDS approaches used factor analysis, Classical-MDS, and cluster analysis and discovered a three-dimensional semantic space that produced interpretable results in relation to language usage. They concluded their results supported the use of MDS to assess word understanding in the context of health communication.

This Research Topic provides a review of contemporary Facet Theory and multidimensional data visualization in quantitative, qualitative, and philosophical research. We thank the contributors and hope that this open, online Research Topic will enable the younger generation of researchers to better understand this unique theory and expand the possibilities of research methodologies available to them.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

ACKNOWLEDGMENTS

The editors would like to thank the contributors to this special edition on facet theory and other allied approaches to research.

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Facet-Mapping Therapy: The Potential of Facet Theory Philosophy and Declarative Mapping Sentences Within a Therapeutic Setting

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Keywords: facet theory, mapping sentences, declarative mapping sentence, therapy, counseling

INTRODUCTION: THEORETICAL AND PHILOSOPHICAL FOUNDATIONS

When we think about our lives we usually do not conceive an undifferentiated existential whole. Instead, we tend to divide our experiences into sub-domains or facets: our work, our family, our friends, fun activities, money earning activities, things that are meaningful to us, things that are less important and we would perhaps rather not have to do, etc. We also sub-divide these facets into elements, for example a work facet into the jobs we do, place we work, people we work with. Thus, when attempting to understand how an individual experiences his or her life, considerations must be both ontological and mereological. By ontological I am meaning that we need to adopt a perspective that embraces: (1) our understanding of our nature of being; (2) the interrelated categories and concepts that are associated to a specified domain. Ontology also involves the relationships between the components within the ontology in terms of part to whole associations, or mereology.

My approach is rooted in facet theory but does not employ all of the components of the approach [the interested reader is guided to the seminal works in facet theory development by: Guttman (1971, 1977), Borg (1977), Canter (1985), and Shye et al. (1994)]. I have claimed elsewhere that facet theory when used with a declarative mapping sentence is concerned with both the ontological and mereological understanding of a research domain (Hackett, 2014, 2016, 2018a,b, 2019; Greggor and Hackett, 2018). A researcher who is adopting facet theory will conceive the research they are conducting as possessing multiple variables (both experimental and outcome) that will in some interactive sense be significant within the domain of their enquiry.

QUALITATIVE AND QUANTITATIVE EXPERIENCES

Consideration of the above listed sub-domains (facets) suggests that these are not all identified using the same criteria. For example, we may expect the facets of work, friends, and family to usually be qualitatively differentiable. Therefore, these facets are unlikely to be understood in terms of their being better or worse, more or less, greater or lesser, etc. Rather, they are likely to be simply distinct or qualitatively different from each other. Thus, family experiences may be seen as distinct from work experiences but not necessarily as better or worse, more or less, etc. In order to differentiate such experiences in terms of extent they may have to be reference to another, more quantitative facets. For example quantitative facets may include any sub-domain that can be thought of in

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Specialty section:

This article was submitted to
Psychology for Clinical Settings,
a section of the journal
Frontiers in Psychology

Received: 07 December 2018

Accepted: 08 May 2019

Published: 29 May 2019

Citation:

Hackett PMW (2019) Facet-Mapping
Therapy: The Potential of Facet Theory
Philosophy and Declarative Mapping
Sentences Within a Therapeutic
Setting. *Front. Psychol.* 10:1223.
doi: 10.3389/fpsyg.2019.01223

terms of better or worse, more or less, greater or lesser, etc., and these could include, fun activities, money earning activities, things that are meaningful to us, things that we do not enjoy, etc. On this understanding the facet of family (for example) could be evaluated as more or less in terms as it is related to other facets such as fun activities. It is therefore through the combination of the two facets, one qualitative, and a second quantitative facet, that a particular activity, state of being or event that involves a person's family can be understood as it impacts on and is experienced by an individual. Finally, there are facets of our lives that place experiential facets into a context, which is either internal or external to the individual. Examples of these would be places, individual health, times, etc.

USING FACET-MAPPING THERAPEUTICALLY

Above, I have suggested how life experiences can be conceived as being ontological and mereological. I have also suggested that breaking life into facets may assist in our understanding the qualitative and quantitative variables (life events) that form our life experiences. On this conception, the role of the therapist can be conceived of as being that of a person who explores a client's life with them and facet-mapping is firmly rooted in what Sklare (2014) calls the assumption that in therapy the client knows him or herself best. The therapist and client together identify facets of the client's life and attempt to consider the interplay between facets, or, as Martin (2015) puts this, "I (the therapist) am a fellow explorer going through this with you, but you are the final authority." Understanding facets of a person's life, how these interrelate to each other and what the outcome of specific levels of each facet when these interrelate with other levels of other facets, can assist the therapist in forming a picture of the client's experiential world and how this relates to discomfort or pathological issues. I have found it useful when working with a client to take time to identify the facets in a person's life that they see as being important in terms of a problem or difficulty they are experiencing and how facets are expressed. Having assembled a list of facets and their elements these may be joined together during discussion with the client in the form of a declarative mapping sentence.

It is important to note that the construction of a declarative mapping sentence does not have to be necessarily co-constructive. Rather, it is the position that is assumed by the therapist that enables co-construction of a mapping. Moreover, a counseling process may be client-centered without the employment of a mapping sentence. However, the advantage that I have found in co-constructing a declarative mapping sentence with a client is that it actively involves both client and therapist, both verbally and physically (through writing the sentence), in an exploration which requires thought and reflection by both parts of this dyad.

In a therapeutic setting the therapist may try to be comprehensive by attempting to clearly locate an issue in terms of a client's whole life. Attempting to focus upon the particular issues a client has impels the therapist to concentrate upon the

specific aspects of a client's life that are of concern to the client. If a therapist takes too broad an outlook this may make the therapy too general to have a significant effect. Conversely, by embracing too narrow a view may miss other significant factors associated with the client's issue(s). Adopting a facet-mapping approach and assembling a declarative mapping sentence of the problem area requires the client and therapist to identify a discrete set of issues and their influences within the client's experiences.

In the research literature facets are typically of a fixed number of structures and these facets have been discovered to interact in specific ways (see, for example, Levy, 1985). As well as being quantitative or quantitative facets may also be focusing facets or layering facets. Facets may come together in a number of ways, for example as a cylindrex, which is a structure that has been found in research into attitudes, values, etc. A cylindrex may be imagined as a layer cake with multiple layers. In this cake, each layer is more similar to adjacent layers than more distant layers, where the top and bottom layers are the most dissimilar. We may also imagine that in the center of the cake the flavor is very intense and that this intensity decreases as we progress toward the outside edges of the cake with there being little flavor at the outside edge. Finally, the cake may be sliced into wedges originating from the center where each slice has a different color. Therapeutically, the illustration of a cake may be discussed and the layers, rings, and wedges identified. Indeed, the aim of therapy is for the client and therapist to "get to know" the structure of the cake. It is also possible for clients to identify where they are positioned in the cake in relation to different circumstances. As has been noted (e.g., Morgan, 2000; Andrews, 2017), narrative statements can be powerful in therapy. It is my opinion that declarative mapping sentences have the ability to personalize such statements and to target therapy.

An example may help to illustrate my claim. If we imagine that a client has a problem at work a declarative mapping sentence may be assembled that identified the major facets as being, job task, degree of personal skill involved, and physical location and let us imagine that these are represented by wedges in the cake. The levels of skill required of our client are represented by the concentric circles emanating from the center of the cake (with more personal skill tasks being positioned centrally and the peripheral items being those that require less skill). The different locations where the client works are the layers of the cake. Situations at work may be located within the cake and situations in which the client is experiencing difficulty may be explored through reference to the cake's structure and the interaction of the facets and elements that together form the cake. Different tasks and events at work may be compared in terms of their relative location in the cake. I have found it useful to use a wooden model of a cylindrex and to let the client handle this when they are discussing their issues. This may reveal surprising influences of a facet in reference to an event of which the client was not previously aware. In this way, the model or a drawn representation of the model may be used in counseling with a client. Alice Morgan makes a similar point when she speaks about what White (1992) calls the statement of a position map. She sees this as involving the negotiating and naming of a client's issue in a way that is congruent with that person's meaning and

experience of the problem, exploring the impact of the problem in the person's life, asking the client to evaluate the impact of the issues identified and asking them to justify their claims.

The facet-mapping approach can allow the identification of facets, their elements, the roles of facets, the importance/salience of facets, how facets interact, how working on one facet of life can influence another or other facets and the relative importance of facets in terms of the client's issues. After a client has discussed their mapping sentence and how the sentence may be depicted in a three-dimensional representation, the therapist may suggest how the facets can be re-assembled through the client changing their actions, thoughts, etc., and the outcome of such changes discussed in reference to the model.

A simplified example of how I used the approach with a client is provided in the case of "Terry." I was counseling Terry because of his problems in the life areas of substance abuse, his unemployment, and issues he had with his partner. Terry and I initially identified these life areas in the development of a declarative mapping sentence. Elements were identified of what were for Terry relatively discrete aspects of each of these life areas. For example, when talking about his partner it emerged that Terry identified her as providing him with his main source of income, as being a source of constraint upon his life-style and also as providing him with emotional support. When speaking about the other two life areas (unemployment and substance abuse) elements emerged that were in some ways both similar and different to those of the partner facet (for example, the elements of having time to do things, affording to go out with his mates, getting money from the government were identified for the unemployment facet). Terry initially positioned the facets in the following order: partner; employment; substance abuse. Having identified the facets and their elements in the declarative mapping sentence we then used the wooden cylindrex model and identified the facets as the circular disks with the elements as wedges in these disks. Issues were also seen to occupy elements in which issues positioned nearer the center of each disk were identified as being of greater importance to Terry.

Terry had several "ah ha" moments when we used this model. For example, he discovered that the facet of partner was intimately related to the facets of unemployment and substance abuse and was better positioned between these two facets. Furthermore, it became apparent that what he had initially identified as being a discrete and relatively important part of his life, the income he received from his partner, was in fact central in this model and indeed that it was not really a discrete facet but rather ran through many of the other facets and elements. Having identified these changes in the model, I was able to talk with Terry about how this related to the violence he had displayed toward his partner and the resentment he felt toward her for paying for his life-style. We were also able to suggest how by

changing his thinking about his partner's financial support from existing on its own as a separate facet and moving this conception to being intertwined amongst other facets could suggest ways he may change his behavior toward her. I will not go further into this case as I provide it as an illustration of how first identifying the pertinent facets and elements in a declarative mapping sentence and then exploring the interrelationship of facets and elements in a model was able to facilitate issue recognition and suggest behavior change.

CONCLUSIONS AND THE FUTURE

By exploring a person's life using the facet-mapping approach the client and therapist assume the roles of co-explorers where such roles may assist in the important task of dispelling notions that the client is in some way crazy but rather that they are rational joint "explorateurs." Future research could enquire into the veracity of this claim. In the future, there is a need for software to be developed that enables a touch-operated model to be built on a tablet. This would allow the therapist and client to travel together more easily through a life domain, issue area, etc., in a way that is perhaps more user-friendly than the wooden model that I have used. Further research is also needed to enquire into the limitations of the facet mapping approach, in terms of the therapeutic situations in which this is a more or less helpful approach to adopt. It has been my experience when developing a mapping sentence in a counseling situation that the process of declarative mapping sentence development can be initially completed in a single session and then refined and modified in later sessions. However, the optimal time this process should take requires further investigation. Eighty years of using facet theory within social science research has demonstrated that the mapping sentence is a flexibility structure that is able to capture and allow the exploration of complex human experiences. Furthermore, the employment of facet theoretical approaches in research design have suggested that when a research question is stated in terms of its facets, that this question usually possesses two to four facets. To date, this has also been my experience when using a declarative mapping sentence where I have found that ~3 facets usually emerge during the development of the sentence. However, further research is needed to determine the flexibility of the declarative mapping sentence and the optimal number of facets that should be present (if such an optimal number does indeed exist) to facilitate a client and therapist co-exploration of complex therapeutic issues.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Book Review: Facet Theory and the Mapping Sentence: Evolving Philosophy, Use and Application

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Keywords: facet, theory, research, qualitative, theoretical, mapping, sentence, Hackett

A Book Review on

Facet Theory and the Mapping Sentence: Evolving Philosophy, Use and Application

Paul M. W. Hackett, (Boston, MA: Palgrave Pivot), 2014, 113 pages, ISBN: 9781137345912.

In *Facet Theory and the Mapping Sentence* Paul M. W. Hackett makes a case for facet theory's ability to describe the complexity of the world and the categorial implications of such investigations. Even if we are familiar with facet theory, its integral instrument the mapping sentence is introduced to us anew in previously unexplored qualitative contexts. Ultimately, Hackett's non-orthodox applications of facet theory involving qualitative data do not seem heretical, in part, because facet theory is first presented as a plausible and enlightening way to see the world backed by centuries of philosophical precedent and recent developments including neuroscience literature. What is more these overviews are succinct and contribute in a clear way to an inspiring, verisimilar worldview. We are left willing to accept the idea that the rigor of mapping sentences could be useful not only as a research tool but also for areas as diverse as therapy and making fine art. In each case the purported usefulness and importance of using mapping sentences is stressed. The effect is intellectually satisfying and rhetorically effective because at each turn what we come to accept as the truth of facet theory is specially and coherently magnified by another display of its kaleidoscopic brilliance.

One of Hackett's more unique takes on what facet theory is and what it could mean to embrace it is distilled in what he calls the "facet theoretical imagination." The mapping sentence is presented as an extension of this imagination: the embodiment of a stance that structures behavior and experience in terms of discrete categories or facets within which are subunits or elements meant to exhaustively account for each facet's variations. Hackett sees in this stance the opportunity to "envisage more complex events and to develop more multifarious awareness" (Hackett, 2014, p. 62). Instead of superimposing a rigid, prescriptive lens over the research domain facet theory achieves a dynamic kind of clarity because the lens through which the user of the mapping sentence perceives the domain and conducts their research is carved by the context and respondents that compose the domain itself. Whilst static, the mapping sentence's inherent guidance for its own use and evolution draws out the real-life bustle of a domain over time where use improves performance.

A more realistic analogy is palate refinement. As this takes place flavors emergent from interactions with the food in the forms of taste and smell are repeatedly and purposefully categorized and subsequently more accurately identified in the context of its relationships with other flavors. Eventually attention to palate development will reveal deeper, longer, orchestral experiences. Moreover, flavors such as almond can be differentiated from cherry, vanilla, etc. The practice of palate development allows not only recognition of the almond flavor in the pastry and the lime blossom flavor in the tea, but also a more immersive, thicker appreciation of the overall experience to which these flavors contribute.

OPEN ACCESS

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Reviewed by:

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Specialty section:

This article was submitted to
Theoretical and Philosophical
Psychology,
a section of the journal
Frontiers in Psychology

Received: 04 December 2018

Accepted: 15 February 2019

Published: 19 March 2019

Citation:

Capobianco PM (2019) Book Review:
Facet Theory and the Mapping
Sentence: Evolving Philosophy, Use
and Application.
Front. Psychol. 10:468.
doi: 10.3389/fpsyg.2019.00468

To wit, recollections become more vivid and our interpretations of them more meaningful. It is through repeatedly stepping back to recognize and scrutinize categories that we appreciate the kinds of experiences from which the categories emerge. The more attention to categories and their contents the more ripe the practice is for discovering unexpected categories that improve the overall experience: e.g., that heavy silverware can improve flavor (Michel et al., 2015). However, this attention is not necessary to enjoy food. This fact, the extra work required, perceptions that this is finicky and pretentious and worries attending to the parts potentially detracting from the total experience are perhaps why people do not pursue palate development. Likewise, mapping sentences can seem like finicky extra work. In both cases novelty and perceived non-essentiality may cause skepticism. Another potential hurdle is the need for repeated uses of facet theory and mapping sentence correction before theory development and theory extension become truly kinetic. It is precisely this systematic self-examination that results in research that is comparable to and cumulative with other research using the same mapping sentence developed through new mistakes and adjustments to a new context.

Returning to the palate development analogy, repeated exposure to initially unliked flavors may be found to have compelling complexities in the same way do new interpretations of data. Likewise, “humility is an acquired taste” (Roberts, 2014, p. 75) and the reflexivity of a mapping sentence built into the systematic methodology prescribed by facet theory compels the researcher to ask in what ways the collected data gels or does not gel with the mapping sentence’s facets; that is, to what extent the hypothesis about the categorial breakdown of the domain in the mapping sentence is respondent-appropriate and relevant to how an individual actually “understands” their experience within the domain’s complex context. Assessing both segments of human

life and also the totality of the experience allows comparisons between people that speak to enlightening patterns undistorted by a researcher’s potential presumptions about the individuals in question.

Hackett does not use words like “humble” nor does he suggest that facet theory might have moral elements in practice. This perhaps was a lost opportunity since a moral dimension would fit into Hackett’s philosophical treatment as well as bringing facet theory closer to everyday concerns. Including more descriptive details and specifics—when speaking of the mapping sentence’s success in therapy, for instance—would have served a similar purpose. In the same vein, some might find Hackett’s examples too niche to give the attention necessary to be convinced of facet theory’s merits in that context. This would be a loss, however, because Hackett’s examples of what a mapping sentence can do are born out as organic extensions of what facet theory reveals to us about reality and what mapping sentences are for.

Since facet theory is most powerful over long periods of time involving many people in different contexts one test of Hackett’s insights and meaning-making will be their echoes in the future in the form of other insights, meaning-making, and perhaps more importantly, as ways to think about domains that map out a way to investigate them. What is needed are more people who believe in facet theory’s potential to be applied in a variety of domains. In the short-term, Hackett has achieved one of the most important feats the proponent of a theory can hope for: stimulating well-founded enthusiasm for its adoption and possibilities.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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A Mapping Sentence for Understanding the Genre of Abstract Art Using Philosophical/Qualitative Facet Theory

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Keywords: perception of art, experience of art, facet theory, mapping sentence, mereology, ontology, aesthetics, art

OPEN ACCESS

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Specialty section:

This article was submitted to
Theoretical and Philosophical
Psychology,
a section of the journal
Frontiers in Psychology

Received: 30 April 2017

Accepted: 19 September 2017

Published: 12 October 2017

Citation:

Hackett PMW (2017) A Mapping
Sentence for Understanding the
Genre of Abstract Art Using
Philosophical/Qualitative Facet Theory.
Front. Psychol. 8:1731.
doi: 10.3389/fpsyg.2017.01731

Whether we are philosophers or are members of the general public, during the course of our daily activities we sub-divide our phenomenological world and form categorial accounts of these experiences. The development of categorial ontologies, or sub-divisions of the most basic levels of our existence, has long been used to enable a clearer understanding of a specific domain of interest. Similarly, ontological scholarship has a long and distinguished history which continues to this day (see for example: Aristotle and Ackrill, 1975; Simons, 1987; Harte, 2002; Sider, 2005; Lowe, 2007; Chisholm, 2010; Poli and Seibt, 2010). Coffey (2016) provides an overall contemporary review of the use of ontologies by philosophers.

In Hackett (2016a) I claimed that facet theory research (Canter, 1985) may be considered a form of meta-ontological enquiry and analysis due to it incorporating the mapping sentence as its guiding structure: The mapping sentence is a template within which the researcher overtly states the major sub-divisions of an area of research interest. I further asserted that facet theory embodied notions of a meta-mereology as the mapping sentence also makes much of the way in which the sub-components of a research domain (the basic ontological units which are called facets) are broken-down into mutually exclusive “elements.” More precisely, the inter-relationships between facets and elements are stated linguistically in the mapping sentence. Earlier, in Hackett (2014) I have already argued for the utility in developing a qualitative or philosophical approach to facet theory¹ and suggested that this is best thought of as a meta-mereology.

The mapping sentence links together the pertinent components of a research domain in such a way that the variables (facets) and sub-components of the variables (elements) are combined using every day prose so as to suggest the inter-relationship between facets and elements in the context of a specific research undertaking. Hackett (2016a,b, 2017) has used a qualitative or philosophical facet theory approach to facilitate an account of perceiving different forms of abstract art. Through amalgamating existing theory within this research domain along with empirical observations, the mapping sentence has the potential to extend psychological and philosophical knowledge and understanding of how abstract forms of modern and contemporary fine art are perceived and experienced. In the above-mentioned articles I addressed abstract art that was either two-dimensional (Hackett, 2016b) or three-dimensional (Hackett, 2017). In the latter of these publications I suggested that the findings from these two branches of research might be brought together to suggest a way to investigate abstract art as a united genre. Below, I address this claim.

¹ On such an approach the data that arises will likely come from individual reflection (as is the case of the analyses reported in this essay, or will come from small sample sizes). In the research reported in this essay, smallestspace analysis (SSA) was used to analyse the data in the form of a case study.

Paul Crowther is philosopher who has developed ontological accounts in his research. Of specific interest to the claims I make in this paper, is his book of 2007 *Defining Art, Creating the Canon: Artistic Value in an Era of Doubt*. Crowther (2007) first puts forward and then justifies the notion that art can be thought of in terms of its ontological components. He proposed an eight part ontology that is made-up of the following categorical characteristics: resemblances—joining, connecting, uniting in an advantageous or rewarding way, colors, shapes and textures so that these resemble certain visual configurations and shapes (e.g., images in cloud patterns); gestural associations—symbolic relationships, connections with visual manifestations that arouse states of mind (e.g., violent shapes, depressing colors); revelations—aspects of articles, objects, associations, tiny small surface features, internal configurations, fleeting atmospheric effects, unusual perspectives, and other events that are not usually visible; novel environments—articles, objects, associations and other events, located in perceptual and physical environments that they are not usual found in; neoteric configurations—bringing about of a visual array, positioning or arrangement through destruction, deconstruction, reduction, reconstruction or in some way altering familiar events; visual suggestions—previous, future or counterfactual events, items or states of affairs arising from visual lines, colors, shapes, symbols or suggestions; spatiality/structure—visual spatial impression and configuration of attributes, such as: color, shape, volume, mass, texture, density, geometric structure, alterations in positions, either alone or in combination; fantasy—a state of unreality or hallucinatory circumstances and appearances.

However, Crowther's comprehensive ontology does not suggest a combinatorial rational for its elements. In this essay I consider the validity of Crowther's characteristics to all two- and three-dimensional abstract art and offer a categorial ontology that considers mereological aspects of these basic units of art experience. However, I first consider my earlier work that exclusively looked at two- and three- dimensional abstract art. In Hackett (2016b) I report research into the two-dimensional format of abstract and found that six of Crowther's eight characteristics legitimately structured perceptions of this art genre. The six legitimate Crowther characteristics were: resemblances; gestural associations; revelations; novel environments; visually suggestions and spatiality/structure. The two characteristics of neoteric configurations, and fantasy did not appear to play an important role in structuring understanding. I later considered Crowther's characteristics in terms of three-dimensional abstract art. Again, not all of the eight characteristics played an important role in structuring understanding of these art works. In this instance the pertinent characteristics were: resemblances; novel environments; visually suggestions; and spatiality/structure features. The feature of fantasy appeared to play a minor role and along with the characteristics of gestural associations, revelations and neoteric configurations were of little importance in structuring understanding. Thus, I believe that it is possible to usefully combine my findings in regard to two- and three-dimensional abstract art. In doing this it is possible to facilitate a depiction and offer understanding of abstract art as an overall genre of art.

Thus, I propose that Crowther's characteristics may be reduced in number as through using smallestspace analysis not all of these were found to structure my appraisals. Consequently, Crowther's characteristics may be reduced in number to those that partitioned both two- and three-dimensional abstract art. These were: resemblances; novel environments; visually suggestions; spatiality/structure. In **Figure 1**, a mereological arrangement of the combination of these four facets and their respective elements of experience is proposed in the format of a mapping sentence.

By using the above mapping sentence, it is possible for an individual painting, drawing, sculpture, installation, piece of land art, etc., to be depicted in terms of its structuples (profile of facets and its elements). Furthermore, if the facets and elements that have been incorporated into the mapping sentence are both valid and comprehensively address the domain of abstract art this account will yield, through structuple combinations, a total definition of the phenomena of the abstract art object.

It is important to note that the combination of pertinent characteristics of how we perceive and understand both two- and three-dimensional abstract art may suggest an overall framework for abstract art perception. However, this statement requires investigation as the identification of characteristics that were employed for understanding the two forms of abstract art when viewing either two- or three- dimensional abstract art works may not combine in a meaningful manner when a person observes two- and threedimensional abstract together. The question as to whether the combination of the findings to study the combined genre of abstract art experience is an area of ongoing research. This caveat notwithstanding, it seems that the combination of the pertinent characteristics for perceiving two- and three-dimensional abstract art, in a mapping sentence format, at the very least provides a framework that will facilitate further enquiry.

I justify my optimism by noting how the mapping sentence is a tool that I have used to investigate fine art within several different and specific contexts including art objects (Hackett, 2013) and art education (Schwarzenbach and Hackett, 2015) which has enabled me to presented multiple mapping sentences for these different aspects of fine art. From these mapping sentences, I believe it is reasonable to state that the mapping sentence is a framework that may facilitate research that clearly addresses a variety of contextualized art experience. However, this research is in its infancy and is subject to ongoing study and further consideration.

My work into the area of facet theory as a qualitative and philosophical approach (Hackett, 2013, 2014, 2016a,b, 2017)² is also supported by my research into abstract art. These publications extend the facet theory literature and support the use of the mapping sentences as meta-ontological and meta-mereological structure within which reliable, valid, consistent and cumulative research may be undertaken and knowledge developed.

²In my current research I have been using a philosophical/qualitative approach to facet theory research in combination with traditional quantitative facet theory procedures in the investigation of avian cognition. The initial results of this approach appear to be providing insight into avian behavior.

Person (x), viewing an abstract three-dimensional artwork, perceives the optical characteristics to:

Resemblance

(resemble)

(to) items – events - states of affairs - through the combination of visual qualities,
(not resemble)

Novel

Environments

(using)

and / or through: (to) items – relations - states of affairs - in novel settings,
(not using)

Suggestions

(suggestive)

and / or by using visual traces that are: (to) of past – future -- counterfactual
(not suggestive)

Spatial / Structural

(spatial/structural)

items - states of affairs, and / or by using features that are: (to) qualities,
(not spatial/structural)

and assess the above characteristics to be present in a specific three-dimensional abstract artwork

Range

(greater)

to a: (to) extent.

(lesser)

FIGURE 1 | Mapping sentence for understanding the experience of abstract art.

I have written this opinion article in an attempt to encourage the investigation of the highly intricate research and experiential domain of visual perception when this is applied specifically to our understanding of abstract art. I have suggested that a faceted understanding of this categorial experience instantiates the multifarious nature of art perceptual experiences. The findings of my research into abstract art require the question to be asked as to whether non-abstract art may be understood using the same mapping sentence? It is obvious that representational art embodies notions of likeness. However, a facet that reflected the similarity of an art object to the event or thing it is representing could be incorporated into the mapping sentence. Even when experiencing the most representational of art objects, perhaps a photographic portrait, this representation will involve other associations that

result from the art object being in experiential dialog with the viewer and which are suggested in the four facets in the Mapping Sentence for Understanding the Experience of Abstract Art (**Figure 1**). Consequently, the facets contained in this mapping sentence may provide a template that can be adapted and used to investigate non-abstract art. What I am claiming is that the mapping sentence investigated within a qualitative and philosophical framework provide a template for understanding the complexities of the perception and understanding of art.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and approved it for publication.

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- Conflict of Interest Statement:** The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
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Concealed and Unconcealed Motives for Joining the Parent-Teacher Association: Mapping Sentence and Smallest Space Analysis

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OPEN ACCESS

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Reviewed by:

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Specialty section:

This article was submitted to
Theoretical and Philosophical
Psychology,
a section of the journal
Frontiers in Psychology

Received: 09 September 2017

Accepted: 23 August 2018

Published: 11 September 2018

Citation:

Fisher Y (2018) Concealed
and Unconcealed Motives for Joining
the Parent-Teacher Association:
Mapping Sentence and Smallest
Space Analysis.
Front. Psychol. 9:1705.
doi: 10.3389/fpsyg.2018.01705

Background and Subject: A Parent-Teacher Association (PTA) is an organization that enables parents to be involved in their children's schools. Participation in the PTA is one of many steps parents can take to ensure their involvement. Few if any studies have examined parents' concealed and unconcealed motives (UCM) for joining the PTA.

Purpose/Hypotheses: The main purpose was to identify the structure of the concept Motives for Joining the PTA, so as to enhance our understanding of what motivates Israeli parents to join the PTA. The second purpose was to differentiate between parents' concealed and UCM.

Method/Procedure: A self-report anonymous questionnaire, containing 40 items (30 items about aspects of being a member of a PTA and 10 items for reporting background variables), was administrated. Data were collected from a sample of 155 Israeli parents. The initial data processing stage involved EFA (Exploratory factor analysis) using SPSS software. Stage two was a Smallest Space Analysis (SSA), conducted using the Hebrew University Data Analysis Program (HUDAP).

Results: EFA indicated three main factors. The internal consistency of the scores in the entire scale, measured using Cronbach's alpha coefficient, was 0.89. Data deployment on the SSA map exhibited both a polarized form (an angular form) and a radial form in a Radex configuration. The first layer (the polarized facet) was composed of three major motives related to self-serving altruistic ideological motives/ (SSAIM), self-serving altruistic pedagogical motives (SSAPM), and egoistic motives (EM). The second layer (the radial form) was composed of concealed motives, UCM, and politically correct-driven motives.

Keywords: Facet Theory, SSA, parental involvement, elementary schools, PTA

INTRODUCTION

Parental involvement in the educational system is a subject that researchers around the world have been exploring for years (Mo and Singh, 2008; Fisher, 2010; Jeynes, 2012; Noy, 2014). The worldwide implementation of the Law of Compulsory Education over the last century has changed many of the roles that family and society play in child-rearing. Families were forced to collaborate

with the State in child-rearing and education, after centuries during which the family alone was responsible for children's education (Noy, 2014).

The research literature provides evidence of correlations between students' academic high achievements and parental involvement, based on discussions between parents and children about the importance of school, studying, and the school experience in general (Ingram et al., 2007). The relationship between academic achievements and parental involvement has been found to be statistically significant (Hoover-Dempsey et al., 2002; Jeynes, 2005, 2007; Mo and Singh, 2008).

Parental involvement has been described in various ways, emphasizing both home, school, and community behaviors (Barton et al., 2004; Smith et al., 2011). However, given that there is no single comprehensive definition of parental involvement at school, clarity should be attained in order to reach a consensus among researchers (Fisher and Friedman, 2009).

One of the ways that parents choose to become involved in schools is through the Parent-Teacher Association (PTAs), which in effect consists of parent committees that work alongside teachers to attain shared goals (Fisher, 2011; Jeynes, 2012). The committee's role is backed by the Director-General Code By-Law. Participation in school- and class-level committees is one of many school-related voluntary activities through which parents opt to get involved in their children's school experience.

Parent Committees

There are countries in the Western world in which the various parental delegations have significant statutory powers. For example, there is the PTA, a voluntary organization that includes parents, teachers and staff, which can be found in various countries, such as Japan, United Kingdom, United States (in the majority of countries, its representatives are officially elected in tandem with the presidential elections, and its representatives are appointed to the board of directors of the schools). Elected parents also have authority over the placement of children with disabilities in schools, in contrast to centralized education systems (such as in Israel, in Netherlands, etc.), wherein parents' authority is limited, and their main function is to advise (Povey et al., 2016).

Parent Committees in Israel

Parent committees are common in Israeli schools. In Israel, the guidelines for the educational system are published in the Director-General-Code-By-Law which reflect the principles of the educational and administrative policy of the Ministry of Education. The purpose of these guidelines is to define roles and determine procedures and to regulate work processes in the education system. The system includes two types of directives: Standing orders and temporary orders and notices.

Standing orders have binding legal force. A standing order is valid until a new order is written down that revokes or updates it. A temporary order is valid until the expiry date specified in the order itself, for example until the end of the school year. Each instruction contains an introduction detailing the date of entry

into force, who it applies to, whether it is a new provision or an update to a previous instruction, as well as a list of previous instructions on the same subject and related subjects. In addition, the person responsible for each of the guidelines and the ways of communicating with him are specified.

The purpose of messages is to provide the schools and their staff with essential information and to arrange work processes, most of which are valid in the school year in which they were published, and at most up to 2 years from the date of publication.

Although more limited in power than the above-mentioned PTA committees, their scope first increased with the establishment of community schools in the 1970s. In 1996, a Director-General Code By-Law was issued, conveying the Ministry of Education's policy regarding parental involvement in general and in the schools in specific, and expressing its support of parental involvement, mostly emphasizing the need to create a positive climate, but setting ambiguous boundaries (Director-General Code By-Law, SB / 4; SD 4 [a]). In a Code By-Law issued in 2003, the Ministry of Education distinguished between three representative offices that parents could hold in the school:

1. A Homeroom Class Committee – a representative group of parents of students assigned to the same homeroom class is democratically elected for the course of the academic year and remains in office until a new representative group is elected for the next school year.
2. A Central Committee of Parents – a committee composed of one or two representatives from each of the class committees, from which a chairman is elected to the institutional committee.
3. Institutional Parents' Committee – A group of parents of the Central Parents' Committee is elected to represent the parents of the entire school at district- and national-level forums.

In addition to these committees, there are other parent organizations that vary between different communities and different populations but are not necessarily affiliated with the schools. Most Parent committees are not authorized to intervene in pedagogic decisions of the school, although according to the State Education Law, parents have some degree of influence on the curriculum (25% of the curriculum, but under additional conditions; Fisher, 2010). Most schools believe that although parents have the right to ensure the welfare of their children, when it comes to pedagogic decisions, parents must rely on the professionalism of the teaching staff (Fisher, 2010; Noy, 2014).

Altruistic Volunteering, Egoism and Concealment

The definition of volunteerism includes a positive attitude toward the activity in which one chooses to engage and toward the cause it serves. The volunteer activity entails no material reward and the volunteer does not receive payment for the service provided. Volunteers play a vital role in helping local schools accomplish their goals and missions. Yet, little is known about the determinants of volunteering in local schools. Thus, community

factors, citizens' concerns, and personal characteristics are possible determinants of general and school volunteering (Wei-Ning and Chin-Chang, 2017). Concepts such as personal (egoistic, narcissistic) and altruistic goals are significant factors among the numerous motivations for volunteering.

Altruistic behavior, generally described as a selfless behavior that benefits a third party's welfare, sheds light on the phenomenon of "social solidarity in modern societies" (Wuthnow, 1993, p. 344). Due to its significance in explaining social behavior, altruism is broadly studied in social sciences, especially in contrast to the predominant selfish and self-interested behaviors that are characteristic of modern societies, wherein individuals' primary focus is on personal achievements and goals (Batson, 2016).

Egoistic behavior is described as a situation in which people regularly prioritize their own individual needs and thoughts, above and beyond those of others; hence, they are likely to ignore the feelings, needs, and perspectives of others (Phillips and Phillips, 2011). Egoism and narcissism are interrelated. Every narcissist has a big ego but not every person with a big ego is a narcissist. The 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM) (American Psychiatric Association, 2013)

defines *narcissism* as a personality disorder belonging to Group B of personality disorders. Its main characteristics are excessive preoccupation with oneself and one's abilities, accompanied by a lack of empathy and an inability to form any kind of sincere relationship (Millon, 2004; Friedman, 2011).

Concealment is the act of concealing, i.e., withdrawing or removing something from observation. It also describes a desire to hide, withdraw, or remove oneself from observation; remaining covered and out of sight.

Definitional Framework and Research Hypotheses

The main purpose of the study was to consider the definitional framework and identify the structure of the concept *Motives for Joining a PTA*.

The second purpose was to tease out the concealed motives, in addition to the unconcealed ones reported. Few if any studies have dealt with parents' concealed and unconcealed motives (UCM) for joining a PTA-type framework.

A definitional framework for Facet Theory was provided by Guttman (1959). The strength of Facet Theory is in being a methodological approach that facilitates the conceptualization of phenomena. This approach enables the planning and testing of hypotheses, by using data analysis that emphasizes the relationships between the hypotheses and the results (Levy, 1994; Shye and Elizur, 1994). It makes it possible to form a theory based on empirical findings. A theory, according to Facet Theory, hypothesizes a correspondence between a definitional system for a universe of observations and an aspect of the empirical structure of those observations, and includes a rationale for such a hypothesis (Guttman, 1982, p. 335).

Facet Theory uses the mapping sentence as a key tool. The facets describe the research issues and each facet has a different

role. The facets make it possible to rationalize the hypothesis of the research (Guttman, 1959). There are three facets: the first facet describes the population (in this study, parents); the second facet describes the study's main issues (motives and concealment) and is called the content facet; and the third facet describes the range (level of perception).

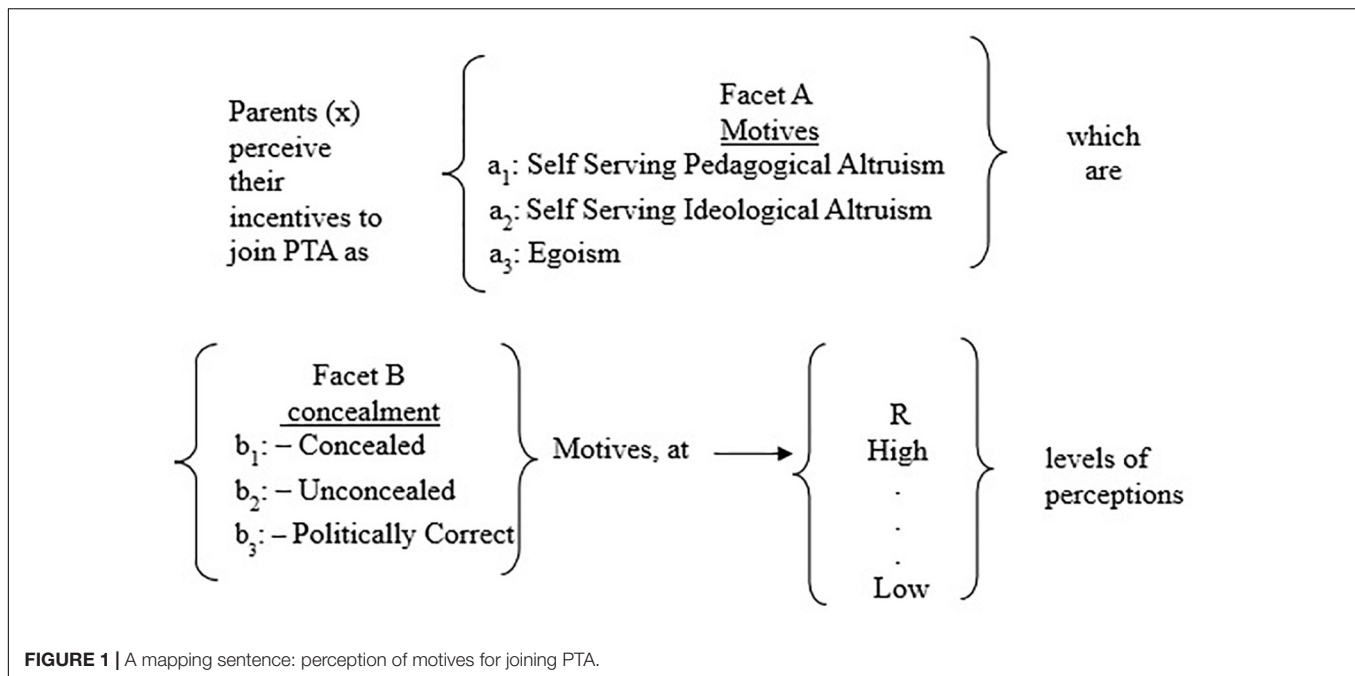
In the current research, Smallest Space Analysis (SSA) was used for the applications. SSA is a statistical model that makes it possible to examine the concordance between the mapping sentence and the relationships between the variables. A correlation between variables is represented as a physical distance in a two- or multi-dimensional space. The points in space are closer when correlations between variables are greater. The map actually affords a better understanding of the correlation matrix. Indeed, there is no other statistical approach that offers a better means of interpretation.

The following mapping sentence (Figure 1) describes the parents' perceptions of their motives for joining a PTA-type committee. The mapping sentence is comprised of two content facets and one range facet:

Facet A, the first content facet (motives) is an unordered facet, since it is not necessary (or possible) to prefer one motive over another. This facet's role is to deploy the variables in an angular form, creating segments on the SSA map, based on the facet's elements:

- a₁ — Self-Serving Pedagogical Altruism: Parents who act out of pedagogical altruistic motives wish to improve not only the pedagogical contents of their children's class, but also the pedagogical contents of the school as an organization. They believe that they can contribute to and even improve the knowledge and performance level of school teachers and wish to be influential partners in all of the school's pedagogical decisions. They also aim to influence their children's class climate and that of the school, as well. Given that the outcome of their participation is expected to be beneficial to their own children, as well as to others, we refer to these as "self-serving altruistic" motives.
- a₂ — Self-Serving Ideological Altruism: Parents who volunteer in order to give a personal example of good citizenship to their children and to all the other students as well. They want to feel that they are a part of a community in which they are active partners. They want to have the ability to express their opinions on violence in school and believe that their input can help eliminate the problem. As part of their ideology, they espouse social and environmental values which they would like to pass on to their children and to other students as well.
- a₃ — Egoism: Parents who volunteer in order to be close to their child's school principal and teachers while promoting issues related to their own child. They feel that they can act against school principals whenever they do not agree with their opinion.

Facet B, the second content facet (concealment), is a hierarchically ordered facet. In a hierarchically ordered facet, the



variables in the SSA map are deployed based on the mapping sentence elements, in a radial configuration forming three circles:

- b_1 — Concealed motives: These motives (inner circle) are not spoken out loud. Parents do not wish to admit that they joined the PTA in order to be close to the local authorities. They do not tell others that they joined the PTA in order to become part of the school management. They keep those motives to themselves.
- b_2 — UCM: These motives are mainstream motives (middle circle). These are conventional motives such as wanting to improve the school curriculum for the benefit of all the students or to improve the school climate.
- b_3 — Politically correct motives: These motives are used in order to avoid being offensive (outer circle). They connote what others would want to hear. Instead of saying “We joined the PTA to be part of the core decision makers,” they use the phrase “We want to partake in the school’s pedagogic decisions.” Given that they present themselves using the politically correct terms, they are found acceptable. Thus, they are savvy, but lack uniqueness.

MATERIALS AND METHODS

Subjects

The study population was comprised of 155 parents whose children were attending elementary school.

- a) Gender: 114 (73.5%) women and 41 (26.5%) men.
- b) Ages: 82 parents (52.9%) were between the ages of 20 and 40 years old, and 73 parents (47.1%) were over 55 years old.
- c) Education: 61 parents (39.4%) had an undergraduate degree; 61 parents (39.4%) had a graduate degree; 4 parents (2.6%)

had a Ph.D.; 29 parents (18.7%) declared a different level of education.

- d) Living location: 45 parents (29%) resided in the northern part of the country; 50 parents (32.3%) in the central part of the country; 60 parents (38.7%) in the southern part of the country.
- e) Members in PTA: 73 parents (47.1%) were PTA members; 82 parents (52.9%) were not PTA members.
- f) Employment status: 113 parents (72.9%) were salaried workers; 30 parents (19.4%) were self-employed; 12 parents (7.8%) were unemployed.
- g) Number of children: 51 parents (32.9%) 1–2 children; 79 parents (51%) 3 children; 25 parents (16.1%) 4 children or more.
- h) School size: 128 parents (82.9%) sent their children to schools attended by 400 to 700 students; 22 parents (14.2%) sent their children to schools attended by 700–1000 students; 5 parents (3.4%) did not provide this information.

Instruments

The research instrument was a new anonymous self-report questionnaire titled “Class and School PTA,” which includes 30 items about aspects of being a member of a PTA (1–5 on a Likert scale) and 10 items for reporting background variables. Altogether, the questionnaire contained 40 items. The questionnaire was prepared specifically for this study (see **Appendix 1**).

Procedure

Permission to proceed with the study was granted by the Israeli Ministry of Education on October 1, 2013. The study was conducted in two stages.

- (a) Defining variables and terminology, generating scale items, and designing the research instrument.
- (b) Administering the research questionnaire: the questionnaire was distributed during parent-teacher meetings of the 2014 school year. Parents were asked to complete the questionnaire and return it a few minutes later. A total of 300 questionnaires were distributed during regional meetings. Of these, 155 questionnaires were completed (51.6% return rate).

RESULTS

The first stage of the data analysis included computation of means for each item, variance, and item-total correlations. A factor analysis was conducted, based on the mapping sentence. This assisted with confirming the content facets concerning motives for joining PTA. Internal consistency of the scale, measured using Cronbach's alpha coefficient, for the scores of the entire scale "Motives for Joining PTA" (MJPTA) and for the three subscales (self-serving, altruistic ideological motives –SSAIM; self-serving, altruistic pedagogical motives –SSAPM; and egoistic motives –EM) were 0.89, 0.84, 0.81, 0.85, respectively (see **Table 1**).

The second level included subjecting the data to an SSA procedure, using the Hebrew University Data Analysis Program

(HUDAP; Borg and Shye, 1995), based on the calculated correlation matrix. Data deployment was examined in a two-dimensional space. The results were tested first by applying the coefficient of alienation. The coefficient of alienation was .18, indicating a good match between the initial correlations matrix and the SSA map. Data deployment on the SSA map exhibited both an angular and a radial form, in a Radex configuration. The two deployment patterns, i.e., the angular (**Figure 2**) and the radial (**Figure 3**), are described below.

The Angular Aspect

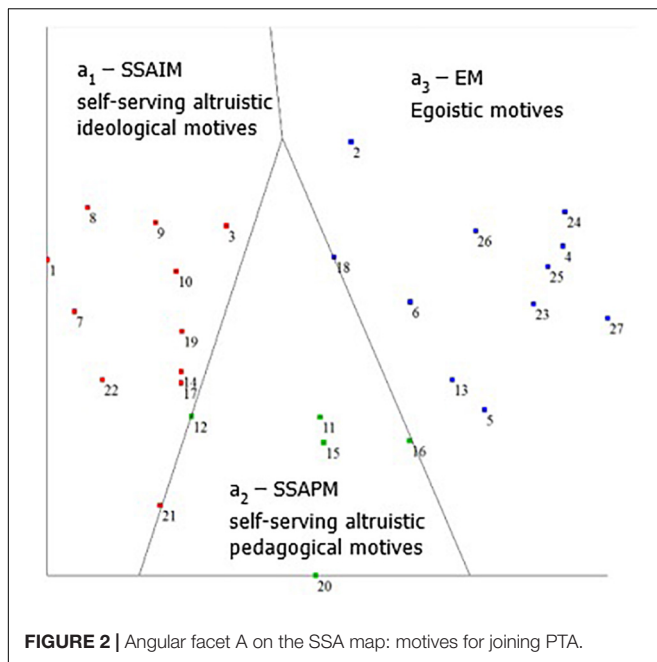
The deployment of the variables for facet A (see **Figure 2**) shows that the SSA map has an angular order. The findings demonstrate a perfect fit between the empirical data and the estimated structure (separation index = 1.000). Facet A divides the map into three regions that emanate from a single point, where each region faces a different direction away from that point, as described below. In an angular aspect, items located farthest from the origin point may best express the semantic content of the entire angular region¹.

The map clearly divided the data into three sections:

¹Similar to factor loading in factor analysis: The higher the load, the more relevant it is in defining the factor's dimensionality (Kim and Mueller, 1978).

TABLE 1 | Factor structure of the MJPTA.

Item no.	Item	Factor I	Factor II	Factor III
Factor I: (9 items; Eigenvalue = 6.99; Explained Variance: 38%; $\alpha = 0.84$)				
27.	Wants to be close to the teaching staff	0.854		
4.	Can promote issues related to one's own child	0.787		
26.	Wants to be close to the child's teacher	0.768		
25.	Wants to be close to the principal	0.723		0.226
29.	Feels that he/she is contributing to the social involvement of one's own child	0.625	0.116	0.131
7.	Becomes part of the school administration	0.557	0.194	0.287
2.	Can express a personal opinion on violence in the child's class	0.521	0.461	–0.173
6.	Can act against the school principal when there is a disagreement	0.471	0.116	0.228
19.	Can affect the treatment of violent events in the child's class	0.463	0.411	0.223
Factor II: (7 items; Eigenvalue = 3.67; Explained Variance: 30.8%; $\alpha = 0.83$)				
9.	Gives a personal example to the child		0.729	
8.	Feels a partner in the community		0.704	0.112
3.	Can express a personal opinion on violence in general	0.278	0.686	
10.	Gives a personal example to all the students in the school		0.678	
20.	Can affect the response to violent school events		0.626	0.358
24.	Wants to improve the daily life of all schoolchildren		0.570	0.244
11.	Contributes to a pleasant learning atmosphere for students		0.564	0.304
15.	Helps the school principal		0.548	0.474
22.	Wants to take part in social decisions related to the school		0.313	0.290
Factor III: (7 items; Eigenvalue = 1.84; Explained Variance: 18.281%; $\alpha = 0.82$)				
13.	Can add learning contents that are important for school students		0.456	0.705
12.	Can add learning contents that are important for one's own child	0.223	0.188	0.703
16.	Can affect the level of school teachers	0.218	0.139	0.669
21.	Wants to take part in the school's pedagogical decisions (and curricula etc.)			0.657
18.	Can affect the school climate		0.579	0.585
14.	Is linked to the local municipality	0.477		0.507
17.	Can influence the climate of the child's class	0.387	0.118	0.430



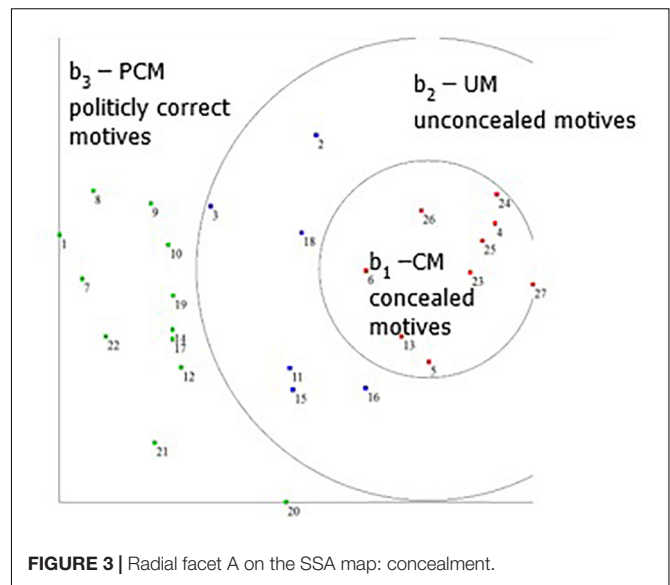
- (A) The left-hand region of the map contains items which relate to self-serving altruistic ideological motives (SSAIM) (a_1): “I think that parents join the PTA so that they can express their opinions on school violence in general.” (item 3).
- (B) The central region of the map contains items that relate to self-serving altruistic pedagogical motives (a_2): “I think that parents join the PTA because it contributes to a pleasant learning climate for the students” (item 17).
- (C) The right-hand section of the map contains items which relate to EM (a_3): “I think that a parent joins the PTA to be close to the school principal for his or her own personal benefits” (item 25).

The Radial Aspect

Figure 3 shows the radial aspect of the data deployment on the SSA map. The separation index was 1.000, indicating perfect separation. The three circles seen in the data deployment concern the concealment aspect of motives for joining PTA.

As can be seen clearly, the items that are very close to each other are in the inner circle, whereas the items closer to the periphery are more distant from each other, separated by large blank spaces. The proximity of the items in the layout map of the SSA indicates greater consensus and unity of semantic items and terminology. Accordingly, a distance between the items indicates little consensus and greater semantic distinction.

The radial deployment forms a central circle in which the common denominator of all nine items is motives that are not stated openly (b_1) and points to motives for which there is usually a consensus among parents that do not join PTA. What are the hidden motives of parents that do join? These items are associated with feelings such as gaining personal benefits, being close to the local authorities, or close to the principal and staff. For example:



“I think that parents join the PTA to become part of the school administration” (item 7); “I think that parents join the PTA in order to be close to the teachers” (item 26); “I think that parents join the PTA to promote issues related to their own children” (item 4).

In the second concentric circle, namely the middle circle (see **Figure 3**), are positioned motives that are stated openly and thus are unconcealed (b_2). These motives are perceived as acceptable motives, mostly mainstream motives that are associated with contributing to the pedagogical and educational contents and to the learning atmosphere. For example: “I think that parents join the PTA because they wish to influence the school climate” (item 18); “I think that parents join the PTA because they wish to influence the treatment of violent events in their children’s classes” (item 19).

The third and outermost circle relates to politically correct motives. These motives are also UCM but are related to what parents think is the proper thing to say to others (a_3). Stating politically correct motives is a means to avoid, intentionally or unintentionally, the use of expressions that contain an explicit or implicit allegation, which might be found offensive. For example: “I think that parents join the PTA because they believe that they are contributing to the school community” (item 1); “I think that parents join the PTA because they want to serve as a personal example to their own children” (item 9); “I think that parents join the PTA because they believe that they can help the school principal” (item 15).

DISCUSSION

This research is unique in that it addresses the issue of parents’ motives for joining the PTA. Although the professional literature has referred to issues related to the PTA framework, it has yet to address the issue of parents’ motives for joining the PTA. To date, the literature has dealt mainly with the roles, responsibilities, and

activities of the PTA (Zafar et al., 2013). As we know that joining the PTA is a voluntary activity, we can presume to know the motivations, as they are familiar from the study of volunteerism. Studies in this field have found that this is a type of community involvement that provides positive outcomes, both physical and mental, for both the volunteers and the community (Bhargava and Witherspoon, 2015). The motives can be related to personal, social, moral, or utilitarian aspects (Stukas et al., 2016).

The current findings show that even a complex term, such as “motives for joining the PTA,” can be conceptualized using facets A and B. The hypothesis that was presented in the mapping sentence (see **Figure 1**) is fully supported, meaning that the concept Motives for Joining the PTA (MJPTA) is based on two layers. The first (Facet A) concerns motives related to SSAIM, SSAPM (self-serving altruistic pedagogical motives) and EM. The second layer (Facet B) of the MJPTA concept concerns the concealment of motives: concealed motives (CM), UCM and politically correct motives (PCM).

Relationships Between Motives

As explained above, the SSA map enables us to understand the relationship between variables that share the same regions, by exploring the distance between them. Each variable is represented by digits or points, so the closer in space they are, the more they share the same content. The other points in the other regions relate to different elements of that facet and the further apart they are, the greater is the difference between the contents they represent (Borg and Shye, 1995).

The order of the facet elements is reflected in the order of the SSA regions, whereas the “role” of the facet in the deployment of the SSA map is reflected in the unique order between the map’s components (Levy, 1994). The higher the correlation is between two items, the closer they are in space and in terms of content.

As can be seen in **Figure 2**, there is a higher correlation (they are closer together) between EM as a group and the SSAIM as a group. Furthermore, most of the motives are perceived either as SSAIM or EM. Observing the circumplex structure, we can see

that most of the motives are either concealed motives (CM), such as “They think it will help them in the future to become political activists in their own local community” (item 30) or politically correct motives, such as “Wanting to improve the daily life of all school children” (item 24). It is interesting that the UCM have lower correlations between them (are farther apart).

The professional literature has not yet dealt with the issue of concealed and UCM of parents joining PTA. Therefore, this is an interesting and new finding, that could assist principals, teachers, and policy makers in gaining a better understanding of these phenomena. Understanding these motives, both by teachers and principals, can expand the preferred activities that are based on altruistic motives, since those are the motives that will probably be beneficial to increase student academic achievements (Ingram et al., 2007) and contribution to the school as a better organization (Fisher, 2010). If they are aware of these phenomena, school principals, and teachers can prevent harmful effects from egoistic factors and promote the contributing effects of altruistic factors. Policy makers may also be able to decide when it is right or wrong to involve parents, based on this understanding.

Although this finding has not emerged in previous studies, it may be relevant not only in Israel, but also in other countries. Furthermore, at this point we have no indication of whether the MJPTA concept is culturally based. Therefore, it is definitely important to conduct a cross-national study, in order to expand our knowledge on this most interesting issue. If similar results will be revealed, we will be maybe be able to show that the fundamental concepts presented in this article are not culturally dependent and are rather shared by different cultures and different nations.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and approved it for publication.

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Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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APPENDIX

TABLE A1 | Questionnaire.

I think that parents join PTA because they:		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1.	Feel that they are contributing to the school community	1	2	3	4	5
2.	Can express their opinions on violence in their children's class	1	2	3	4	5
3.	Can express their opinions on violence in school in general	1	2	3	4	5
4.	Can promote issues related to their own children	1	2	3	4	5
5.	Can promote school-related issues	1	2	3	4	5
6.	Can act against the school principal in case of major disagreements	1	2	3	4	5
7.	Become part of the school administration	1	2	3	4	5
8.	Feel they are partners in the community	1	2	3	4	5
9.	Want to serve as a personal example to their own children	1	2	3	4	5
10.	Want to serve as a personal example to all the students in the school	1	2	3	4	5
11.	Believe that they contribute to a pleasant learning atmosphere for students	1	2	3	4	5
12.	Can add learning contents that are important to their own children	1	2	3	4	5
13.	Can add learning contents that are important to school students	1	2	3	4	5
14.	The PTA is linked to the local municipality	1	2	3	4	5
15.	Believe that they can help the school principal	1	2	3	4	5
16.	Can affect the level of school teachers	1	2	3	4	5
17.	Can influence the climate of their own children's class	1	2	3	4	5
18.	Can affect the school climate	1	2	3	4	5
19.	Can affect the treatment of violent events in their children's classes	1	2	3	4	5
20.	Can affect the treatment of violence in the school	1	2	3	4	5
21.	Want to take part in the school's pedagogical decisions (curricula etc.)	1	2	3	4	5
22.	Want to take part in social decisions related to the school	1	2	3	4	5
23.	Want to improve the daily life of their children at school	1	2	3	4	5
24.	Want to improve the daily life of all school children	1	2	3	4	5
25.	Want to be close to the principal	1	2	3	4	5
26.	Want to be close to their children's teachers	1	2	3	4	5
27.	Want to be close to the teaching staff	1	2	3	4	5
28.	Feel that they are contributing to improving the achievements of their own children	1	2	3	4	5
29.	Feel that they are contributing to the social involvement of their own children	1	2	3	4	5
30.	Want to become political activists in their own local community in the future	1	2	3	4	5



Examination of Performance Appraisal Behavior Structure

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The personality (dispositional) characteristics, attitudes, beliefs, and orientation of 498 managers and military officers toward performance appraisal and organization were collected in order to examine their structural relationships to raters' behavior, in terms of (a) mean appraisal ratings, (b) measures of performance dimensions discrimination, and (c) rate discrimination. A mapping sentence comprising a modality, a reference group, and an aspect (content) facet were used. The empirical results largely confirmed this definitional system. Moreover, a polarizing partition of the space into three regions—Self (rater), Ratee, and Organization/System—was found, possibly implying that these three considerations are equally proximal in determining rater behavior. Future directions for research are advanced.

Keywords: attitudes, beliefs, performance appraisal behavior, facet analytic approach, personality, mapping sentence, facet theory

OPEN ACCESS

Edited by:

Paul M. W. Hackett,
University of Cambridge, UK

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Specialty section:

This article was submitted to
Theoretical and Philosophical
Psychology,
a section of the journal
Frontiers in Psychology

Received: 22 November 2016

Accepted: 22 December 2016

Published: 09 January 2017

Citation:

Tziner A and Levy S (2017)
Examination of Performance Appraisal
Behavior Structure.
Front. Psychol. 7:2075.
doi: 10.3389/fpsyg.2016.02075

INTRODUCTION

The rating process has come under much scrutiny in the performance appraisal literature. One of the main conclusions that assists us to understand the nature of that process is that both the appraisal system and its organizational context are critical elements that play a part in the eventual employee evaluation outcomes. These outcomes, in turn, impinge upon the employees' status in the organization and, indeed, on the productivity of the business concern (e.g., Cleveland and Murphy, 1992; Murphy and Cleveland, 1995; Murphy, 2008).

The organizational context covers many aspects of organizational life including (1) raters' personality traits, (2) their attitudes toward the organization, and (3) their beliefs concerning, and attitudes toward, the performance appraisal system. Empirical research has increasingly demonstrated how these dispositions influence raters' performance during the appraisal process (e.g., Tziner et al., 1998; Tziner and Murphy, 1999; Tziner et al., 2002).

Rater Personality

The literature abounds with evidence of the links between broad personality characteristics and behavior in organizations (e.g., Barrick and Mount, 1991; Tett et al., 1991). This body of literature assists us to understand how an employee's attributes and personality traits contribute toward job performance and interaction in groups, among other organizational behaviors. With respect to appraisals, we could expect the traits of conscientiousness and self-monitoring to play a significant role in shaping appraisers' rating behavior, acting both as a direct influence on rating, and as a moderator of the relationships between the rating context and rating behavior.

Conscientious Raters

Raters who are conscientious are generally dependable, rule-abiding, and diligent. Such conscientious raters are likely to set high standards of performance, duteousness, and motivation

to excel on the job (Costa and McCrae, 1992); consequently, they are more likely to conduct their performance rating responsibilities with greater diligence. The result: efficient discrimination among performance appraisal dimensions and among ratees, and less inflation of ratings. Raters who display conscientiousness are less likely to be swayed by the rating context than their less conscientious peers. The possibility thus exists that conscientiousness moderates the relationships between rating context and rating behavior measures (Tziner et al., 2002).

Self-Monitoring Raters

High self-monitoring individuals examine and control their own behavior successfully. They are susceptible to interpersonal and situational cues and typically manifest a strong desire to maximize social approval and to minimize social disapproval (Jawahar and Stone, 1997). Thus, we might also posit that individual differences in self-monitoring are associated with differences in rating behaviors among appraisers. Since social acceptance is a critical factor, in an appraisal context, high self-monitors (in contradistinction to low self-monitors) can be expected to inflate ratings of their subordinates and to discriminate less among ratees and performance dimensions.

Attitudes toward the Organization

Previous studies have confirmed links between organizational climate and rating behavior (e.g., Tziner et al., 2001). In this study we examined, in particular, organizational citizenship, a concept which is defined here as employees' cooperative behavior that is discretionary (rather than compulsory); it is not formally rewarded, and it contributes to the smooth functioning of the organization (Organ, 1988). This "informal" employee behavior has important consequences in the workplace and, indeed, Bolino (1999) has demonstrated how two manifestations of organizational citizenship—employee initiative and proactive cooperation—enhanced organizational functioning. Since high organizational citizenship implies working to promote organizational performance, raters displaying this characteristic can also be expected to pursue their appraisals with greater care. This should manifest itself in less incidents of rating inflation and better discrimination among performance dimensions and ratees.

Beliefs about the Appraisal System

Research conducted by Murphy and Cleveland (1995) and later by Tziner and colleagues (e.g., Tziner et al., 1998; Tziner and Murphy, 1999; Tziner et al., 2002), have borne out the supposition that raters' beliefs about performance appraisal systems are likely to affect their ratings. In particular, raters' beliefs about their ability to carry out the task of performance appraisal (self-efficacy), and the way in which performance appraisals are used in the organization, are important determinants of rating behavior.

Self-Efficacy

Raters differ in self-efficacy, their concern regarding their competencies with respect to possessing the requisite knowledge, tools, and professional skills with which to appraise their

subordinates' performance accurately. In this respect, appraisers are less likely to discriminate among rating dimensions when they feel they lack the information or skills to rate accurately (Tziner et al., 2002).

The way in which appraisers regard themselves in this respect is also likely to play a motivational role that affects both the amount of effort they apply to the task of appraisal and their behavioral choices during that process. Specifically, following Bandura's (1977, 1982) social learning theory, raters' low self-efficacy might induce raters to distort their ratings. Moreover, raters' negative self-perceptions are likely to engender insufficient motivation to come up with appraisals that are solidly grounded, well-documented, reliable, and accurate (Frayne and Latham, 1987). Such adverse consequences have led the researchers to indicate that, under such circumstances, the appraisal process is a futile exercise (Napier and Latham, 1986). In contrast, raters with a high level of self-efficacy might be expected to perform the appraisal task more conscientiously.

Ways in Which Performance Appraisal Is Used

A substantial body of research demonstrates that raters are more likely to be more motivated (Cleveland and Murphy, 1992), lenient (Cleveland et al., 1989; Murphy and Cleveland, 1991; Landy and Farr, 1992) and attentive (Steers and Lee, 1983), when they believe that appraisals are to be used to determine administrative rewards such as promotions or salary raises. In contrast, when ratings are used for feedback purposes, and thus have fewer concrete consequences, supervisors may be more likely to provide biased evaluations. For instance, Fried et al. (1992) demonstrated that when appraisers rated employees who had little experience on the job, or were known to engender low confidence levels in their supervisors and/or the appraisal system, the appraisers were prone to discriminate against these subordinates.

Orientation to the Appraisal System

Raters' attitudes toward their own work play a crucial part in the way appraisers function during performance evaluations. Some raters are comfortable with the system while others are distrustful and cynical. Raters who have confidence in the results of the appraisal will likely produce more accurate ratings than those who are negative or skeptical. Why, however, would raters adopt a negative attitude to what is, after all, a primary task in their job description?

First, we may cite research conducted by Bernardin and Orban (1985) regarding raters who believed that their colleagues in the organization were biasing their performance appraisals. They perceived the "rogue" appraisers as being too lenient, consequently, inflating their subordinates' ratings to increase the benefits accruing to their workers. As a result of this perception, and especially when the performance appraisals were used for administrative purposes, the initial raters were induced to act likewise and to distort the appraisal results.

Second, raters have been observed as being very uncomfortable when they evaluate subordinates' performance and provide them with feedback (Murphy and Cleveland, 1991, 1995). One consequence of this discomfort is the tendency to inflate the ratings and to avoid making distinctions among

subordinates (Villanova et al., 1993). By giving uniformly high appraisals, it appears that the raters avoid the potentially unpleasant consequences of assigning high ratings to some subordinates and low ratings to others.

FACET ANALYTIC APPROACH

In the present study, we capitalized on the facet analytic approach to examine the structure of performance appraisal behavior. After Guttman (1959), this approach posits that the components of a researched issue can be defined formally. Accordingly, the content of a concept is broken down into components or “facets.” We can thus say that a facet is a criterion or a rule to classify items comprising a given concept (Roazzi et al., 2015) and that when we define the structural configuration of a concept, we spell out all its facets, exhausting its content (Elizur, 1984; Tziner, 1987).

We see that this definitional facet approach requires a taxonomy or classification of the content universe under scrutiny. We can thus describe the facets as the most important properties or components of the concept domain (content). The facets, therefore, constitute a classification of the constituents (elements) of a concept’s content, according to some rule (i.e., exclusive features).

We are also interested in a taxonomy of the responses of the respondents to the issue under scrutiny. These responses are connected in the form of a statement, called the mapping sentence, which reads like an ordinary sentence (Hackett, 2014). The mapping sentence is then submitted to an empirical investigation, which if substantiated, becomes a valid representation of the content domain. The mapping sentence also serves as the basis of the generation of a theory (Canter, 1985; Shye et al., 1994).

The most compelling evidence of whether the empirical structure of the relationship among the variables conforms to the hypothesized structure appears when the hypothetical topological structure is superimposed onto the SSA depiction. The SSA (Smallest Space Analysis) is the non-metric scaling procedure that portrays geometrically the matrix of intercorrelation among the variables (e.g., questionnaire items and psychological tests). The geometrical display is done so that the intercorrelation among variables, which constitute measures of similarity, are plotted in space by distances between pairs of points: the stronger the intercorrelation the closer will be the points from one another.

The examination of the SSA output begins with an inspection of the inter-correlations matrix. To the extent that the following conditions are fulfilled by all variables, positive or zero inter-correlations are expected to emerge¹:

1. Variables relate to a common object of exploration (i.e., they concern the same observation or content domain).
2. Variables have the same range of responses (e.g., “5” being very high to “1” being very low) and reflect the same direction

(with low figures at one extreme of the range to indicate low preference or disagreement with a statement, and with high figures at the other extreme to indicate high preference or agreement with the statement).

3. The population of the respondents was not selected artificially, specific to the domain of inquiry.

The first principle to be applied is the principle of contiguity which states that the geometric space in the SSA outcome should be partitionable into regions that reflect the facets and their “structs” (i.e., components, elements). According to this principle, variables that share the same facet structs should be more highly correlated and thus closer together in multidimensional space than variables that do not share the same facet structs. For example, in study of the achievement motive, the three variables entitled “preference for tasks involving uncertainty”; “satisfaction with tasks involving uncertainty”; and “undertaking tasks involving uncertainty,” shared the same “structuple” (i.e., a pair of two elements, each comprised in a different facet). Consequently, we would expect them to be closer to each other than to other variables in the space, an expectation that was, in fact, upheld by the empirical data.

Furthermore, the more similar the variables are to each other in terms of their facet structs, the higher their expected inter-correlations. The consequence of this principle is that an inverse relationship is predicted between (a) similarity of variable structuples and (b) their distance within the special representation of their correlations. Indeed, an inspection of the inter-correlation matrix in article reveals that most of the variables that share two structs have a markedly higher inter-correlation than those sharing only one struct.

The division of the structure into regions is accomplished through boundary curves introduced to aggregate the variables according to the structuples of the mapping sentence.

However, variables of a region do not always cluster together. In most studies, the variables employed are only a sample of all conceivable items in the domain of observation. Because they comprise points everywhere in a geometric representation, some variables at the edge of one region may correlate less with other variables of the same region than with certain variables at the edge of neighboring regions.

An important feature of SSA is its relative insensitivity to variations in variable sampling. Thus, two different selections of items from the same observation domain can be expected to result in their small spaces having identical partition patterns. This is true even though the correlation matrices are different. Different correlations lead to considerable variations in variable positioning from one sample to another. Hence, almost identical configurations in the SSA plots can correspond to two considerably different inter-correlation matrices.

The Performance Rating Context

The rating context factors (e.g., comfort with performance appraisal), rater personality factors (e.g., self-monitoring), and rating behaviors (e.g., the extent of discrimination among ratees) can be classified into three facets: modality of behavior

¹This requirement was termed First Law. First Law is always concerned with the sign of correlation among variables. Second Law calls for an inspection of the relative sizes of correlations, which warrant regional hypothesis derivation.

(cognitive, affective, and instrumental); referent group (self, ratee, appraisal system); and aspect (context: personal, interpersonal, organizational). The classification of the present study's variables by the elements comprising these three facets is displayed in **Table 1**.

Using these content facets and their elements, we developed the following mapping sentence, which interrelates factors affecting rating behavior:

Rater (x) in an organization (y) who
 displays a **Facet A: Modality of behavior**
 { 1. Cognitive
 2. Affective
 3. Instrumental } mode of behavior
 in respect to **Facet B: Reference group**
 { 1. Self (rater)
 2. Ratee
 3. Appraisal system } in
 a **Facet C: Aspect (content)**
 { 1. Personal
 2. Interpersonal
 3. Organizational } context
 evidences \rightarrow **Facet D: Range**
 { High (positive)
 Low (negative) } rating behavior.

The purpose of the present study was to examine this definitional framework empirically.

METHODS

Rating context factors, raters' conscientiousness, and raters' self-monitoring were measured by means of questionnaires, and were correlated with measures of rating level, discrimination among ratees, and discrimination among rating dimensions.

TABLE 1 | Classification of the study variables according to elements of the three facets.

Variable	Modality	Reference group	Aspect (context)
Confidence in the appraisal system	Affective	Appraisal system	Organizational
Self-efficacy	Cognitive	Self (rater)	Personal
Use of performance appraisal (between)	Instrumental	Appraisal system	Organizational
Use of performance appraisal (within)	Instrumental	Ratee	Organizational
Comfort with performance appraisal	Affective	Self (rater)	Interpersonal
Organizational citizenship	Instrumental	Self (rater)	Organizational
Conscientiousness	Cognitive	Self (rater)	Personal
Self-monitoring	Cognitive	Self (rater)	Personal
Rating level	Instrumental	Ratee	Interpersonal
Discrimination among ratees	Instrumental	Ratee	Interpersonal
Discrimination among dimensions	Instrumental	Ratee	Organizational

Participants and Procedure

Questionnaires were distributed to 600 managers from several organizations and to 220 Israeli military officers. All the participants were responsible for appraising the performance of at least five subordinates. Usable data were obtained from 355 managers (59%) and 143 officers (65%). Of the managers, 77.7% were men and 22.3% women, whose average age was 43.54 years ($SD = 10.01$). The average tenure in the current company was 15.03 years ($SD = 10.46$). 11.7% completed high school, 14% had some academic training, while 74.2% held a university degree in fields other than Business Administration. 87.9% officers were male, and 12.1% were female; their average age was 32.31 years ($SD = 7.02$) and tenure in the military, 12.13 years ($SD = 7.01$). 12.6% completed high school, while 5.6% had some academic training, and 81.8% held a university degree.

Instruments

The instruments were administered in Hebrew and an equivalence of measures was achieved through back translation from English.

Rater Personality (Conscientiousness)

Ten items drawn from the NEO-Five Factors Inventory (Costa and McCrae, 1992) was employed to measure conscientiousness, whereby a high score on the scale reflects a high degree of conscientiousness. The internal consistency was $\alpha = 0.713$ ($M = 3.66$; $SD = 0.52$) for managers, and $\alpha = 0.83$ ($M = 4.91$; $SD = 0.57$) for officers.

Self-Monitoring

Self-monitoring was gauged by means of five items garnered from an instrument developed by Gangestad and Snyder (1985). A high score on this scale indicates a high level of self-monitoring. The internal consistency of self-monitoring measure was $\alpha = 0.62$ ($M = 4.42$; $SD = 0.70$) for managers and $\alpha = 0.63$ ($M = 3.83$; $SD = 0.82$) for officers.

In regard to all the above measures, it should be noted that they were calculated as average scores from the individual responses to the items comprising each variable.

Attitudes toward the Organization (Organizational Citizenship Behavior)

Organizational citizenship behavior was assessed using seven items from Podaskoff and MacKenzie's (1989) Organizational Citizenship Behavior Scale. A high score on this measure indicates strong organizational citizenship behavior. The internal consistency of the items used here was $\alpha = 0.81$ ($i = 5.07$; $SD = 0.74$) for managers, and $\alpha = 0.80$ ($M = 4.99$; $SD = 0.90$) for officers.

Beliefs about the Appraisal System (Self-efficacy)

Eight items taken from scales developed by Napier and Latham (1986) were used to measure self-efficacy, specifically to assess the extent to which subjects believed that they possessed the appropriate competencies to appraise their subordinates. A high score indicated a high level of self-efficacy. The internal consistency of this measure was $\alpha = 0.70$ ($M = 4.67$; $SD = 0.79$).

Perceptions of Uses of Performance Appraisals

Raters' perceptions concerning the uses of performance appraisal were measured using items drawn from the questionnaire devised by Cleveland et al. (1989), designed to produce two indices, namely: (a) perceptions of the extent to which performance appraisals are used by the organization to distinguish between ratees (between-person discrimination) for administrative purposes, including promotion, remuneration, and the identification of poor performers, and (b) perceptions of the extent to which appraisals are used to identify employees' strengths and weaknesses (within-person discrimination) for such purposes as performance feedback and the identification of individual training needs. Raters who evidenced high scores on these dimensions could be considered as perceiving that their appraisals were extensively used by management to achieve the goals for which the performance appraisals were originally proposed.

The first index consisted of 10 items, and yielded an internal consistency of $\alpha = 0.863$ ($M = 3.69$; $SD = 0.91$) for managers, and $\alpha = 0.91$ ($M = 3.65$; $SD = 0.99$) for officers. The second index consisted of eight items and produced an internal consistency of $\alpha = 0.69$ ($M = 3.09$; $SD = 0.79$) and $\alpha = 0.75$ ($M = 3.52$; $SD = 0.68$) for managers and officers, respectively.

Comfort with Performance

Eleven items from the Performance Appraisal Discomfort Scale (Villanova et al., 1993) were employed to measure comfort with performance. We reversed the responses to the items, in order that a higher score would indicate a stronger degree of comfort with the performance appraisal and feedback. The internal consistency of this measure was $\alpha = 0.866$ ($M = 5.02$; $SD = 0.73$) for managers, and $\alpha = 0.87$ ($M = 4.93$; $SD = 0.66$) for officers.

Orientation to Appraisal Systems

Confidence in the appraisal system was measured using 11 items relating to political considerations taken from Performance Appraisal Questionnaire. The items inquire as to the extent to which political considerations play a role in the process of formulating performance ratings. A high score on this measure indicates that raters perceive the appraisal system to be heavily loaded with political manipulations and distortions and that the appraisers, consequently, harbor low levels of confidence in the appraisal process. The internal consistency of this measure, orientation to appraisal systems, was $\alpha = 0.82$ ($M = 3.43$; $SD = 0.76$) for managers, and $\alpha = 0.81$ ($M = 3.60$; $SD = 0.79$) for officers.

Rating Behavior Measures

Each supervisor rated multiple subordinates (usually three or more) using a 12-item behavioral incident rating scale. The extent to which each behavior was exhibited by the ratee was registered on a 6-point scale ranging from "never" (1) to "always" (6). A high score indicates good performance. The coefficient alpha for these scales was 0.95 for officers and 0.88 for manager.

For each rater, three rating behavior measures were obtained, namely, (1) rating level, (b) discrimination among ratees, and

(3) discrimination among dimensions. *Level of rating* was represented by the overall mean of each rater's evaluations. ($M = 4.57$; $SD = 0.60$). Following earlier studies of this nature, the index of ratee discrimination was derived from the standard deviation of the ratee means obtained from each rater (see Tziner et al., 2001; $M = 0.94$; $SD = 0.52$). Discrimination among dimensions was represented by the variability of the mean score assigned to each performance incident statement by each rater ($M = 0.76$; $SD = 0.36$). It is worth noting that all the scales and measures of this study demonstrated reasonable psychometric qualities in a stream of previous publications (e.g., Tziner et al., 2001).

RESULTS

The correlation matrix was first computed, **Table 2** displays the results.

Inspection of the correlations indicates that the general expectation that the more facet structs the variables share, the higher they will be correlated (according to the contiguity principle) is largely upheld. For example, rating level and discrimination among ratees share the same structuple: Instrumental, Ratee, Interpersonal. Therefore, each of these two variables should inter-correlate higher than either of them with variables with which they have no structs in common, such as self-efficacy, conscientiousness, or self-monitoring (-0.40 vs. $0.26, 0.8, 0.13, 0.15, -0.2, 0.19$).

This matrix was then submitted to the SSA software (using a non-metric solution), which maps the variables as points in the Euclidean space of two dimensions. The geometrical configuration is presented in **Figure 1**.

The coefficient of alienation obtained was 0.104, which can be considered a very good fit of the two-dimensional plot to the original inter-correlation matrix. The figure shows that variables sharing the same facet elements are positioned closer together in the configurative plot than variable that do not.

The division of the space is largely radial (polarizing), with one region consisting primarily of variable related to the self (rater), neighbored by a region of mostly ratee-associated variables, and a

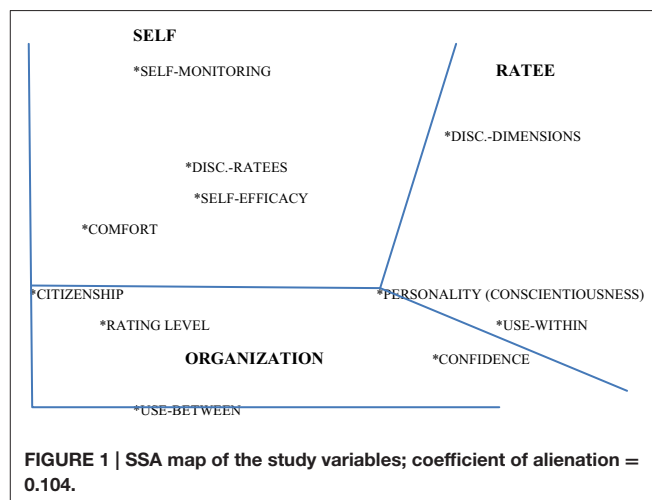


TABLE 2 | Correlations among study variables (*N* = 498).

		1	2	3	4	5	6	7	8	9	10	11
1	Confidence	100	−07	−11	62	−18	−02	10	−35	−23	05	12
2	Self-efficacy	−07	100	22	13	30	21	41	40	26	08	17
3	Use-between	−11	22	100	09	22	16	24	05	23	00	−31
4	Use-within	62	13	09	100	−28	−18	35	−01	−12	−16	37
5	Comfort	−18	30	22	−28	100	60	16	39	18	21	−29
6	Citizenship	−02	21	16	−18	60	100	10	09	23	13	−28
7	Conscientiousness	10	41	24	35	16	10	100	−12	13	15	45
8	Self-monitoring	−35	40	05	−01	39	09	−12	100	−02	19	39
9	Rating level	−23	26	23	−12	18	23	13	−02	100	−40	−50
10	Discrimination – ratees	05	08	00	−16	21	13	15	19	−40	100	−13
11	Discrimination – dimensions	12	17	−31	37	−29	−28	45	39	−50	−13	100

Decimals are omitted.

third region occupied mainly by the organization/system-related variables.

DISCUSSION

On the whole, the findings of the present study provide empirical support for the veracity of the mapping sentence, relating rater attitudinal, and dispositional (personality) factors with rating behavior.

Specifically, our results suggest, as in previous investigations and publications (e.g., Tziner et al., 1998, 2001; Tziner and Roch, 2016), that attitudes and beliefs regarding performance appraisal systems and rater personality qualities are relevant factors likely to relate to high (positive) vs. low (negative) rating behaviors. For example, in regard to ratee discrimination, this implies that the rater discriminates between ratees of high vs. low levels of performance by according high ratings to the former and low ratings to the latter. It also emerges from **Figure 1** that there is no order between the regions; namely, the rater, the ratee, and the organization/system play equal roles in explaining the structure of the considerations and qualities affecting rating behavior. Unlike the study by Tziner et al. (2001), here we cannot conclude that certain factors are more proximal to the task of performance rating than other; all seem to be equally proximal. It is possible that the facet analytic approach helps to discern findings, which remain hidden when linear analytical methods, such as regression analyses, are used.

However, we cannot exclude the possibility that the present results differ from previous findings because of cultural differences. The data in the present investigation were collected from Israeli respondents, whereas previous studies primarily examined North American respondents. Nonetheless, it could well be that the structure generalizes across cultures as it was demonstrated in a study that explored cross-cultural values structure using the facet analytic approach along with the SSA procedure (Gouveia et al., 2015).

We suggest that in order to test the generalizability of the present findings, future studies should be pursued

using respondents from various organizations, cultures and organizational strata. Moreover, efforts should be directed to exploring whether each facet plays a different role (e.g., modulating, polarizing), and whether the combined interaction results in a defined structure (e.g., radix, conex). The theoretical and practical implications of such structures should be explored.

In summary, the present findings appear encouraging in that they provide clear evidence of the structure of relationships between rater attitudes and beliefs about performance, rater personality qualities, and rating behavior. As such, this study paves the way for further investigations aimed at extending and expanding our understanding of this issue. Likewise, our current study demonstrates as in other OB/HRM investigations, such as the exploration of the coping with stress strategies (Rabenu et al., 2015) and the career span of principal's self-efficacy (Fisher, 2015), that the facet analytic approach along with its statistical tools (e.g., SSA, POSAC) is very instrumental in revealing insights unavailable with other commonly used methodological and statistical procedures.

AUTHORS' NOTE

The authors wish to thank Gil Sharoni for his help in collecting and analyzing data. and to Professors Kevin R. Murphy and Jeanette N. Cleveland for help with the conception of the theoretical foundation and research instruments.

An earlier version of this paper was presented at the Facet Theory Association Congress.

No ethics review process is needed for survey studies in Israel (both at the national and institutional levels); only in cases where experimental studies with human subjects are pursued such an approval is required.

AUTHOR CONTRIBUTIONS

All authors listed, have made substantial, direct and intellectual contribution to the work, and approved it for publication.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Organizing the Confusion Surrounding Workaholism: New Structure, Measure, and Validation

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OPEN ACCESS

Edited by:

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Specialty section:

This article was submitted to
Theoretical and Philosophical
Psychology,
a section of the journal
Frontiers in Psychology

Received: 27 April 2017

Accepted: 29 September 2017

Published: 19 October 2017

Citation:

Shkoler O, Rabenu E, Vasiliu C,
Sharoni G and Tziner A (2017)
Organizing the Confusion Surrounding
Workaholism: New Structure,
Measure, and Validation.
Front. Psychol. 8:1803.
doi: 10.3389/fpsyg.2017.01803

Since “workaholism” was coined, a considerable body of research was conducted to shed light on its essence. After at least 40 years of studying this important phenomenon, a large variety of definitions, conceptualizations, and measures emerged. In order to try and bring more integration and consensus to this construct, the current research was conducted in two phases. We aimed to formulate a theoretical definitional framework for workaholism, capitalizing upon the Facet Theory Approach. Two basic facets were hypothesized: A. Modalities of workaholism, with three elements: cognitive, emotional, and instrumental; and B. Resources of workaholism with two elements: time and effort. Based on this definitional framework, a structured questionnaire was conceived. In the first phase, the new measure was validated with an Israeli sample comparing two statistical procedures; Factor Analysis (FA) and Smallest Space Analysis (SSA). In the second phase, we aimed to replicate the findings, and to contrast the newly-devised questionnaire with other extant workaholism measures, with a Romanian sample. Theoretical implications and future research suggestions are discussed.

Keywords: workaholism, facet, work drive, measurement, research methods, cultural differences

INTRODUCTION

Since the early 1970s there have been concrete and strong testimonies to the centrality of work in people’s lives (Arvey et al., 2004), much beyond being only an economical consideration (Highhouse et al., 2010). As evidence, the majority of people would still continue working regardless of their economic status (NRC, 1999). The experience of working is vastly more important than the job itself, and this also explains why many of us devote most of our waking hours to work, beyond any other human activity (for further reading, see Landy and Conte, 2016).

In recent years there has been a considerable increase in the time invested in work, also as a byproduct of the greater accessibility to technology and industrial competition (Lee et al., 2007). Regardless of this trend, research has found individual differences in the devotion of time to work. One of the pioneering works that tried to address those differences was Oates’ (1971) research on workaholism.

Oates (1971) coined the term “workaholism” and defined the phenomenon as “... an addiction to work, the compulsion or uncontrollable need to work incessantly” (Oates, 1971, p. 11). Oates noted that workaholics’ need to work becomes exaggerated and may cause harm to their health, personal happiness, interpersonal relations, and social functioning. In a later discussion of the term, Spence and Robbins (1992) regarded workaholism as an addiction. They noted that “the workaholic feels driven or compelled to work, not because of external demands or pleasure in

work, but because of inner pressures that make the person distressed or guilty about not working” (p. 161). Since Spence and Robbins (1992), there have been many papers in the academic literature devoted to workaholism (e.g., Schaufeli et al., 2008; Patel et al., 2012; Andreassen et al., 2014). Most researchers agree upon workaholism’s core behavioral manifestation, namely, heavy investment in work (Spence and Robbins, 1992; Scott et al., 1997; Snir and Harpaz, 2015). That is to say, workaholics spend many hours a week on work-related activities when given the opportunity to do so (Snir and Zohar, 2008), and much beyond what is required or expected by colleagues or organizational demands (Scott et al., 1997). However, in a recent meta-analysis (Clark et al., 2016), the authors argued that “there continues to be confusion surrounding the definition, conceptualization, and measurement of workaholism, which has resulted in diverging opinions...” (p. 2).

Consequently, workaholism has been addressed with vague conceptual definitions and operationalizations, lacking compelling theoretical frameworks and sufficient studies in this regard. Moreover, there are several overlapping concepts of workaholism such as passion to work, job engagement, job involvement, and more (Andreassen, 2015; see also McMillan and O’Driscoll, 2006). As Clark et al. (2016) concluded in their recent meta-analysis:

... we also encourage the development of new measures of workaholism derived deductively using the largely agreed-on themes relating to the definition of workaholism, rather than the continued use or modification of existing scales that may not fully assess this multifaceted construct (or that examine additional factors that are not necessarily aspects of workaholism) and/or have consistently fared poorly when subjected to factor analyses and other psychometric analyses (e.g., Spence and Robbins’s Workaholism Battery) (p. 31).

In light of operationalization and conceptual difficulties, we applied the Facet Theory. It attempts to formally define the universe of observations and to test hypotheses about the relationship between the definitional framework and the structure of the empirical observations (Elizur, 1984). Facet theory is a method by which the components of a problem or the issue under investigation can be defined formally (Guttman, 1957), and it allows for depicting a complex interplay of variables (Hackett, 2014a). A facet is a group of common traits that represents semantic components of a context field (Yaniv, 2011).

In the present study we attempted to develop a framework of workaholism. Based on the literature, we distinguished two basic facets to define workaholism: A—modalities of workaholism, and B—resources of workaholism.

Facet A—Modalities of Workaholism

“Workaholics are those whose emotions, thoughts, and behaviors are strongly dominated by their work” (Ng et al., 2007, p. 114). As mentioned, workaholism requires an investment of cognitive energy. The workaholic is driven to allocate a vast amount of thoughts into his or her work (Snir and Zohar, 2000), being overly concerned with it (Andreassen et al., 2014), or even

persistently thinking about work when not working (Scott et al., 1997). Therefore, we defined the first element: a1—cognitive.

One of the dimensions of workaholism suggested by Ng et al. (2007) was the affective one, and, indeed, in most of the existing measures of workaholism, the emotional aspect is very clearly addressed (e.g., Spence and Robbins, 1992; Robinson, 1998; Schaufeli et al., 2009; Andreassen et al., 2012). However, it was not fully theoretically defined until the current study, as far as we know, and even in a recent meta-analysis, Clark et al. (2016) encourage conducting future research on the emotional aspect of workaholism “... as we really do not know enough about the affective nature of workaholism based on the extant literature” (p. 31). It is important to note that the emotions surrounding workaholism can be both positive (e.g., enthusiasm about working) and negative (e.g., frustration about not working). Therefore, we defined the second element: a2—emotional.

Another dimension of workaholism suggested by Ng et al. (2007) was the behavioral one (we prefer to call it—instrumental). The act of working (rather than the nature of the work itself, Ng et al., 2007, p. 114) is fundamental for the definition of workaholism (e.g., Schaufeli et al., 2009), and also explains why workaholics are considerably invested in work activities (Snir and Zohar, 2000). Therefore, we defined the third element: a3—instrumental.

Facet B—Resources of Workaholism

There is mild consensus in a body of research that has emphasized long working hours as the critical component of workaholism’s definition (e.g., Oates, 1971; Spence and Robbins, 1992; Scott et al., 1997; Ng et al., 2007). Mosier (1983) even defined workaholism as working over 50 h a week. Therefore, we defined the first element: b1—time.

Effort in work is the quantity and quality of physical activities invested in the job (e.g., Gorman and Kmec, 2007). It is clear that while many measures emphasize the time aspect of workaholism, only few, in actuality, regarded the effort invested in work. It is notable that those who referred to effort did so by addressing it as “working hard” (e.g., Spence and Robbins, 1992; Schaufeli et al., 2009). This necessitates a renewed reference to the effort aspect of workaholism, and, indeed, recently, Snir and Harpaz (2012) included this aspect of workaholism in their study. Therefore, we defined the second element: b2—effort.

Mapping Sentence

“A mapping sentence allows formal and exacting consideration of the variables that comprise a research domain” (Hackett, 2014b, p. 67), and is the heart of the facet theory approach (Fisher, 2011; Hackett, 2014b). This sentence serves as a guide for formulating hypotheses, creating structured assumptions, planning and collecting observations, and analyzing data (Levy, 2005; Fisher, 2011). It provides a sound basis for the empirical associations between observed variables (i.e., different facets and elements) (Fisher, 2011). The following mapping sentence (see **Figure 1**) presents the definitional framework suggested for workaholism. The Cartesian product of the facet elements provided $3 \times 2 = 6$ combinations, upon which our new

measure was based (see Method section). Workaholism will be sampled methodically by creating three items for each combination resulting in 18 items in total. The created items were consequently used to build a facet questionnaire of workaholism (see Appendix B).

Thus, we hypothesize:

H1—The empirical results will reflect the components of the concept of workaholism, as defined in the mapping sentence. A distinct area will be found for each facet and each element.

H2—The workaholism modalities facet (A) will have a polarizing role, in which its elements are away from the center (the origin) in a different direction in the geometric space (Elizur, 1984). This is a general facet and can be found in many behavioral sciences papers. Depending on the hypotheses and the research context, this facet can fulfill various roles: a modulating role (e.g., Elizur and Tziner, 1985; Sagie, 1995) or a polarizing role (e.g., Elizur, 1984, 1991; Rabenu et al., 2015b). We found no base to organize the elements in this facet in a particular order, and thus we assumed it to be a polarizing facet.

H3—The workaholism resources facet (B) will be modulating. A modulating facet organizes the elements from the central area to the peripheral area in the geometric space (Elizur, 1984). The higher the proximity between the items, the closer the region will be to the center of the dimensional map. Even though time and effort can be regarded subjectively, it is the time aspect which is more generally agreed upon due to its universal measurement scale (i.e., seconds, minutes, working hours, formal work break, etc.). Because of this universal understanding of time, we assumed that the time items would be more closely related to each other. Thus, we assumed that the elements in this facet will be ordered so that the time aspect is central and the effort aspect is peripheral.

H4—The total structure obtained from facets A and B will be a circular-radial formation. As such it is called *radex*, and is created by the combination of polarizing and modulating facets (Guttman, 1954; Elizur, 1984).

The current paper, as stated, is based on two samples. In the first phase we validate our new measure with a convenience sample from Israel, and then, in the next phase, try to replicate the results in a sample from Romania for the hypothesized facets' structures see **Figure 2**. We have chosen Romania because it is an ex-communist state in Central and Eastern Europe (CEE) that joined the European Union only a decade ago (in 2007). Romania, a country currently in transition from a centrally-planned economy to a free-market economy, offers a unique and interesting focus since "little is known about the possibilities of applying Western conceptual models in an eastern European context" (Buzea, 2014, p. 426). In the communist era, the labor market was heavily regulated and the main objective was full employment, irrespective of whether it was productive or not (Parlevliet and Xenogiani, 2008). The new labor code established in Romania in 2003 introduced important changes with respect to the types of labor contracts that can be recognized (e.g., part-time and fixed-term). At the same time, there is vast informal employment in Romania (Parlevliet and Xenogiani, 2008). We

believe that the "virgin soil" in Romania, translated into the actual possibility of making a considerable investment in work (in terms of time and effort), and the probability that addiction to work is manifested, is worth investigating.

METHOD

Participants

We used two samples in our study—166 Israeli workers and 1,117 Romanian MBA working students. The demographic data is presented in **Table 1**.

Measures

- Our new measure, the *Workaholism Facet-Based Scale* (WFBS) was gauged by 18 items on a Likert scale between 1 ("strongly disagree") and 6 ("strongly agree"). This measure was based on our mapping sentence (as stated above). The measure is divided into six structuples, and for each one we generated three different items. For example: the structuple a1–b1 (cognitive modality + time resource) is presented by "... think about the job all the time". The structuple a3–b2 (instrumental modality + effort resource) is presented by "... Work very intensely".

We used different measures to compare to our *Workaholism Facet-Based Scale* (WFBS, see below) for four main reasons: (1) These measures addressed workaholism as an addiction or work drive, by following its classical definition: "an addiction to work, the compulsion or uncontrollable need to work incessantly" (Oates, 1971, p. 11), and (2) in order to avoid overlapping of measures [for example: the Dutch Work Addiction Scale (DUWAS; Schaufeli et al., 2009) already consists of Spence and Robbins' (1992) Drive dimension], we (3) chose the most recent workaholism scales (Schaufeli et al., 2009; Andreassen et al., 2012), and by this we also (4) avoided wearing the participants down with multiple measures of the same nature. In addition, the table in Appendix A presents the similarities and distinctions among the different workaholism measures and our own (WFBS).

Furthermore, we included the Heavy-Work Investment (HWI; Snir and Harpaz, 2012) scale because it has a common ground with the rest of the measures in our survey, because they all regard the time and effort elements, important for defining workaholism.

- *Demographic items.* In addition to demographic items such as: gender, age, tenure, etc., we added four items for job characteristics: (1) "Do you work in a team?" (No/Yes/Other). The two samples did not differ significantly in this regard: $\chi^2(1, N = 1,238) = 0.33, p = 0.568, \phi = 0.02$. (2) "Are you responsible for other people's work?" (I am not responsible for other people's work/I am a unit/team manager/I am a department manager/I am a director). The two samples differed significantly: $\chi^2(3, N = 1,238) = 45.19, p = 0.000, r_c = 0.19$, so that the Israeli participants were more responsible for others' work (48.7%) as opposed to the Romanians (24.6%). (3) "To what extent do you have the freedom/autonomy in setting your amount of work hours?" (Likert-type, 1 = "little

The assessment of a subject (x) as a workaholic is based on a:

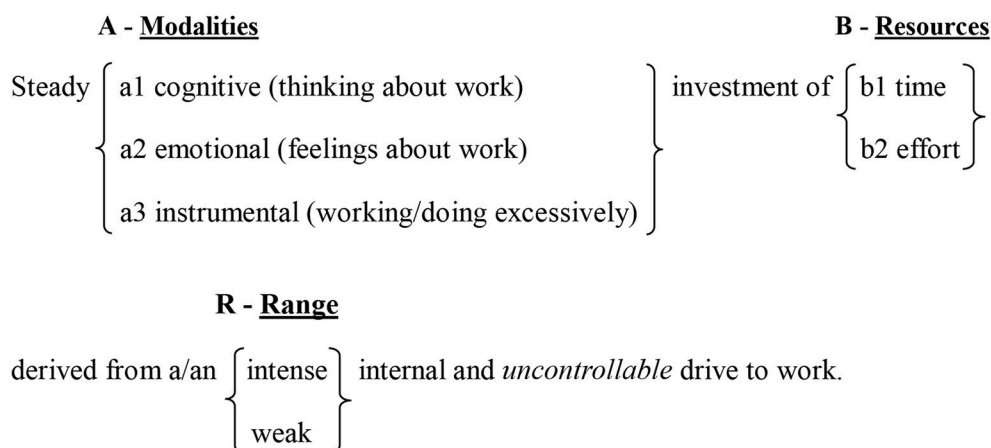


FIGURE 1 | Mapping sentence definition of workaholism.

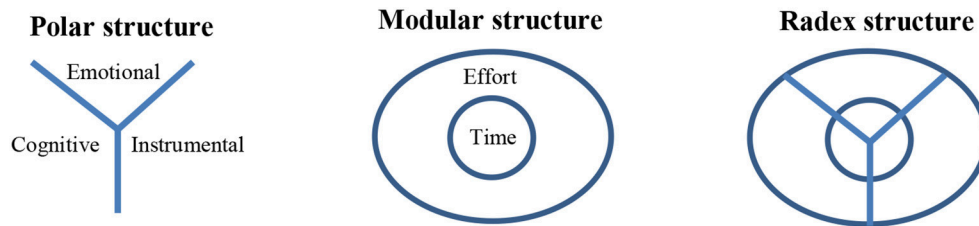


FIGURE 2 | The roles of the facets.

- extent,” 6 = “large extent”; *Israeli* sample: $M = 3.81$, $SD = 1.44$, $R = 1-6$. *Romanian* sample: $M = 3.31$, $SD = 1.73$, $R = 1-6$. The means differ significantly between the two samples: $t_{(1, 281)} = 3.48$, $p = 0.001$, Cohen’s $d = 0.31$. (4) “To what extent do you have the flexibility to decide when to work your amount of work hours?” (Likert-type, 1 = “little extent,” 6 = “large extent”; *Israeli* sample: $M = 3.70$, $SD = 1.53$, Range = 1–6. *Romanian* sample: $M = 3.22$, $SD = 1.75$, Range = 1–6). The means differ significantly between the two samples: $t_{(1, 281)} = 3.50$, $p = 0.000$, Cohen’s $d = 0.30$.
- **Dutch Work Addiction Scale (DUWAS;** Schaufeli et al., 2009) was gauged by 10 items on a Likert scale between 1 (“strongly disagree”) and 6 (“strongly agree”). The measure is divided in two subscales, five items each: Working Excessively (WE, $\alpha = 0.68-0.78$, e.g., “I spend more time working than on socializing with friends, on hobbies, or on leisure activities”), and Working Compulsively (WC, $\alpha = 0.73-0.78$, e.g., “I feel obliged to work hard, even when it is not enjoyable”). In our study, the measure received good reliability (see Table 2).
 - **Bergen Work Addiction Scale (BWAS;** Andreassen et al., 2012) was gauged by seven items on a Likert scale between 1 (“never”) and 6 (“always”), with good reliability ($\alpha = 0.80-0.84$, e.g., “spent much more time working than initially intended?”). In our study, the measure received good reliability (see Table 2).
 - **Heavy-Work Investment (HWI)** was gauged by 10 items on a Likert scale between 1 (“strongly disagree”) and 6 (“strongly agree”). The original measure is based on Brown and Leigh’s (1996) paper and was named “effort” in work. The measure is divided into two subscales, five items each: Time Commitment (TC, $\alpha = 0.82-0.86$, e.g., “Few of my peers put in more hours weekly than I do”), and Work Intensity (WI, $\alpha = 0.82-0.83$, e.g., “When I work, I really exert myself to the fullest”). However, it was recently conceived as a new concept: Heavy-Work Investment (Snir and Harpaz, 2012, 2015). Meaning, a heavy-work investor must be rated high on both—time and effort—invested in the job. In our study, the measure received good reliability (see Table 2).
- Table 2** presents the reliability coefficients, ranges, means and standard deviations for all of the variables.
- **Common-method bias.** In order to test for common-method bias (CMB), we employed Harman’s single-factor test (see Podsakoff et al., 2003). The single-factor explained 32.8% of the variance in the *Israeli* sample and 29.6% in the *Romanian* sample, and as such is not considered to have CMB problems (criterion for CMB problems is $R^2 > 50\%$).

TABLE 1 | Demographic information for Israeli and Romanian samples.

Parameter	Category	Israel		Romania	
		N	%	N	%
Gender	Males	58	34.9	448	40.1
	Females	108	65.1	669	59.9
Age	18–25	24	14.5	606	54.3
	25–35	48	28.9	298	26.7
	35–45	58	34.9	89	8.0
	45–55	28	16.9	103	9.2
	55–65	8	4.8	19	1.7
	65+	–	–	2	0.2
Marital status	Single	49	29.5	418	37.4
	Married/coupled	20	12.0	73	6.5
	Married/coupled + children	91	54.8	417	37.3
	Divorced/separated/widowed	–	–	209	18.7
	Divorced/separated/widowed + children	–	–	579	51.8
Education	High-school	9	5.4	300	26.9
	Tertiary	12	7.2	203	18.2
	Student/graduate of B.A	77	46.4	15	1.3
	Student/graduate of M.A. and above	68	41.0	20	1.8
Tenure	0–5	94	56.6	787	70.5
	5–10	34	20.5	159	14.2
	10–15	15	9.0	67	6.0
	15–20	11	6.6	26	2.3
	20–25	7	4.2	26	2.3
	25+	5	3.0	52	4.7
Team work ^a	No	29	17.5	216	19.3
	Yes	137	82.5	901	80.7
Responsibility ^b	No	85	51.2	842	75.4
	Unit/team manager	55	33.1	163	14.6
	Department manager	16	9.6	69	6.2
	Director	10	6.0	43	3.8
Sector	Public sector	26	15.7	253	22.6
	Union/labor federation	6	3.6	18	1.6
	Private sector	120	72.3	823	73.7
	Nonprofit organization	14	8.4	23	2.1
Industry	High-tech	45	27.1	153	13.7
	Low-tech	28	16.9	316	28.3
	Services	93	56.0	648	58.0

^aWorking in a team.^bResponsibility for other people's work.

Procedure

The full survey was delivered in two manners: (1) online internet questionnaires and (2) hard-copy questionnaires. The majority of

the Israeli sample was derived from the internet source (63%) as opposed to the hard-copy one (37%). The Romanian sample was solely derived from the internet source. The data were analyzed using SPSS (v. 22) and AMOS (v. 22) software packages.

RESULTS

About the Analyses

In order to test our hypotheses, we employed two different analyses methods: (1) factor analysis and (2) similarity structure analysis. In the next section we explain their purposes and differences. We did so aiming to find the most elegant data representation in accordance with the suggested mapping sentence.

Factor analysis (FA) is a variable-directed multivariate statistical technique, which depends on an identified statistical model. FA explains the covariance and/or correlation structures among the measured variables. Another purpose is to develop a new set of uncorrelated variables, with the aim of giving a better understanding of the data, using the smallest sets of variables. Meaning, it strives to be more parsimonious (Spearman, 1904).

Similarity structure analysis or smallest space analysis (SSA) is a non-metric case of multidimensional scaling (MDS) used in the facet theory (Gaul et al., 2009). It was developed by Guttman (1968) later than MDS. Its aim is to depict the data in the smallest number of dimensions available (Bloombaum, 1970). Like MDS, SSA is a form of non-linear dimensionality reduction analysis. It is a mathematical technique that allows mapping of distances between points in dimensional/geometric spaces. Points are, in fact, the variables measured in a data set. Most common, and most useful, is a two-dimensional mapping of the points (see Cox and Cox, 2001), which may be visualized in a plot. The points can be seen as distant (dissimilar) or close (similar) to each other. When a similarity between two items is high, the distance between the geometric points representing them (e.g., in a diagram) is relatively small. Conversely, when the similarity between two items is low (i.e., dissimilarity), the distance between their points should be relatively large (Elizur, 1984). MDS can also be used as cluster analysis for grouping observations (Young and Hamer, 2013). SSA is less restrictive than FA, and such an unrestrictive approach could potentially reveal “insights that classical factor analytic techniques seem to have hidden” (Sternberg, 1984, p. xii). SSA produces two goodness-of-fit indices, namely *Coefficient of Alienation* (COA) and *Regionality Index* (also known as Separation Index). COA is the degree to which the geometric distances between the points on the dimensional map reliably reflect their interrelations, meaning, how the algorithm had to make concessions in order to display them. COA ranges between 0 and 1, and the lower the coefficient, the better the fit (Friedman, 2008). Regionality Index evaluates the extent to which the obtained empiric model reflects the assumed content facets, that is to say, the congruence between the theoretical model and the spatial dispersion (corresponding distances) of the empiric data (Friedman, 2008). This index ranges between 0 and 1; the higher the value, the better the fit. In this paper we used the ALSCAL algorithm of the SPSS software and the SMACOF algorithm of the R software. As such, there is

TABLE 2 | Reliability coefficients, ranges, means, standard deviations, for both samples.

Variable	Subscale	Israeli sample				Romanian sample			
		α	Range	<i>M</i>	<i>SD</i>	α	Range	<i>M</i>	<i>SD</i>
BWAS ^a	–	–	–	–	–	0.81	1–6	2.85	0.94
DUWAS ^b	WC ^c	–	–	–	–	0.73	1–6	3.15	0.96
	WE ^d	–	–	–	–	0.76	1–6	3.44	1.02
	Total	–	–	–	–	0.85	1–6	3.30	0.92
HWI ^e	TC ^f	–	–	–	–	0.83	1–6	3.41	1.08
	WI ^g	–	–	–	–	0.92	1–6	4.49	0.99
	Total	–	–	–	–	0.87	1–6	3.95	0.86
WFBS ^h	Cognitive ⁱ	0.86	1.3–6	3.98	1.06	0.85	1–6	3.71	0.99
	Emotional	0.56	1.1–5.6	3.27	0.76	0.58	1–6	3.18	0.77
	Instrumental	0.75	1.1–6	3.86	0.96	0.77	1–6	3.74	0.90
	Time	0.74	1.4–5.7	3.38	0.82	0.76	1.1–6	3.26	0.82
	Effort	0.76	1.6–5.7	4.04	0.81	0.75	1–6	3.83	0.73
	Total	0.85	1.6–5.7	3.71	0.74	0.86	1.2–6	3.54	0.72

^aBWAS, Bergen Work Addiction Scale.^bDUWAS, Dutch Work Addiction Scale.^cWC, Working Compulsively.^dWE, Working Excessively.^eHWI, Heavy-Work Investment.^fTC, Time Commitment.^gWI, Working Intensely.^hWFBS, Workaholism Facet-Based Scale.ⁱThe WBFS' elements of each facet.

one widely accepted fit index—*stress*, although the way in which it is computed differs from one algorithm to the other (for further reading, see Jacoby, 2012).

SSA and FA share a common purpose—reducing the number of variables/items by making parsimonious groupings (Maslovaty et al., 2001). However, there are several main differences between the methods (Guttman, 1982), such as: (1) SSA is more flexible in describing the relationships among variables; (2) SSA represents domains in fewer dimensions (parsimony); (3) FA's technique relies on strict assumptions of linearity, while SSA allows for possible non-linear relationships; (4) Similarity coefficients are not adjusted for reliability; (5) SSA results may be easier to represent in a visual geometric form; (6) For SSA results to be meaningful, a large sample size is not critical.

Exploratory Factor Analysis (EFA)

We performed EFA (rather than confirmatory FA, see Sternberg, 1984) to see how the items converge with a linear modulation. The analyses found 5 and 4 different factors (Varimax rotation) for the Israeli ($R^2 = 0.65$) and Romanian ($R^2 = 0.59$) samples, respectively. We also performed forced analyses so that the items would converge on a single-factor ($R^2 = 0.33$ and $R^2 = 0.36$ for Israeli and Romanian samples, accordingly), in order to compare the results to a factorized solution as opposed to a single-factor one. All of the solutions, as expected, however, had poor model fit (Byrne, 2010). The 5-factor solution (Israeli sample): $\chi^2_{(110)} = 279.38$, $p = 0.000$, $\chi^2/df = 2.54$, SRMR = 0.08, CFI = 0.84, NFI = 0.77, GFI = 0.84,

ECVI = 2.21, RMSEA (90% CI) = 0.10 (0.08–0.11), $p = 0.000$. The 5-factor solution (Romanian sample): $\chi^2_{(129)} = 1,519.29$, $p = 0.000$, $\chi^2/df = 11.78$, SRMR = 0.08, CFI = 0.82, NFI = 0.81, GFI = 0.85, ECVI = 1.43, RMSEA (90% CI) = 0.10 (0.09–0.10), $p = 0.000$. The single-factor solution (Israeli sample): $\chi^2_{(135)} = 495.75$, $p = 0.000$, $\chi^2/df = 3.67$, SRMR = 0.11, CFI = 0.68, NFI = 0.61, GFI = 0.73, ECVI = 3.44, RMSEA (90% CI) = 0.13 (0.12–0.14), $p = 0.000$. The single-factor solution (Romanian sample): $\chi^2_{(135)} = 2,686.62$, $p = 0.000$, $\chi^2/df = 19.90$, SRMR = 0.10, CFI = 0.67, NFI = 0.66, GFI = 0.75, ECVI = 2.47, RMSEA (90% CI) = 0.13 (0.12–0.13), $p = 0.000$. The factor analyses and loadings are presented in **Table 3**.

FA identified only the cognitive (a1, except item 14 for both samples) and emotional (a2, except item 5 in the Israeli sample) elements of the modalities facet, and time (b1) element of the resources facet, in both samples (see **Table 3**). FA also identified the effort (b2) element in the Romanian sample. Moreover, the third factor (in both samples) is a combination of both elements—instrumental (a3) and effort (b2), and not a pure element. However, we had two exceptional items (5 and 14) which did not converge logically well with the factors' solution. Nevertheless, as will be shown below, they do converge very well in the similarity structure analysis (SSA).

In addition, we performed a FA for the other measures in the second phase of the research (with the Romanian sample). The results are presented in **Table 4**.

TABLE 3 | Exploratory factor analyses loadings and results for the WFBS.

	Israeli sample (<i>N</i> = 166) ^a						Romanian sample (<i>N</i> = 1,117) ^b				
	1	2	3	4	5	Single ^c	1	2	3	4	Single ^c
Item 1	0.82					0.76	0.63				0.65
Item 7	0.85					0.72	0.85				0.72
Item 13	0.71					0.82	0.74				0.78
Item 2	0.68					0.68			0.61		0.61
Item 8	0.79					0.74	0.81				0.75
Item 14		0.60				0.51			0.49		0.59
Item 15		0.57						0.77			0.50
Item 11		0.64				0.65		0.46			0.65
Item 17		0.68				0.66		0.55			0.59
Item 6			0.77			0.40			0.78		0.42
Item 12			0.59			0.76			0.75		0.64
Item 18			0.70			0.63			0.66		0.63
Item 9				0.67		0.46		0.58			0.52
Item 10				0.78		0.47		0.73			0.56
Item 16				0.66		0.41		0.77			0.55
Item 3 (<i>R</i>) ^d					0.80					0.82	
Item 4 (<i>R</i>)					0.75					0.82	
Item 5					−0.55	0.40			0.46		0.64
Eigenvalue	3.55	2.32	2.03	1.98	1.86	5.90	3.11	3.05	2.98	1.65	6.17
<i>R</i> ²	0.20	0.13	0.11	0.11	0.10	0.33	0.17	0.17	0.16	0.09	0.34
α coefficient ^e	0.88	0.67	0.72	0.61	0.64	0.87	0.86	0.79	0.78	0.66	0.90

Loadings are based on Varimax rotation in Principal Axis Factoring (PAF) method. Factor loadings with a value of 0.40 or higher (in absolute value) were retained.

^aFor Israeli sample *KMO* = 0.83, Bartlett's $\chi^2_{(153)} = 1,228.83$, *p* = 0.000.

^bFor Romanian sample *KMO* = 0.89, Bartlett's $\chi^2_{(153)} = 7,963.51$, *p* = 0.000.

^cSingle, single-factor solution.

^d*R*, reverse-coded items.

^eCronbach's Alpha coefficient.

As can be seen, the DUWAS, for example, did not converge as its authors intended, but the BWAS and the HWI measures did align with their intended use.

Similarity Structure Analysis (SSA)

As FA showed partial concordance with our mapping sentence and facets, we proceeded to perform SSA analyses. SSA is an intrinsic data analysis technique with an emphasis on looking at regions in the geometric space of variables rather than at coordinate systems (Levy, 2005). We, however, wish to elaborate on two well-known algorithms for SSA analyses: (1) ALSCAL, and (2) SMACOF.

ALSCAL (Alternating Least Squares SCALing, see Takane et al., 1977) is an older algorithm than SMACOF (Scaling by MAJorizing a COmplicated Function, see de Leeuw and Heiser, 1980; Young and Hamer, 1987, 2013). The latter improved upon the former in three main fashions: (1) speed, elegance and simplicity, (2) it is based on distances (including negatives) and not squared-distances (Young and Hamer, 1987, 2013), (3) minimizing the Stress function (see de Leeuw and Mair, 2009). Another advantage is that the SMACOF algorithm can only be used in the R software package (version 2.7.0 and later) which is a free open-source program and “the functions available in R implement many state-of-the-art statistical procedures, and the

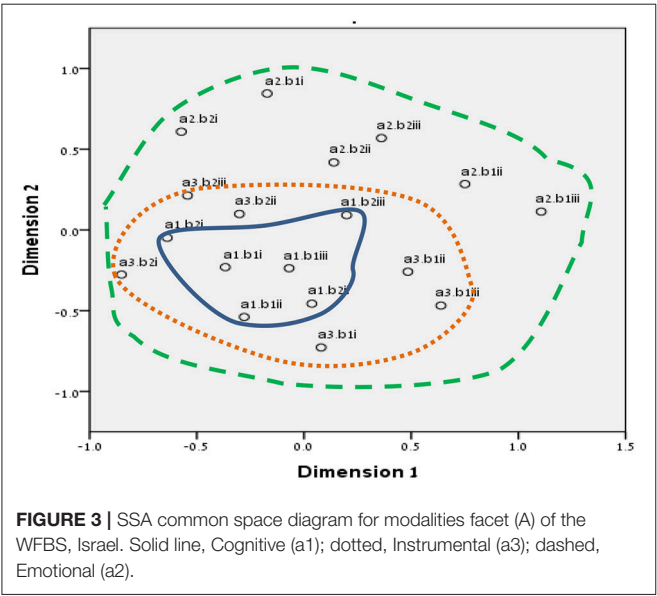
graphics are better than those available in any other software package” (Jacoby, 2012). SMACOF in R can be implemented in many fields and practices, such as: social sciences, individual differences, geography, 2D and 3D graphical presentations, rectangular matrices, quadratic surfaces, using metric and non-metric data, and more (de Leeuw and Mair, 2009).

We chose to run SSA with the two multidimensional scaling algorithms ALSCAL (in SPSS vs. 22) and SMACOF (in R v. 3.4.1). The divergence and convergence of the items in both methods resembled our mapping sentence and hypotheses more accurately. The results are shown in **Figures 3–8** for the Israeli and Romanian samples, accordingly, and both analyses indicated good and almost-identical fit for both samples (see Kruskal, 1964; Dugard et al., 2010; Jacoby, 2012) Stress = 0.05 and 0.06 (for SMACOF and ALSCAL in the Israeli sample, respectively) and Stress = 0.04 and 0.05 (for SMACOF and ALSCAL in the Romanian sample, respectively). This also shows: (a) the superiority of SSA over FA (in fit indices and intensifying the structure of the mapping sentence), (b) SMACOF algorithm produced better fit than the ALSCAL. However, it can clearly be seen that the disparity of the items in the Romanian sample is far larger than in the Israeli one, regardless of the almost-identical fit indices. This implies that it is not mandatory for the items to be in very close proximity to

TABLE 4 | Exploratory factor analyses loadings and results for other measures, for Romanian sample ($N = 1,117$).

	DUWAS		BWAS	HWI	
	1	2	1	1	2
Item 1	0.84		0.67		0.58
Item 2	0.75		0.65		0.81
Item 3		0.59	0.68		0.83
Item 4		0.81	0.74		0.74
Item 5		0.78	0.69		0.82
Item 6	0.73		0.68	0.84	
Item 7	0.67		0.71	0.86	
Item 8	0.68		–	0.85	
Item 9		0.64	–	0.86	
Item 10		0.68	–	0.85	
Eigenvalue	3.01	2.72	3.29	3.80	3.03
R^2	0.31	0.27	0.47	0.38	0.30
KMO	0.86		0.83	0.88	

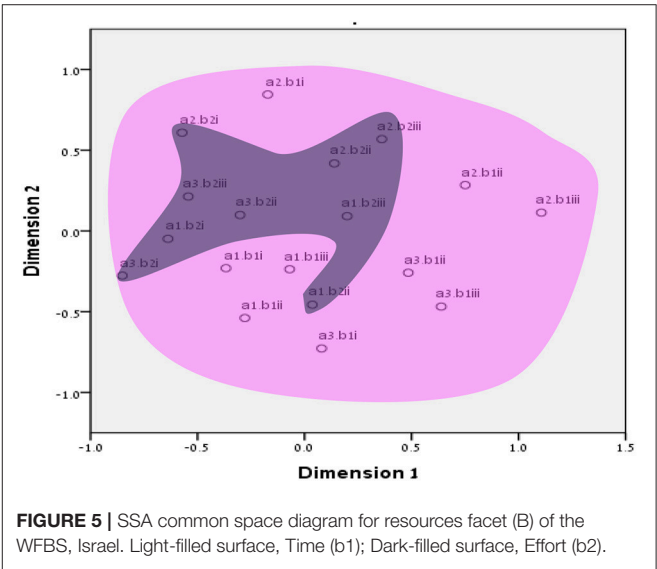
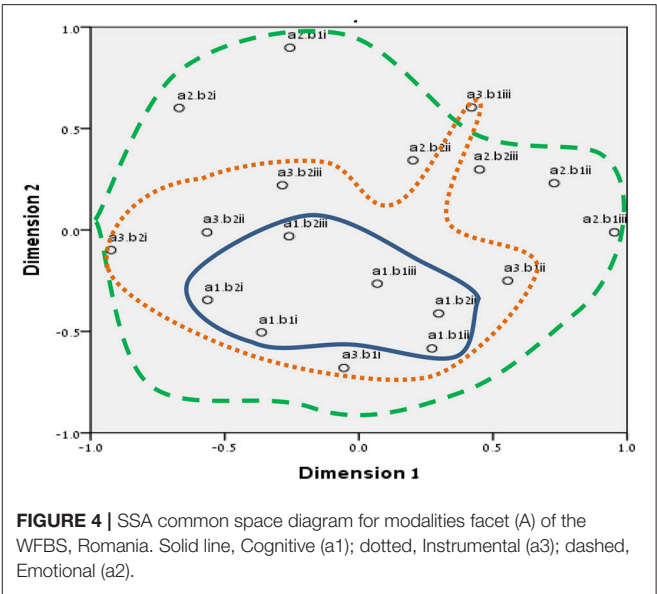
Loadings are based on Varimax rotation in Principal Axis Factoring (PAF) method. Factor loadings with a value of 0.40 or higher (in absolute value) were retained. (1) Items 1–5, Working Compulsively; items 6–10, Working Excessively (Schaufeli et al., 2009). (2) Andreassen et al., 2012. (3) Items 1–5, Time Commitment; items 6–10, Working Intensely (Brown and Leigh, 1996). (4) This row represents the number of factors derived from the analyses.



each other in order to be meaningful and retain their facet structure.

In order to encompass our statistical options, after having employed EFA and SSA, we also used a CFA analysis for the SMACOF results (in AMOS v. 22), as the fit of the model was greater (see Appendix C). As can be seen in the analyses, for both Israeli and Romanian samples, SSA is still superior to both FA methods.

Furthermore, the SMACOF results converged on a three-dimensional space, meaning the data is multidimensional (not fitting for FA), and must also be visualized in a 3D diagram.



Using the R software, we produced 3D spheres with the SMACOF coordinates (see Figures 9–12).

Regarding Our Hypotheses

- 1 Workaholism can be classified according to its modalities facet (cognitive, emotional, and instrumental) and the workaholism resources facet (time, effort). Meaning, the empirical results reflect the components of workaholism, as defined in the mapping sentence. Each facet and its elements occupy a distinct region.
- 2 Observing Figures 3, 4 for the Israeli and Romanian samples, respectively (the structure of facet A, workaholism modalities), three circular regions can be clearly distinguished—cognitive items in the center, instrumental items next in the second circle, and emotional items in the peripheral region. This

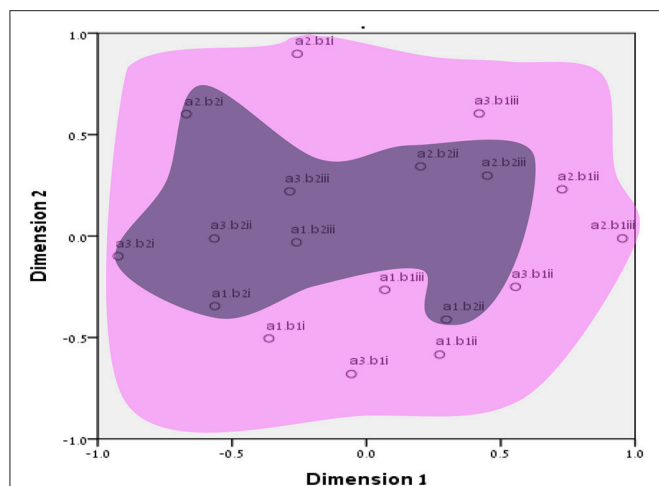


FIGURE 6 | SSA common space diagram for resources facet (B) of the WFBS, Romania. Light-filled surface, Time (b1); Dark-filled surface, Effort (b2).

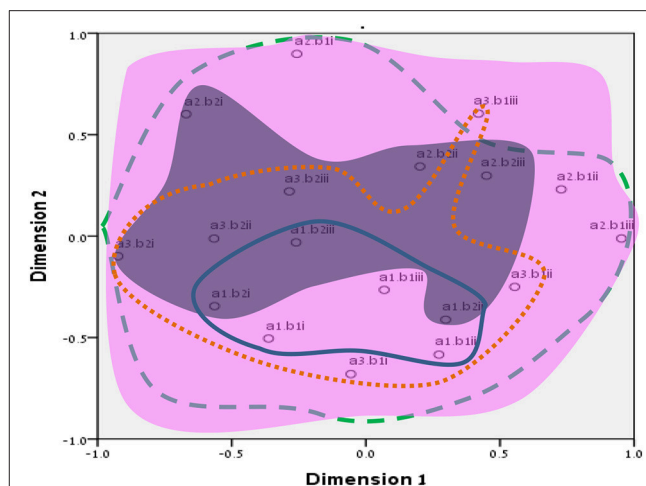


FIGURE 8 | Total SSA common space diagram for the WFBS, Romania. Solid line, Cognitive (a1); dotted, Instrumental (a3); dashed, Emotional (a2). Light-filled surface, Time (b1); Dark-filled surface, Effort (b2). Stress: 0.05 (SMACOF).

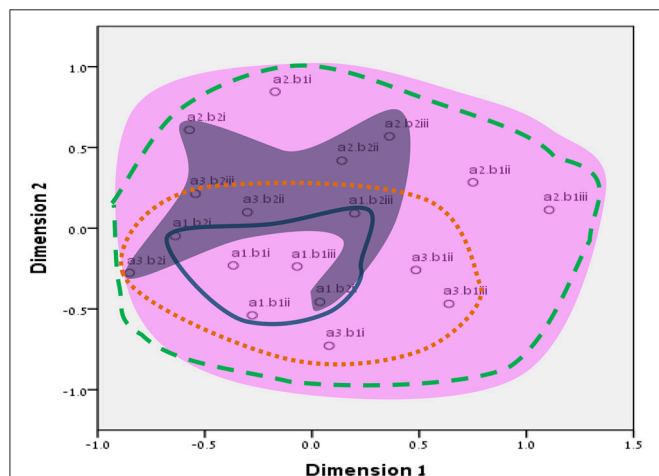


FIGURE 7 | Total SSA common space diagram for the WFBS, Israel. Solid line, Cognitive (a1); dotted, Instrumental (a3); dashed, Emotional (a2). Light-filled surface, Time (b1); Dark-filled surface, Effort (b2). Stress = 0.05 (SMACOF).

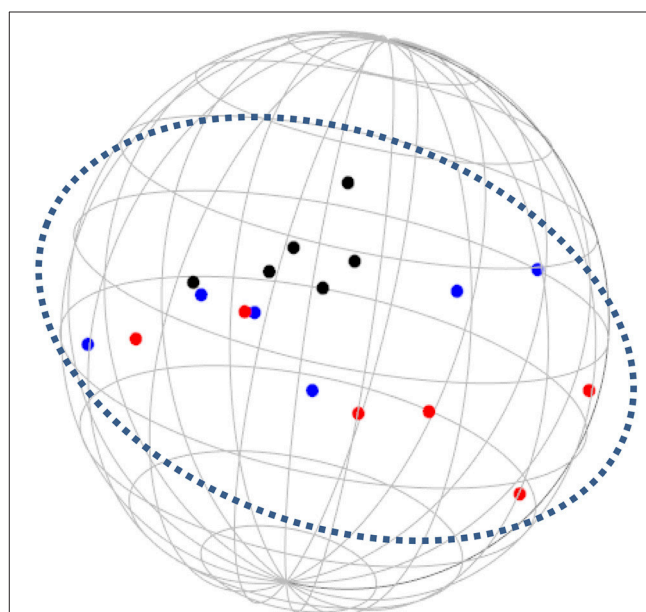


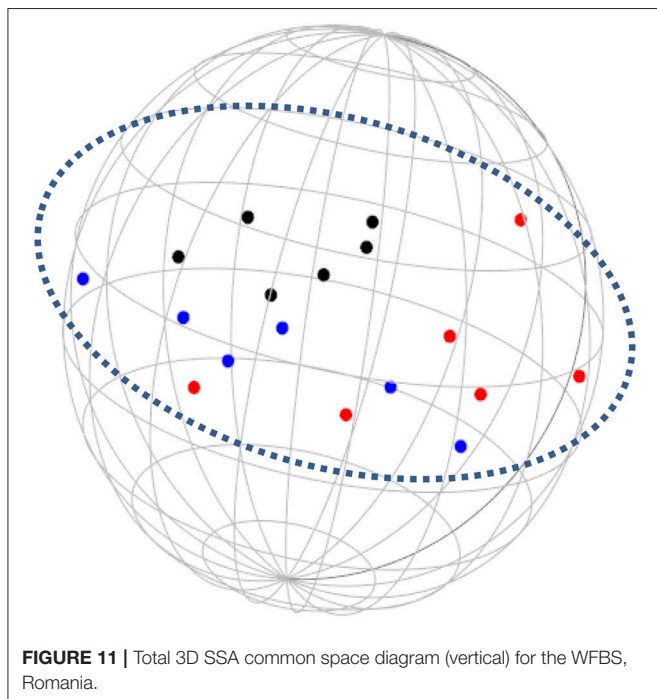
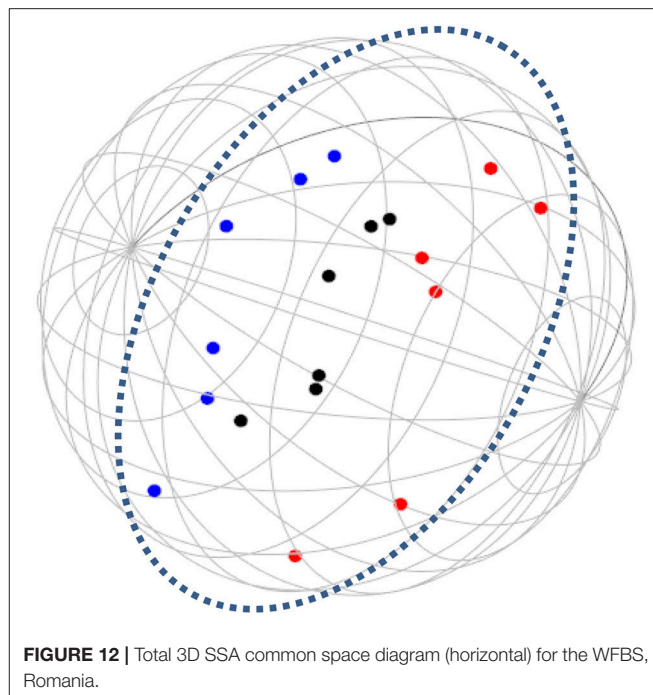
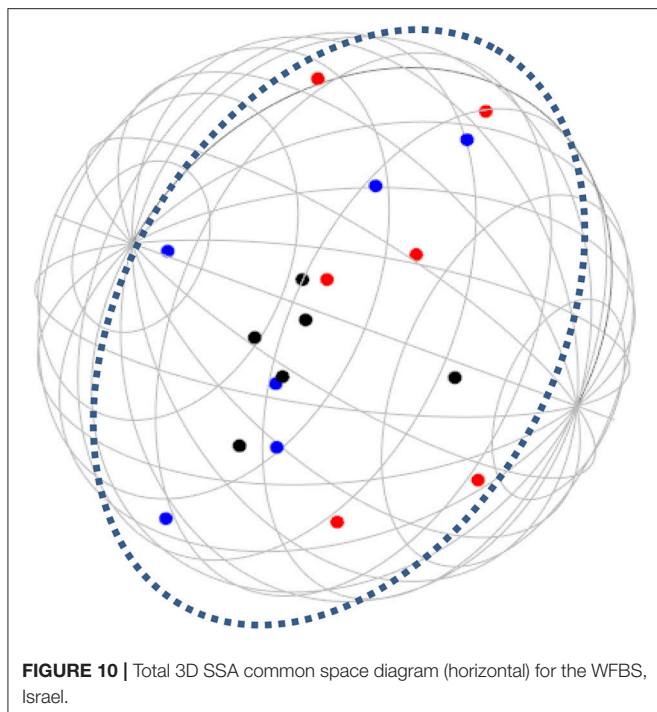
FIGURE 9 | Total 3D SSA common space diagram (vertical) for the WFBS, Israel.

facet structure (organizing the items from the center to the periphery) is called a modulating facet. As such, our hypothesis for a polarizing facet was not supported in this regard. The results showed a modulating structure with a great fit.

- 3 Observing **Figures 5, 6** for the Israeli and Romanian samples, respectively (the structure of facet B, workaholism resources), two circular regions can be clearly distinguished—effort items in the center, and time items in the peripheral region. This facet structure (organizing the items from the center to the periphery) is called a modulating facet. Thus, our hypothesis for a modulating structure was indeed supported, but the elements were laid out in reverse order to our hypothesis (which assumed that the time items would be central, and the effort items—peripheral). This structure had a great fit as well.

- 4 Observing **Figures 9–12** for the Israeli and Romanian samples (the total 3D structure of the SSA, both facets), we can clearly see it is not a radex configuration, but rather an oblate *ellipsoid* (which might be the outcome of two combined modulating facets). In which case, the structure in the Romanian sample was tighter, more oblate than the Israeli.

Lastly, in order to see the associations among the various variables and their subscales (only for the Romanian sample), a Pearson correlation matrix was formed, as shown in **Table 5**.



As seen in Table 5, the measures are not foreign to each other and have good correlations with one another. Regarding the WFBS subscales, they also correlated highly with each other, although the emotional subscale had the lowest associations of them all.

DISCUSSION

The main goal of this paper was to attempt and clear some of the confusion surrounding workaholism (see Clark et al., 2016) in a two-phase research. In light of these operationalization and conceptual difficulties, we embraced the Facet Theory approach (Guttman, 1954, 1957).

In the first phase, we formulated a theoretical definitional framework for workaholism. The empirical results supported the definitional framework suggested for the workaholism domain. The components of workaholism, as defined in the mapping sentence, were indeed reflected, and distinct regions for each of the facets and their elements (A Modalities: cognitive, emotional, and instrumental; B Resources: time and effort) could clearly be distinguished.

In regard to facet A (modalities), as opposed to our hypothesis for a polarizing structure, three circular regions were distinguished—cognitive items in the center, instrumental items next in the second circle, and emotional items in the peripheral region. Meaning, this facet is a modulating one. As workaholism is defined as an uncontrollable inner drive, it is not exclusively instrumental/physical, but it is first reflected cognitively. Meaning, the employee may think about work even when absent from it. Usually, thought precedes action, and this explains the central regionality of the cognitive element (see also Harpaz and Snir, 2016).

The emotional element, though existing in most of the measures of workaholism (e.g., Spence and Robbins, 1992; Robinson, 1998; Schaufeli et al., 2009; Andreassen et al., 2012), was not fully theoretically defined until the current study, as far as we know. As can be seen in Figures 3, 4 (for the Israeli and Romanian samples, accordingly) the emotional element

TABLE 5 | Pearson correlation matrix, for Romanian sample ($N = 1,117$).

		1	2	3	4	5	6	7	8	9	10	11	12
	BWAS												
1	WC	0.67											
2	WE	0.65	0.74										
3	DUWAS	0.71	0.92	0.93									
4	TC	0.55	0.55	0.62	0.63								
5	WI	0.20	0.31	0.39	0.37	0.38							
6	HWI	0.47	0.52	0.61	0.61	0.84	0.81						
7	Cognitive	0.53	0.53	0.56	0.59	0.52	0.41	0.56					
8	Emotional	0.31	0.39	0.25	0.34	0.26	0.15	0.25	0.37				
9	Instrumental	0.52	0.50	0.56	0.57	0.60	0.45	0.64	0.67	0.35			
10	Time	0.62	0.62	0.59	0.65	0.59	0.31	0.55	0.82	0.62	0.79		
11	Effort	0.43	0.47	0.48	0.51	0.48	0.49	0.59	0.78	0.62	0.79	0.71	
12	WFBS	0.57	0.60	0.58	0.63	0.58	0.43	0.61	0.87	0.67	0.85	0.93	0.91

All of the correlations are statistically significant at $p < 0.001$. BWAS, Bergen Work Addiction Scale; DUWAS, Dutch Work Addiction Scale; WE, Working Excessively; WC, Working Compulsively; HWI, Heavy-Work Investment; TC, Time Commitment; WI, Working Intensely; WFBS, Workaholism Facet-Based Scale.

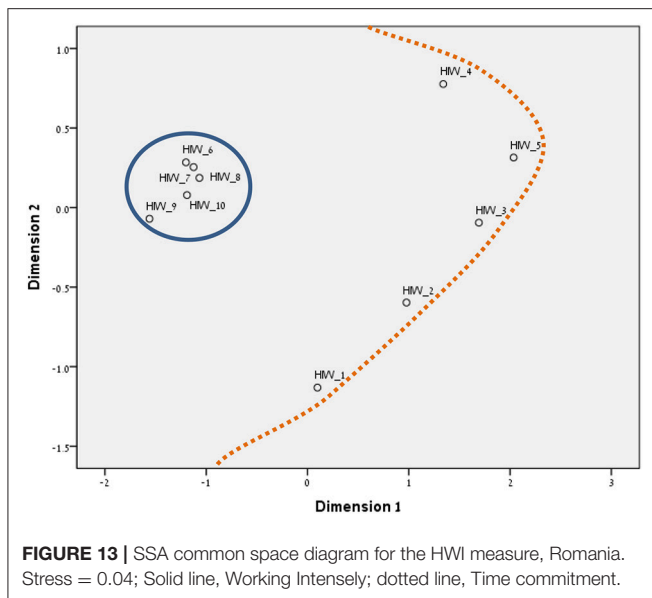
is the most peripheral and the disparity of its points is far larger than any other element. While there is no denying what “thinking about work” and “doing work” mean, “feeling about work” is more obscure. Emotions about work may be positive or negative (based on interpretation) and might be culturally-dependent as well, while “doing” and “thinking” about work are less ambiguous.

In regard to facet B (resources), as opposed to our hypothesis that the time items would be central, and the effort items—peripheral, the effort items were placed in the central circle and the time items in the peripheral circle of the modulating structure. Support for this modulation (albeit reversed) can be seen in the second phase SSA results regarding HWI (see **Figure 13**); the effort (working intensely) items are very much converged, as opposed to the time commitment items. Effort investment may be accompanied by time commitment, but not necessarily vice versa. Like the presenteeism phenomenon, when an individual invests time in work, an investment of effort will not always follow (e.g., Pseudo-Heavy Work Investment, see Astakhova and Hogue, 2015. Low-Heavy Work Investment, see Rabenu and Aharoni-Goldenberg, in press). Another plausible explanation may be nested in methodological reasoning: as stated before, the time aspect is more generally agreed upon due to its universal measurement scale (i.e., seconds, minutes, working hours, formal work break, etc.). We, therefore, tried to encompass time’s entire scale range, which resulted in more scattered items. However, since effort is less agreed upon, we were trying to be careful and stick to its terminology, which led us to generate items that were semantically closer to each other, as opposed to the items in the time element. This may have been the reason behind the higher similarity of the effort items.

Our hypothesis concerning the total structure of workaholism (radex) was thus not supported, due to the different nature of the facets attained in the analyses, since the two facets, modalities (A) and resources (B), were both modulating. Such a combination of two modulating facets may be quite confusing to the observer (dual circular layout; see end of results section); however, the

possible conceptual combination is much clearer and interesting. In a circumflex structure of one modulating facet, the proximity between the elements in the circular layout hints at a functional dependence between close items, whether they differ qualitatively or quantitatively (Friedman, 2008). Ergo, in our results of two modulating facets, the core of the cognitive element (a1) is comprised of the time (b1) items while the effort (b2) items are scattered in the peripheral area of the cognitive circle. This occurred only in the Israeli sample, and a possible explanation is the occupational differences between the two samples. In Israel, there were statistically significant χ^2 (2, $N = 1,238$) = 23.98, $p = 0.000$, $r_c = 0.14$) more high-tech workers (27.1%) in comparison to Romania (13.7%), while the Romanian sample was more low-tech oriented (28.3%) than the Israeli one (16.9%), although the samples did not differ in the services industry (56 and 58% for Israelis and Romanians, accordingly). Especially for the high-tech industry “... long hours are the norm. Those present are assumed to be working elsewhere... others will do so in their minds and—a few would report—even their dreams” (Kunda, 2009, p. 3). This demonstrates that high-tech is vastly characterized by high cognitive investment, throughout the entire day cycle. In addition, even in correlational terms (see **Table 5**), the relationship between the cognitive element and the time element was stronger than the association between the cognitive and effort elements.

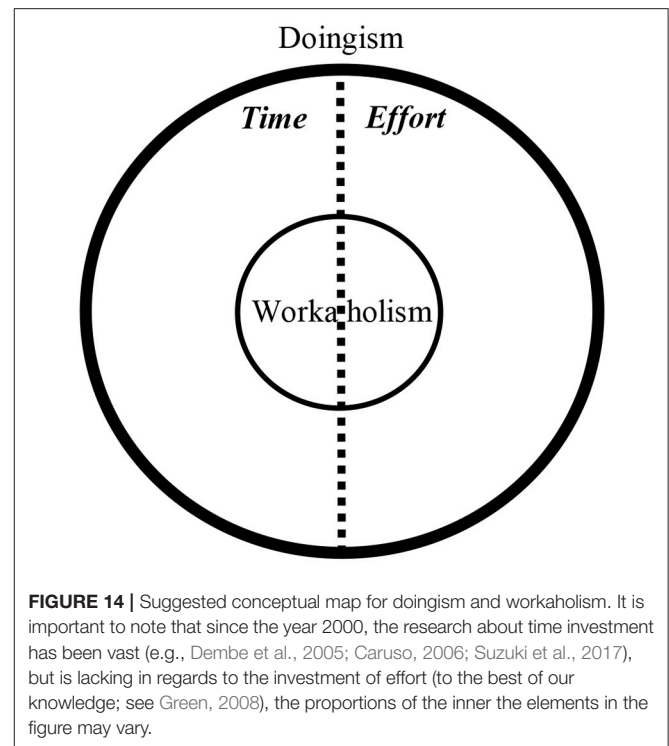
Furthermore, employees working longer hours may be idolized as “heroes” and displayed as role models (Shimazu et al., 2015). Such a reward system may promote workaholic behaviors by setting fewer limitations on excessive work routines (Mazzetti et al., 2014). Similar organizational cultures, those promoting long working hours, may become triggers which may activate the drive to work disposition (Harpaz and Snir, 2016). However, effort may be more internal and less outwardly visible than time. For example, many managers observe the amount of time that employees are present at work as an indication of their performance, especially when it is difficult or complicated to assess the output (Tziner and Rabenu, 2011). In addition to the



differences between industries, they may be cultural as well. For example, in our findings (see **Figures 3, 4**), it can be seen that item no. 17 of WBFS [... work all the time, even on breaks (e.g., lunch breaks, smoking breaks, etc.)] converged well with the instrumental element (a3) in the Israeli sample, according to the mapping sentence. However, it was more proximal to the emotional (a2) one in the Romanian sample (where it should not belong). It is even more interesting to notice that item 17 is proximal to items 10 and 16 which both reflect “enthusiasm about investing effort in work.” As Israel is known to have an overworking job culture, working much more hours than the OECD’s average (OECD, 2013), investing time in working (even on breaks) may seem normative. However, in Romania, one must probably have high drive for work (i.e., being a workaholic) in order to be enthusiastic about pouring effort into it on breaks.

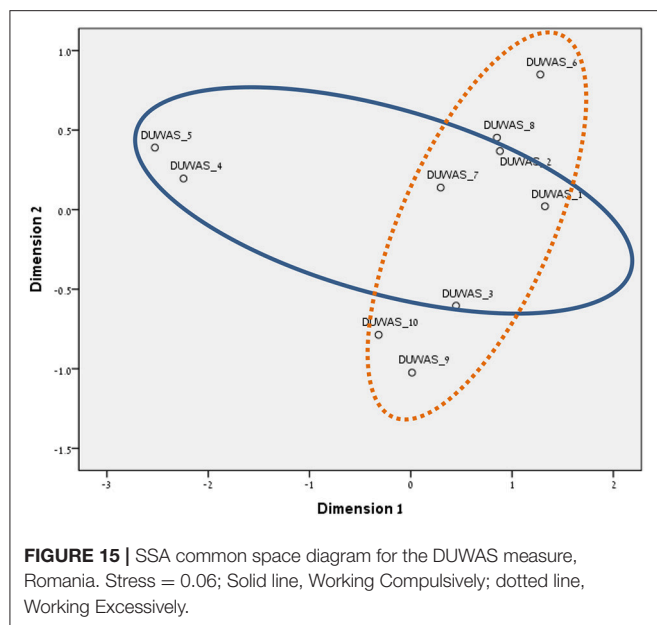
Nonetheless, comparing the main results from Israel and Romania, they were relatively similar, despite the Israeli one had less participants ($N = 166$) than the Romanian ($N = 1,117$). As Israel is already considered a highly overworking country, all of the WBFS subscales (in terms of means) were higher than in the Romanian sample (see **Table 2**). The discussion about cultural differences makes cross-cultural, in general, and Romania, in particular, an interesting field to further research work-related topics.

Since the mapping sentence was supported, and according to the results that the cognitive and effort elements were the most central of the two facets (modalities and resources, accordingly), it may be argued that workaholism is a private case of a phenomenon we may call “Doingism.” Doingism is a portmanteau composed of the words “doing” and “alcoholism” (on a similar notion that workaholism is composed of “work” and “alcoholism”). Its definition resembles the one defined in the mapping sentence of workaholism in the current paper, except that it is more general and not workplace-specific. Meaning, a workaholic is driven to heavily invest in the work itself (i.e.,



effort and time), while the “doingist” is driven to heavily invest in and out of the job (e.g., at home, volunteering, etc.). As such, by Set Theory terms, workaholism is a subset of doingism (i.e., all the elements of workaholism are also elements of doingism); $\text{workaholism} \subseteq \text{doingism}$. The doingist is driven to “do” in general, not only at work, while the workaholic is driven to “do work” exclusively. That is the reason workaholism is a private case of doingism (in the workplace). Depending on contextual differences, doingism may be translated into workaholism since working is usually valued (see also Shimazu et al., 2015). See **Figure 14** for a conceptual map.

Regarding the comparisons among the different measures in our study (i.e., BWAS; Andreassen et al., 2012, DUWAS; Schaufeli et al., 2009, HWI; Snir and Harpaz, 2012, 2015), although all of them had good reliability and model fit indices from FA and SSA (not including BWAS which had no subscales), there were still some oddities in a few findings. As can be seen in **Table 5**, the DUWAS items do not converge in FA as its authors intended, and did not do as well as in SSA (see **Figure 15**). This may be a byproduct of “arbitrariness” with producing the measure’s items, as opposed to doing so by a formal conceptual framework and a Cartesian multiplication of theoretically based item composition (see also Clark et al., 2016). In addition, regarding our new measure, FA (see **Table 5**) recognized our elements only partially [modalities (A)—cognitive (a1) and emotional (a2), resources (B)—time (b1) and effort (b2)], but even so, most of the factors were “contaminated” with items from other elements (e.g., time with effort items, etc.). While FA needed 4–5 (sometimes contaminated) factors for its solution, SSA resulted in a much clearer and more elegant picture of the facets



consistent with the mapping sentence. Only two dimensions (modalities and resources) were needed for this solution, and as such it is more parsimonious. Thus, SSA has an advantage in describing the concept in the fewest parameters possible, an approach embraced in current scientific notions. This stresses the necessity of using the facet theory methodological framework.

Future Research

We recommend replicating the current study in more cross-cultural contexts. As already shown in the paper, we found interesting differences between the Israeli and the Romanian samples, which lead us to believe that such comparisons would benefit the literature and broaden the generalizability of the results.

We also think it would be highly interesting to test known research models regarding workaholism with our new measure (WFBS) and see how the outcomes differ. Perhaps WFBS will shed new light on former findings, a paraphrase on “new wines in old bottles.” In addition, because it is a Cartesian product, the WFBS can be used as 18-, 12-, and 6-item scales. We also tested the reliability for each derivative and the results were adequate. We thus encourage researchers to use the measure differently with same models, in order to see if and how the results vary.

There should be more validating papers accounting for WFBS and constructs which have known associations with workaholism (convergent validity) or are unrelated to it (discriminant validity). Our measure may enable to gauge the nature of workaholism in which individuals might feel *pushed* (driven) to the act of working; while on the other hand, job engagement or harmonic passion to work, for example, *pull* (attract) them by the nature of the work itself.

Regarding the statistical aspects of the paper in relation to Facet Theory, the aggregative knowledge about comparing SSA and FA results has consistently pointed to the superiority of

the scaling methods (i.e., SSA) over FA (e.g., Tziner, 1992; de Souza et al., 2015; Rabenu et al., 2015a). Apparently it is less appropriate to use the FA method, which is linear and unidimensional, in multidimensional data. As such, only scaling methods such as SSA (and other MDS) should be implemented. We recommend the use of cross-algorithmic validation for the scaling methods. Meaning, for example, analyzing the data using at least two different MDS algorithms (e.g., ALSCAL, SMACOF, fSSA, PROXSCAL) and comparing the results. In addition, we also suggest intra-sample validation in future studies, in which the sample is divided into at least two randomized unbiased groups and the analyses run on each one in order to replicate results group-wise and not just total-sample-wise.

We suggest formulating a refined mapping sentence and a consequent new scale for the concept of “doingism.” This mapping sentence should also include a new facet (C) titled “life-area domains” (including the elements: work, home, leisure). This would enable researchers to identify “doingistic” tendencies in general, or even potential workaholics.

Limitations

The present research has a number of limitations. First, the Romanian sample filled out four workaholism measures in a single survey (i.e., WFBS, DUWAS, BWAS, HWI) for a total of 47 items. This might have biased the participants into a “workaholic state of mind,” but as shown in the method section the data did not suffer from CMB issues, and even the correlations between the constructs (see **Table 5**) were not inflated. Another possible drawback is that the research variables in this study were collected from single-source data, namely self-report questionnaires. We believe that due to the nature of the variables (the need to describe *inner drive*) subjective reports would be the most appropriate. However, we did not collect objective data that may be relevant to the instrumental items specifically. For example, the item “... arrive very early to work, and leave it very late” (WFBS, item no. 11) can be also checked objectively in the workplace hard data (e.g., time clock records).

In addition, the Romanian sample consisted of working MBA students, and half of the Israelis were managers (at various levels). Since managers have unique characteristics, and workaholism is a phenomenon typical to senior managers (Pines, 2011, p. 164), this might have biased the results.

ETHICS STATEMENT

The current study was correlational, based on a survey, and not a manipulation on subjects. At the beginning of each questionnaire, we explained the general goal of the research, ensured anonymity and discretion of the results, and also ensured the subjects know they could leave the participation at any time they choose.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

ACKNOWLEDGMENTS

We would like to express our profound gratitude to three reviewers for their insightful and helpful comments which considerably contributed to improving the quality of this paper.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2017.01803/full#supplementary-material>

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Commentary: Wild psychometrics: Evidence for ‘general’ cognitive performance in wild New Zealand robins, *Petroica longipes*

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Keywords: facet theory, cognition, avian intelligence, comparative psychology, “g” factor in intelligence, psychometrics

A commentary on

Wild psychometrics: Evidence for ‘general’ cognitive performance in wild New Zealand robins, *Petroica longipes*

by Shaw, R. C., Boogert, N. J., Clayton, N. S., and Burns, K. C. (2015). *Anim. Behav.* 109, 101–111. doi: 10.1016/j.anbehav.2015.08.001

OPEN ACCESS

Edited by:

Erica Cosentino,
Ruhr University Bochum, Germany

Reviewed by:

Jonas Rose,
University of Tübingen, Germany

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Specialty section:

This article was submitted to
Theoretical and Philosophical
Psychology,
a section of the journal
Frontiers in Psychology

Received: 12 December 2016

Accepted: 25 January 2017

Published: 08 February 2017

Citation:

Hackett PMW (2017) Commentary:
Wild psychometrics: Evidence for
‘general’ cognitive performance in wild
New Zealand robins, *Petroica*
longipes. *Front. Psychol.* 8:165.
doi: 10.3389/fpsyg.2017.00165

Studies into the psychometric structure of human intelligence and cognitive ability have identified a “g” or *general* factor, e.g., Buckhalt (2002), and in comparative psychology, in primates: Reader et al. (2011) and in rodents: Matzel et al. (2003). As well as this “g” factor, intelligence is conceptualized as possessing multiple specific intelligences. Due perhaps to more recent discoveries regarding the complexity of birds cognitive abilities (see, Emery, 2016), birds have become the subject of psychometric investigation (e.g., Ackerman, 2016).

Seminally, Shaw et al. (2015) assembled a test battery for avian cognition to assess the cognitive abilities in New Zealand robins (*Petroica longipes*). Their test battery was comprised of a series of, “tasks based on established measures of avian cognitive performance: a motor task, color and shape discrimination, reversal learning, spatial memory and inhibitory control.” (Shaw et al., 2015, p. 101). These scientists found robins to vary greatly in their ability to solve tasks. They also discovered weak, positive, non-significant correlations between performances on most tasks. They analyzed test performance using principle component analysis (PCA) using the criteria for extracting components as being the possession of an eigenvalue of unity or above. All sub-tests were found to load positively on the first component, which explained >34% of between-test variance. As a consequence of this finding, the authors identified this first factor as a “g” factor, and concluded that New Zealand robins, tested in their wild habitat, displayed a general cognitive factor analogous to the human “g” factor. They continue to draw similarities between their own research and the body of literature on human general intelligence. In their article, Shaw et al. (2015) state that: “In human psychometric testing, individuals’ scores in tests of diverse cognitive processes are positively correlated, and a “g” factor typically accounts for at least 40% of total variance” (Shaw et al., 2015, p. 101).

However, several researchers, (e.g., Guttman, 1965, 1981; Koop, 1985; Guttman and Levy, 1991) have expressed concerns with the use of PCA to analyze tests of cognition as this procedure embodies specific assumptions regarding the data being analyzed that may not be met. For example, PCA requires that the data being subjected to PCA possesses the following characteristics: that the data is parametric in nature; that there is a correspondence between the data and the psychological

structure of the construct being assessed; that comparability exists between the measurement scales in different sub-tests, etc.

Within human psychometrics questions have been asked regarding the nature of the relationship between general and specific forms of intelligence. Rimoldi (1951) hypothesized upon the nature of a “g” factor in intelligence. Koop (1985) notes how Rimoldi proposed that the “g” component was better understood as being a second-order factor (as being a product of specific intelligences) rather than as a primary factor with secondary specific intelligences. A psychometric approach that has been employed to analyse human cognition (and many other forms of behavior and experience) is that of facet theory (see Hackett, 2014, 2016). Typically, when a facet theory perspective is utilized, a definitional framework, known as a mapping sentence, is developed and research instruments are designed to investigate this initial propositional definition. Data reduction techniques (similar to PCA, but having different assumptions about the data), such as smallest space analysis (SSA) and partial order scalogram analysis (POSA) are used to test the veracity of the mapping sentence. Another way in which facet theory has been used is to analyse existing data sets. The data set produced through Shaw et al.’s research into New Zealand robin’s cognitive performance is a data set that would be suited to such analysis.

An example of how a facet theory approach has been used to interrogate an existing data set is Koop’s (1985) reanalysis of Rimoldi’s (1951) data using facet theory’s analytic procedure: SSA and found a radial (qualitative) array of sub-tests (geometrical; numerical and verbal tests). Furthermore, he discovered that each of these sub-types of intelligence sub-tests were modified in terms of whether a specific sub-test required: inference, application or learning. Other researchers have divided the “g” intelligence into two forms: fluid (gf) and crystalized (gc) general intelligence (Cattell, 1963; Horn, 1988). Beauducel et al. (2001) used the facet theory approach to investigate the structure of fluid and crystalized general intelligence. They discovered support for the discrete existence of the tests of: verbal, numerical and figural abilities, with these being divided into:

fluid (gf) and crystalized (gc) general intelligence, in a 2×3 structure.

Shaw et al.’s (2015) psychometric test battery and framework has demonstrated cognitive structures analogous to human intelligence and their findings are an extremely important steps toward better understanding how birds cognitively experience and process their world. Of particular relevance to this commentary is the fact that Shaw and colleagues identification of a complex structure to exist within avian intelligence offers a new research area for facet theory.

To conclude, facet theory approach has allowed the depiction and modeling of human cognitive processes and for understanding human intelligence. It is the contention of this author that facet theory provides a way to conceptualize and design avian cognition research. The approach also provides a way to analyse data that arises from research designed in this way using non-parametric techniques (e.g., SSA and POSA) to reveal the structure of avian intelligence in the form of a mapping sentence. By using a mapping sentence to design research and non-parametric statistical analyses this allows the investigation of the structure of avian intelligence in a way that does not make unsubstantiated assumptions of the psychometric qualities of the data. Furthermore, facet theory based research produces cumulative and directly comparable results across studies employing a faceted design. Thus, the use of facet theory could potentially develop greater understanding of avian cognitive processes.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and approved it for publication.

ACKNOWLEDGMENTS

I would like to thank the authors of the article upon which this commentary is based (Shaw, R. C., Boogert, N. J., Clayton, N. S., and Burns, K. C.) for their co-operation and for making their work available to me.

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Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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What Is Your Faction? Multidimensional Evidence for the Divergent Series As the Basis for a New Model of Personality and Work Life

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OPEN ACCESS

Edited by:

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Netanya Academic College, Israel

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Specialty section:

This article was submitted to
Theoretical and Philosophical
Psychology,
a section of the journal
Frontiers in Psychology

Received: 27 November 2016

Accepted: 21 September 2017

Published: 06 October 2017

Citation:

de Souza BC and Roazzi A (2017)
What Is Your Faction?
Multidimensional Evidence
for the Divergent Series As the Basis
for a New Model of Personality
and Work Life.
Front. Psychol. 8:1751.
doi: 10.3389/fpsyg.2017.01751

Introduction: The successful “Divergent” sci-fi trilogy by writer Veronica Roth portrays a dystopian and post-apocalyptic society where the population is divided into five groups called “Factions,” each with a specific social role and associated to a specific set of psychological traits. Though fictional, such typology is compelling and may provide a significant contribution to personality studies.

Objectives: To investigate the accuracy of the classification of psychological and sociocultural traits into five Factions as described in Divergent and their potential practical usefulness for understanding work life choices and experiences in organizations.

Method: A total of 217 Brazilian adult men and women of various ages, socioeconomic status and ethnicities were submitted to measures of several psychological and sociocultural variables, as well as of how strongly they supposedly manifest each Faction. The resulting dataset was studied using Smallest Space Analysis (SSA) and Facet Theory.

Results: The Factions were shown not only to be associated to psychological variables in ways consistent with the descriptions from Divergent, but also to be related to specific aspects of one’s work life in organizations.

Conclusion: The five Factions conceived by Roth appear to constitute an original set of constructs that are psychologically valid and, at the same time, of practical use in predicting work life choices and experiences. This justifies engaging in future empirical and theoretical work toward a new scientific model of potential practical value.

Keywords: personality dimensions, Facet Theory, work, fiction, Divergent trilogy

INTRODUCTION

Since their origins in the early 20th Century, personality tests were developed to aid organizations in activities such as personnel selection, career counseling, coaching, team formation, evaluation of group dynamics, leadership training, marketing, and management of the quality of life at work (Mischel, 1968; Kaplan and Saccuzzo, 2010). Currently, personality testing for organizational use

is a thriving global US\$ 2–4 billion dollar industry, in spite of the existence of significant criticism as to its effectiveness and value (The Economist, 2013).

Among the myriad of tests presently utilized in corporations throughout the World, perhaps the most widely used is the Myers Briggs Type Indicator (MBTI), which is also one of the most criticized, particularly in terms of scientific validity and usefulness (Pittenger, 1993a,b; Gardner and Martinko, 1996; Coffield et al., 2004; Morgeson et al., 2007). Also very widely used are the instruments based on the “Big Five” or “OCEAN” personality traits, such as the Revised NEO Personality Inventory (NEO PI-R), the Five-Factor Model Rating Form (FFMRF), and the Big Five Inventory (BFI), which have a much better scientific standing, though it can still be pointed out that they leave something to be desired in terms of theory and practical applications (Hunter et al., 1990; Rosenthal, 1990; Mount and Barrick, 1998; Block, 2010).

Engler (2008) points out that many of the theoretical and even experimental developments in personality studies have come not just from science, but were also originated from a very broad set of concepts and assumptions present in philosophy, religion, and even art. Therefore, future advances in the field may very well arise from ideas inspired by similarly non-scientific sources, including works of pure fiction, with the scientific development and testing of models occurring later. This can be seen as a form of tapping into what Jerome Bruner referred to as the “folk psychology” that emerges in the narratives of a culture (Bruner, 1990).

McCrae et al. (2012) argue that writers of fiction must be able to accurately portray human psychology in order to create good stories. They also demonstrated the existence of characters portrayed in classical literature from Goethe, Voltaire, and Molière that display personalities with psychological coherence, real-life similarity, and even the possibility of a quasi-clinical evaluation according to current personality models.

Crysel et al. (2015) go as far as providing evidence of a fictional writer producing a classification of personality dimensions that seems to mirror at least some elements of scientific personality theories and measures. Specifically, they have shown that the fictional classification of student “houses” described in wildly popular Harry Potter fantasy books seems to have specific and quantifiable associations to different psychometric measures of personality.

Personality types and testing are the central theme in the best-selling trilogy of books written by American fiction writer Veronica Roth, namely, *Divergent*, *Insurgent*, and *Allegiant* (Roth, 2013), which has recently been adapted into a very successful motion picture franchise (The Wrap, 2014). In the series, the fictional dystopian and isolated city of Chicago divides its people into five “Factions,” named Abnegation, Amity, Candor, Dauntless, and Erudite, each of which corresponds to a specific personality type and relates to a specific set of functions in society. The psychological typology presented in this literary work is very compelling, and it is considered as one of the main reasons for its success (Dominus, 2011). The *Divergent* Series Complete Collection even includes a small, non-validated, test, called “Faction Quiz,” aimed at identifying the reader’s

propensity toward each of the Factions (Roth, 2013). There are commentators that have already perceived the Factions as having some analogies to the Big Five personality dimensions (Freeman, 2012) and to the VIA Classification of Character Strengths and Virtues (Niemi, 2014).

The present paper investigates the scientific validity of the Factions, as described in the *Divergent* series and measured through the Faction Quiz, in terms of being dimensions that might be associated in specific ways to psychological measures of personality, values, emotional regulation, cognition, and behavior. It also aims to assess how effective such a system might be in terms of a practical use for people management in organizations, particularly predicting an individual’s professional choices and work life experiences.

An early version of this investigation, addressing only the preliminary results regarding the associations between the Factions and psychological variables, has been presented at the 15th International FTA Conference (Souza and Roazzi, 2015). The present paper, on the other hand, includes all the findings, variables, analyses, and interpretations of the study, plus those pertaining to professional choices and work life experiences.

Human Personality and People Management

The concept of personality can be seen as the very core of Psychology (Atkinson et al., 2000; Santrock, 2008; Feist and Gregory, 2009). Even though there is no universally accepted definition for the term, most authors would agree that it entails a set of individual traits that act upon motivational, emotional, cognitive, and behavioral processes to produce a consistent pattern of thought and action throughout one’s existence, something that involves self-perception, values, and attitudes (Krauskopf and Saunders, 1994). Such traits are also generally defined as being relatively stable in time and exclusive to each person (Feist and Gregory, 2009).

The relevance of the concept of personality for People Management comes from the fact that individual traits can both influence and be influenced by an organization (Paz, 2004). Career counseling, coaching, team formation, evaluation of group dynamics, leadership training, marketing, and management of the quality of life at work are just some of the practical applications of the knowledge on the subject (Mischel, 1968; Kaplan and Saccuzzo, 2010). There are also several studies attempting to associate personality factors to the performance of personnel selection for various careers, as well as to professional success (Santos et al., 2003). Others try to identify the impact of organizational configurations of social power and personality types on the well-being of a company (Dessen and Paz, 2010).

Personality Theories, Models and Tests

The Big Five

The Big Five model of personality traits arose from a study done by Sir Raymond Cattell with 171 adjectives in the English language referring to stable and observable individual traits, from which he built the Sixteen Personality Factor Questionnaire (16PF). By means of multivariate analysis, he discovered five

factors that could explain most of the variance in the personality data produced by the 16PF (Tupes and Christal, 1961), a finding later confirmed by Walter Norman (Norman, 1963). In 1980, Lewis Goldberg, Naomi Takemoto-Chock, Andrew Comrey, and John M. Digman revised all the personality measurement instruments available at the time and concluded that the most promising ones were, again, those that contained five factors, similarly to what was previously found by Cattell and Norman (Goldberg, 1980, 1981), which eventually lead to the widespread dissemination and acceptance of the model.

As summed up by Goldberg (1980, 1981) and Digman (1990), the Big Five model identifies five personality factors with the following traits:

- **Openness to Experience:** Intellectual curiosity, creativity, and a preference for novelty and variety, as well as an appreciation of art;
- **Conscientiousness:** Self-discipline, emphasis on duty and obligation, aim for achievement, and a preference for planned rather than spontaneous behavior;
- **Extraversion:** Tendency toward positive emotions, assertiveness, sociability, talkativeness, and search for the company of others, its opposite being Introversion;
- **Agreeableness:** Inclination to being compassionate, cooperative, trusting, and helpful, having a concern for social harmony and getting along with others;
- **Neuroticism:** Tendency toward states of anger, fear, and/or depression, vulnerability to anxiety, its opposite being Stability.

The Big Five personality traits have been associated to mental health (Saulsman and Page, 2004), academic achievement (Komarraju et al., 2011), and work success (Hunter et al., 1990; Rosenthal, 1990; Mount and Barrick, 1998), an indication of both the validity and usefulness of the model. However, there is still criticism as to the lack of an actual theory of personality to explain the five factors (Block, 2010), the occurrence of correlations between the traits (van der Linden et al., 2010), the evidence of possible additional traits (Paunonen et al., 2003; Santrock, 2008), and limited applicability for personnel selection (Morgeson et al., 2007).

The Myers-Briggs Type Indicator

The Myers Briggs Type Indicator is one of the most widely used in the American and Western European corporate environment (Morgeson et al., 2007; The Economist, 2013). It was originally based on the theory of psychoanalyst Carl Gustav Jung regarding the psychological types, though it later evolved to become a distinct and separate model (Myers and Myers, 1980).

According to Myers and McCaulley (1985), the MBTI assumes that human personality is based on four independent dichotomous functions, namely: Introversion(I)-Extraversion(E), Sensing(S)-Intuition(N), Thinking(T)-Feeling(F), and Judging(J)-Perceiving(P). The basic premise is that people tend to have traits that are situated in one of the two extremes of each function, thereby producing a total of 16 possible combinations ($2 \times 2 \times 2 \times 2$) that would constitute a fundamental typology for human personality (Myers and

Myers, 1980; Myers and McCaulley, 1985). It is also assumed that the four functions follow a hierarchy of dominance, so that a given individual will have one primary function that is the most conscious, secondary and tertiary functions that are intermediate, and a quaternary one that is the most unconscious.

In spite of its immense popularity even within the corporate world, there is strong scientific criticism aimed at the MBTI, particularly regarding its questionable statistical validity, low test-retest reliability, and dubious or biased evidence as to its practical value in professional and organizational contexts (Pittenger, 1993a,b; Gardner and Martinko, 1996; Coffield et al., 2004).

Other Influential Models

There are many personality theories, models, and instruments that, even though not as widespread as the MBTI and the Big Five, are also commonly used in organizations. Some of them are:

- **RIASEC Vocational Model or Holland Codes** (Holland, 1973): Stipulates six personality types, i.e., Realistic (Doers), Investigative (Thinkers), Artistic (Creators), Social (Helpers), Enterprising (Persuaders), and Conventional (Organizers), organized into a circumplex model represented as a hexagon;
- **Type A and Type B Personality Theory** (Friedman, 1996): Proposes that people are either intense, hard-driving, competitive and high-achieving personalities (Type A) or relaxed, less competitive, and transcendent ones (Type B);
- **HEXACO Model of Personality Structure** (Ashton and Lee, 2008): Considers the Big Five dimensions plus a sixth called Honesty-Humility;
- **VIA Classification of Character Strengths and Virtues** (Peterson and Seligman, 2004): Based on Positive Psychology (Snyder and Lopez, 2007), it identifies an individual's profile within a set of six dimensions (Wisdom and Knowledge, Courage, Humanity, Justice, Temperance, and Transcendence);
- **Enneagram** (Wiltse and Palmer, 2011): Model of human personality comprised of nine interconnected types (Reformer, Helper, Achiever, Individualist, Investigator, Loyalist, Enthusiast, Challenger, and Peacemaker) that lacks consistency in its definition and interpretation, being difficult to submit to scientific scrutiny.

All of these models have in common the fact that they seem to lack credible and unbiased empirical evidence for their psychological validity and/or their usefulness in clinical or organizational settings.

Possible Scientific Value of Literary Fiction

Engler (2008) points out that most personality theories have a basis on a very broad set of assumptions originating from philosophy, religion, and even art. She notes that this is a natural process in the development of scientific knowledge, one that, *per se*, does not imply any lack of scientific rigor, as long as certain methods and criteria are met in the development and evaluation of such models.

Jerome Bruner proposed that the way people make sense out of life and organize their activities in daily existence is by means of a set of beliefs and practices that he referred to as “folk psychology,” a cultural phenomenon that is constructed and expressed through narratives (Bruner, 1990). Literary texts are of particularly great importance in this process as both a cause and an effect, for authors and readers simultaneously manifest and change the understanding of the self and others in themselves and in society as a whole (Bruner, 1986).

McCrae et al. (2012) argue that a literary author must provide a relatively accurate portrayal of persons and their reactions to events in order to write engaging and successful stories, something which requires from them the ability to think psychologically and to communicate their insights to others. They also quote third-party evidence, as well as results from their own empirical investigations, showing that independent assessments from different personality psychologists regarding the traits of the same literary characters (evaluated based on the traits of the NEO Inventories of the Five Factor Model) yielded similar results in the case of Goethe’s Faust, Moliere’s Alceste, and Voltaire’s Candide.

Crysel et al. (2015) took the matter one step further by evaluating the validity of a fictional system of classification in terms of identifying real-life personality traits. They considered, within the context of the extremely successful Harry Potter fantasy books, the Hogwarts school four communities or “houses” (Gryffindor, Hufflepuff, Ravenclaw, and Slytherin), that are presented as corresponding to characters’ specific traits. Their findings indicate that an individual’s inclination toward Ravenclaw was associated to measures of Need for Cognition, whereas the inclination toward Slytherin was related to measures of the Dark Triad traits, both results being in accordance with the depiction of such “houses” in the stories. Though some additional expected associations were not confirmed (i.e., Gryffindor with Extraversion and Openness, as well as Hufflepuff with Need to Belong), the authors concluded that fiction can reflect real underlying personality dimensions.

All things considered, it would seem that fictional literature can be the source of coherent and realistic depictions of human personality traits, as well as provide relevant insights into the functioning of human psychology to the point of creating systems of classification with some scientific value.

The Divergent Series

Origins and Psychological Inspiration

Divergent is a young-adult dystopian novel series written by the American author Veronica Roth, and later turned into a movie franchise, that was very well received by the public and critics (The Wrap, 2014; Dominus, 2011).

Roth (2011) declared that her inspirations for the plot in the Divergent trilogy included an interest in government systems that divide people into classes or castes and “an obsession with personality tests,” particularly the Meyers-Briggs Type Indicator and the Enneagram. She also was taking an introductory course in psychology at the time of writing, and was particularly impressed with exposure therapy in the treatment of phobias

and the Milgram experiment on obedience to authority figures (Dominus, 2011; Roth, 2011). However, she never intended to produce or reproduce a theory or model of human personality, nor has she ever made any claims regarding the scientific validity or practical value of the concepts presented in her literary work.

Story Background

The story of the Divergent trilogy is set within the dystopian, isolated, post-apocalyptic city of Chicago, where order is maintained by dividing the population into five Factions, each with its own values, patterns of behavior, social functions and personality traits of its members. At the age of 16, every individual is required to, with the help of a personality test, choose to which Faction he or she wants to belong to and live with for life. Failure to live up to the standards of one’s Faction will lead to expulsion, making one “Factionless” and socially excluded, a fate considered to be “worse than death.” The plot of Divergent revolves mainly around the fact that the protagonist (“Beatrice Prior” or “Tris”) has inclinations toward Abnegation, Dauntless and Erudite all at the same time, instead of to just one of the Factions, which means facing possible persecution and death (Roth, 2013).

The Factions

A brief list of each Faction, its social function, and main psychological characteristics that are attributed to them, as idealized by Roth (2013) is summarized in **Table 1**.

Roth (2013) describes the five Factions in Divergent as philosophical responses to the human faults considered to be “the cause of all the evil faced by humankind.” Each Faction has its own “Manifesto” which states its belief in the overwhelming relevance of the particular vice it stands against and how they propose to overcome it. Thus, Abnegation fights selfishness with selflessness, Amity counters aggression with pacifism, Candor combats duplicity with honesty, Dauntless opposes cowardice with bravery, and Erudite attempts to defeat ignorance with knowledge (Roth, 2013). It is relevant to note that the plot seems to lead the author of the books, perhaps unwittingly, toward a more profound depiction and characterization of Abnegation, Dauntless and Erudite than of Amity and Candor.

The Faction Quiz

In annex to The Divergent Series Complete Collection is the Faction Quiz (Roth, 2013), which contains seven questions with five possible answers each, one for every Faction. It was designed specifically to help the reader have a feeling of his or her inclination toward each of the five Factions. The form corresponds to the allocation of seven points into five categories, so that each Faction may receive as little as zero points and as many as seven, though the more points one assigns to one Faction, the fewer are left to be assigned to another. This is a non-validated instrument created solely for the purpose of entertainment, but that can be considered as a legitimate measure of the concept of each Faction as defined by Roth (2013).

TABLE 1 | Summary of the Factions based on descriptions by Roth (2013).

Faction	Social functions	Psychological characteristics
Abnegation (The Selfless)	Government, public service and social assistance	Altruism, support of others, focus on duties and obligations, attention to details, organization, self-discipline, religiousness
Amity (The Peaceful)	Agricultural production, counseling and caretaking	Pacifism, valuing social harmony, forgiveness, desire to please, taste for pleasure and entertainment, hedonism
Candor (The Honest)	Application of the Law and trials	Frankness, honesty, energy, seeking attention and interaction with others, positive emotions, talkativeness
Dauntless (The Brave)	Defense and maintenance of order	Thrill-seeking, courage, capacity to overcome fear, competitiveness, assertiveness, importance given to physical fitness
Erudite (The Intelligent)	Teaching, research, technology, medicine and librarianship	Intelligence, curiosity, eloquence, appetite for knowledge and information, creativity, critical thinking, appreciation of art

RESEARCH PROBLEM

Considering the notion that personality theories tend to naturally come from philosophy, religion and art (Engler, 2008), and that such sources can be seen as having the potential to tap into elements of folk psychology (Bruner, 1986, 1990), due to the need to depict credible psychological traits for fictional characters (McCrae et al., 2012), it makes sense to investigate the possible scientific value of compelling fiction in terms of providing a basis or inspiration for useful models (McCrae et al., 2012; Crysel et al., 2015).

The Factions system in the *Divergent* series (Roth, 2013) might very well serve as a source of concepts for a new and improved scientific understanding of human personality. The basic idea is that humankind has five fundamental flaws which threaten its collective existence: selfishness, aggression, duplicity, cowardice and ignorance. To counter them, there are five corresponding broad sets of values, behaviors and traits from which five specific forms of functioning in society emerge. From the descriptions in **Table 1**, one can argue that:

- Abnegation is characterized as being the rigorous adherence to an ethos of altruism, steering one's actions toward effectively helping others, generally with a religious attitude. This implies core values regarding being supportive of the needs of fellow human beings even in detriment of one's own needs, something tied to cultural traditions that focus on the community, emphasize discipline, favor social stability and manifest themselves in concrete practices. A substantial level of self-control is required for that, implying in strong mechanisms of emotional regulation and a high level of Conscientiousness. This would favor a lower level of Neuroticism (or a higher level of Stability). On the other hand, the introjection and internalization of such values would be expressed as a higher level of Agreeableness.
- Amity is simplistically described as being essentially oriented toward social harmony, individual happiness and hedonism. As such, its is associated to values regarding the satisfaction of personal desires and interacting well with others, as well as to the time spent on rest and relaxation.
- Candor is basically depicted as being frank and outgoing, seeking the attention of others. This essentially corresponds

to Extroversion in the Big Five model. It is perhaps the Faction that was least elaborated.

- Dauntless is conceived as being assertive, competitive and thrill-seeking, with a great attention to physical prowess and feats. Therefore, it is expected to be associated to valuing status and influence, sexual activity, and being an “adrenaline junkie.” It is also expected to be associated to dedicating time toward attaining physical fitness.
- Erudite is defined as an inclination toward all things intellectual, scientific and technological, which suggests that it encompasses traits regarding cognitive ability and skills, educational attainment, and the relationship with technology and the Digital Revolution. It is to be expected that such traits be related to personal values regarding the acquisition of knowledge and the appreciation of art, as well as pertaining to the development and use of one's potentials in that regard. This would translate into dedicating more time to professional work, which would tend to be mental in nature, as well as to “extracurricular” or “dilettante” interests. In the Big Five Model, these characteristics are within the realm of Openness to Experience.

It is, therefore, possible that the Factions constitute a classification of traits that can be regarded as an “anatomy” of human personality that categorizes cognition, relationship with knowledge and technology, emotional regulation, values, and the allocation of time, as well as to the Big Five dimensions.

It should be noted that the best available models of personality are frameworks where one considers multiple dimensions of personality that are present, to varying degrees, within each individual, rather than a mere classification of people into just one of multiple types (Goldberg, 1980, 1981; Digman, 1990; Pittenger, 1993a,b; Gardner and Martinko, 1996; Coffield et al., 2004). This is in agreement with the main plot of the *Divergent* series, where the idea of classifying every member of a population into one of five mutually exclusive Factions ultimately fails (Roth, 2013). Thus, in the present paper the choice was made to study the accuracy of the Factions system in terms of constituting relatively independent overarching dimensions of personality rather than as types *per se*.

It is also worth observing that the design of the Faction Quiz allows for only seven possible items per Faction, plus a scoring system that creates artificial negative correlations

between Factions, both things making it difficult to perform a meaningful traditional factor analysis of the relational structure or to calculate reliability score through a Cronbach Alpha (Cronbach, 1951; Kline, 2000; Voss et al., 2000; Swailes and McIntyre-Bhatty, 2002). This implies a lower level of precision (i.e., a higher level of dispersion) in the evaluation of the dimensions assessed, even though there are precedents for valid instruments using such format (e.g., Belbin, 1990). However, the Faction Quiz has the virtue of being a legitimate reflection of the classification introduced by Roth (2013). Furthermore, if the constructs appraised are robust, their relationship to other psychological variables might be strong enough to emerge even if measured under a relatively high margin of error. Thus, it is reasonable to attempt to use such an instrument in preliminary evaluations of validity and, in finding encouraging initial results, later produce an improved version of the test.

STUDY GOALS

The present study has two aims. The first is to scientifically investigate the accuracy of the Factions, as described in the Divergent trilogy and measured by the Faction Quiz (Roth, 2013), in terms of describing specific combinations of cognition, relationship with knowledge and technology, emotional regulation, values, and the allocation of time that may be considered as constituting overarching personality traits. The second is to assess the practical usefulness of these Faction dimensions for the understanding of social life, particularly in the context of work life choices and experiences in organizations.

MATERIALS AND METHODS

Participants

A total of 217 individuals from the Metropolitan Area of Recife, Pernambuco, Brazil, being 101 men (46.5%) and 116 women (53.5%), with a mean age of 35.7 years ($SD = 14.52$). Roughly 40.6% had fundamental level of schooling, 17.5% high school, 20.7% a higher education degree, and 21.1% a graduate degree.

Materials

The following instruments were chosen to measure sociodemographics, cognition, relationship with knowledge and technology, emotional regulation, values, allocation of time, the Big Five dimensions, and work life, most selected due to their practicality in terms of quickly and easily assessing the desired variables, as well as because of validity:

- **Sociodemographics and Work Life Form:** An especially prepared form containing questions regarding sex, date of birth, marital status, income, religion, level of education, field of education, type and segment of occupation, position at work, job satisfaction, satisfaction with relationships at work, and personal time dedicated to sports/physical exercise, work, sleep, and other activities;
- **Hyperculturality Form (Souza et al., 2012):** A form containing questions regarding one's relationship with

Information and Communications Technologies (ICT) and the sociocultural elements created around them, from which one can calculate the following measures:

- o **Hypercultural Index:** The level of internalization of the thinking and acting of the Digital Age, which includes mastery of the use of ICT, scientific and mathematical thinking, abstract thought, multitasking, and fragmentation of knowledge;
- o **Experience With ICT:** The number of years passed since one began to use computers regularly;
- o **Digital Precociousness:** The inverse of the age in which one began to use computers regularly.
- **Mini IQ Test (Souza et al., 2010):** A very short intelligence test containing a total of five questions involving mental reversal of images, use of geometric knowledge and visualization, word analogies, and mathematics;
- **General Knowledge Test (Souza et al., 2010):** A short test containing 10 simple "true" or "false" questions in high school mathematics, physics, chemistry, biology, history, geography, Portuguese, and English;
- **Basic Values Questionnaire (Gouveia et al., 2013):** An instrument designed to measure basic human values according to the Functionalist Theory, comprising 18 specific values or markers to be self-appraised on a scale that varies from 1 (totally unimportant) to 7 (highest importance), such values being:
 - o **Affectivity:** Have a deep and lasting affective relationship; have somebody to share one's successes and failures;
 - o **Beauty:** Be capable of appreciating the best of art, music and literature; go to museums or expositions where one can see beautiful things;
 - o **Belonging:** Get along with one's neighbors on a daily basis; being part of a some social, sporting or other type of group;
 - o **Emotion:** Enjoy challenging danger; seek adventure;
 - o **Health:** Concern with one self's health even before one becomes sick; not being physically or mentally ill;
 - o **Knowledge:** Search for updated news regarding little-known subjects; try to discover new things about the World;
 - o **Maturity:** Feel that one has attained one's objectives in life; develop all of one's capacities;
 - o **Obedience:** Fulfill one's day-to-day duties and obligations; respect one's parents, superiors and elders;
 - o **Personal Stability:** Be certain that tomorrow one will have all one has today; have an organized and planned life;
 - o **Pleasure:** Enjoy life; satisfy all one's desires;
 - o **Power:** Have power to influence others and control decisions; to be the head of a team;
 - o **Prestige:** Know that many people know and admire you; in one's old age, receive a tribute for one's contributions;
 - o **Religiosity:** Believe in God as the savior or humanity; fulfill God's will;
 - o **Sexuality:** Have sexual relations; obtain sexual pleasure;

- o **Social Support:** Obtain help when one needs it; feel that one is not alone in the World;
 - o **Success:** Achieve what one proposes oneself to obtain; be efficient in all one does;
 - o **Survival:** Have food, water, and be able to sleep well every day; live in a place with an abundance of food;
 - o **Tradition:** Follow the social norms of one's country; respect the traditions of one's society.
- **Ten Item Personality Inventory (Gosling et al., 2003):**
A standardized brief measure of the Big Five dimensions (Openness, Conscientiousness, Extraversion, Agreeableness, and Stability), that was structurally validated in Brazil by Souza et al. (2013);
 - **Emotional Regulation Questionnaire (Gross and John, 2003):**
A standardized measure of emotional regulation, validated in Brazil by Boian et al. (2009), that yields two measures.
 - o **Emotional Suppression:** Tendency to regulate emotions by means of controlling their expression;
 - o **Cognitive Reappraisal:** Regulation of emotions by means of the reinterpretation of the underlying situation.
 - **Faction Quiz (Roth, 2013):** Questionnaire with seven questions designed to measure one's inclination toward each of the Divergent series Factions (Abnegation, Amity, Candor, Dauntless and Erudite), generating a 0–7 score for each based on the answers, but also allowing the calculation of a “Divergence” score based on the inverse of the mean deviation of the scores given to each faction.

Procedures

A total of 16 students from the Graduate Program in Business Administration of the Federal University of Pernambuco, approached the subjects in the streets of the Metropolitan Area of Recife, Pernambuco, Brazil, explained the nature and purpose of the investigation, invited them to participate, and applied the instruments to those who accepted. The application was done in various locations according to convenience, but always within the setting of a quiet room with a closed door and a place to sit and write. The experimenters were each instructed to collect anonymous data on 16 subjects, to be equally divided into: (a) men and women, (b) those aged 30+ years and those younger, and (c) those with intermediate level of education or more and those with less schooling. A total of 256 subjects were obtained, leading to a final dataset of 217 after 39 were discarded due to incomplete or incorrect records.

Analysis

Social and human phenomena are typically extremely complex due to the large amount of variables involved and the intricate covariance between them. Usually, the relationship between variables A and B seems to depend on the relationship between each of them and other variables, which interact in a similar fashion with yet other variables, and so forth. The major challenge is to find overarching patterns in a broad and convoluted set of observations to inspire and/or put to test scientific models

regarding mechanisms and processes. The prominent Israeli-American mathematician, sociologist and psychologist Louis Guttman developed a theoretical-analytical framework, called Facet Theory, which addresses precisely such issues. It allows for a spatial representation of the relational structure of a large number of variables simultaneously. This is achieved through the concept of a “mapping sentence,” which permits the identification of clusters, latent variables, and/or constructs by means of a simple partitioning of the geometric representation of a multivariate space. Such space can consist of literally any kind of data, form of relationship, and measure of association, visually expressing all the relationships, including covariances, in a very intuitive way (Guttman and Greenbaum, 1998; Levy, 2005). It has significant advantages to Factor Analysis and Cluster Analysis in terms of weaker assumptions, more precise expression of associations, and the better integration of the findings to a theoretical framework (Guttman, 1992; Maslovaty et al., 2001; Borg and Groenen, 2005).

The current investigation included 68 variables of different types (psychological, sociodemographic, organizational), measured in different scales (dichotomous, ordinal, ratio), and with both linear and non-linear relationships between them. Additionally, the large number of variables measured introduces numerous possible confounding factors and mediation effects that render simple bivariate analysis virtually meaningless.

Considering all the above, plus the fact that the groupings of variables that were derived from the descriptions of each Faction in **Table 1** constitute a veritable mapping sentence, the decision was made to use SSA and Facet Theory as the approach to deal with both the scope and the complexity of the data involved, with Stasoft Statistica 10 as the software tool.

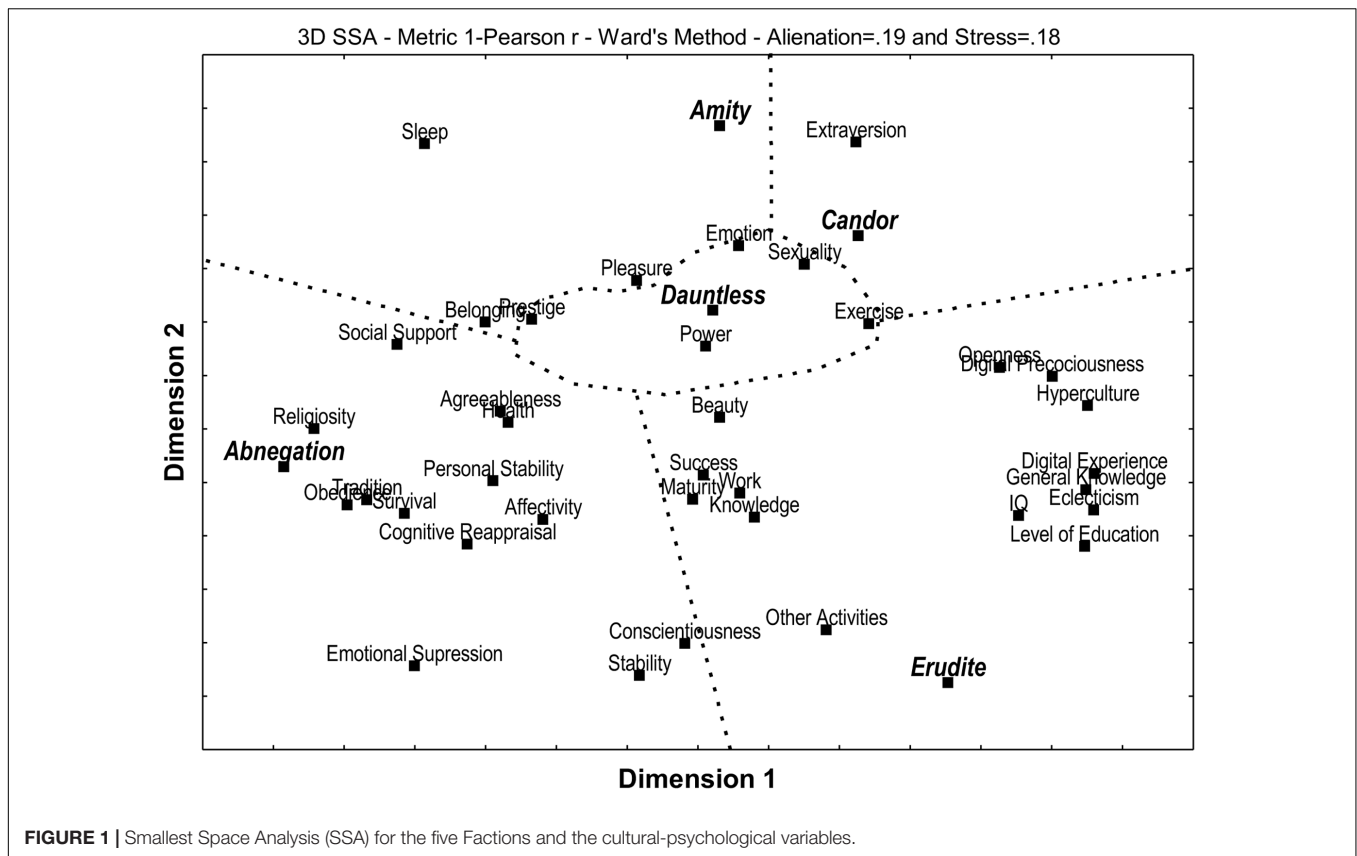
For each SSA, the solution chosen was the one with the lowest number of dimensions that still obtained levels of Alienation and Stress below 20, considered reasonable for the relatively large number of variables involved. Dimensions 1 and 2 were privileged because this view of the multidimensional space approximates very well what is to be found in a two-dimensional solution, which is simpler to interpret. Multiple projections are possible, but one is not required to explore all them to validate the interpretation of one (Guttman and Greenbaum, 1998; Borg and Groenen, 2005; Levy, 2005).

RESULTS

Factions vs. Psychological Variables

Figure 1 shows an SSA displaying the multiple relationships between the scores obtained for each Faction on the Faction Quiz and the measures of: the Big Five personality traits, basic human values, emotional regulation, IQ, hyperculturality, general knowledge, level of education, eclecticism (no. of different fields in which one has some level of formal education), and use of time (for exercise, sleep, work, and other activities).

One can partition the SSA space in **Figure 1** into five contiguous regions, one for each Faction and its specific set



of cultural and psychological variables as indicated by Roth (2013). The resulting structure is a radix (combination of polar and modular structures) with Dauntless at the center and the remaining Factions surrounding it.

Abnegation was in the same partition as the basic values of Obedience, Tradition, Religiosity, Survival, Social Support, Personal Stability, Health and Affectivity. It was also linked to both aspects of emotional regulation that were measured, namely, Cognitive Reappraisal and Emotional Suppression, as well as to the personality dimensions of Agreeableness, Conscientiousness and Stability.

Amity was linked to the values of Belonging and Pleasure, along with the time dedicated to sleep.

Candor was grouped only with the Big Five dimension of Extraversion.

Dauntless was related to the values of Emotion, Power, Prestige and Sexuality, and also to the time spent on physical exercise or sports.

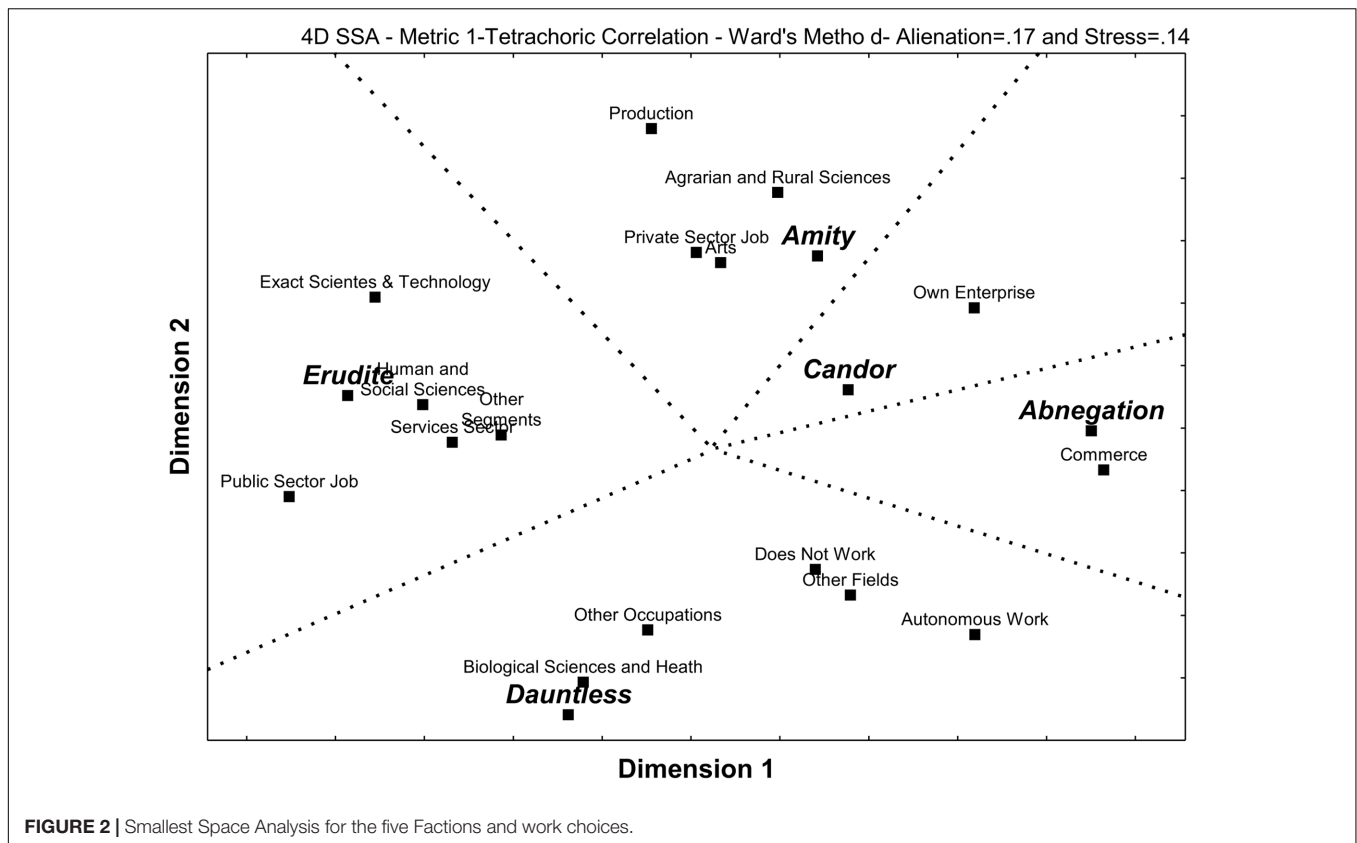
Erudite was in the same partition as the cognitive variables of IQ, General Knowledge, as well as Digital Age, Digital Precociousness and Hyperculture, along with level of education and Eclecticism. It was also linked to the Big Five dimension of Openness to Experience, along with the values of Knowledge, Maturity, Success and Beauty. There was a link to the amount of time spent working, plus to the time spent on activities other than work, exercise or sleep.

Factions vs. Work Choices

Figure 2 shows an SSA displaying the multiple relationships between the scores obtained for each Faction on the Faction Quiz and the field of education, type of occupation, and segment of work. Given that most of these variables are dichotomous, here the scores for each Faction were dichotomized at the median so as to establish a common denominator.

Here one can partition the SSA space in **Figure 2** into five contiguous regions, one for each Faction and its specific set of work choices. The resulting structure is a polar pattern.

Abnegation was associated to working in commerce. Amity was linked to having a background in Agrarian and Rural Sciences and/or in Arts, as well as with having a Private Sector Job or one in Production. Candor was related to having one's Own Enterprise. Dauntless was linked to a background in Biological Sciences and Health, and/or to one in a field other than Exact Sciences and Technology, Biological Sciences and Health, Human and Social Sciences, Agrarian and Rural Sciences or Art; it was also associated to Autonomous Work, occupations other than Private Sector Job, Public Sector job or Autonomous Work, and to not working. Erudite was associated to a background in Exact Sciences and Technology, but also to one in Human and Social Sciences, as well as to working in the Services Sector and likewise to working in sectors other than Services, Commerce or Production.



Factions vs. Work Life

Figure 3 shows an SSA displaying the multiple relationships between the scores obtained for each Faction on the Faction Quiz and income per year at job, hierarchical position at work per year at job, job satisfaction, and satisfaction with relationships at work.

One can partition the SSA space in **Figure 3** into five contiguous regions, one for each Faction and its specific set of work life experiences. The resulting structure is a polar pattern.

Amity and Dauntless were associated with each other and to Divergence, but not to any particular aspect of work life experiences. Abnegation was linked to General Job Satisfaction, Satisfaction w/ Activities, Satisfaction w/ Wages, Satisfaction w/ Promotions, and Satisfaction w/ Perspectives. Candor was related to Relationship w/ Boss, Relationship w/ Colleagues, and Relationship w/ Subordinates. Erudite was linked to Income per Year at Job and Position per Year at Job.

DISCUSSION

The Factions in Divergent and Their Psychological Associations

The Psychology of Abnegation

Figure 1 shows that the basic human values associated to the scores in Abnegation were Tradition and Obedience (a tendency for self-discipline and conformity), Social Support and Affectivity (a need for interpersonal security), Survival, Health and Personal

Stability (material pragmatism), and Religiosity (belief in God). This Faction was also related to the two types of emotional regulation, that is to say, Cognitive Reappraisal and Emotional Suppression (both indicative of self-control), and to the Big Five personality dimensions of Conscientiousness (discipline, organization and a focus on duty), Agreeableness (concern for others) and Stability (impulse control and ability to deal with negative feelings).

The Psychology of Amity

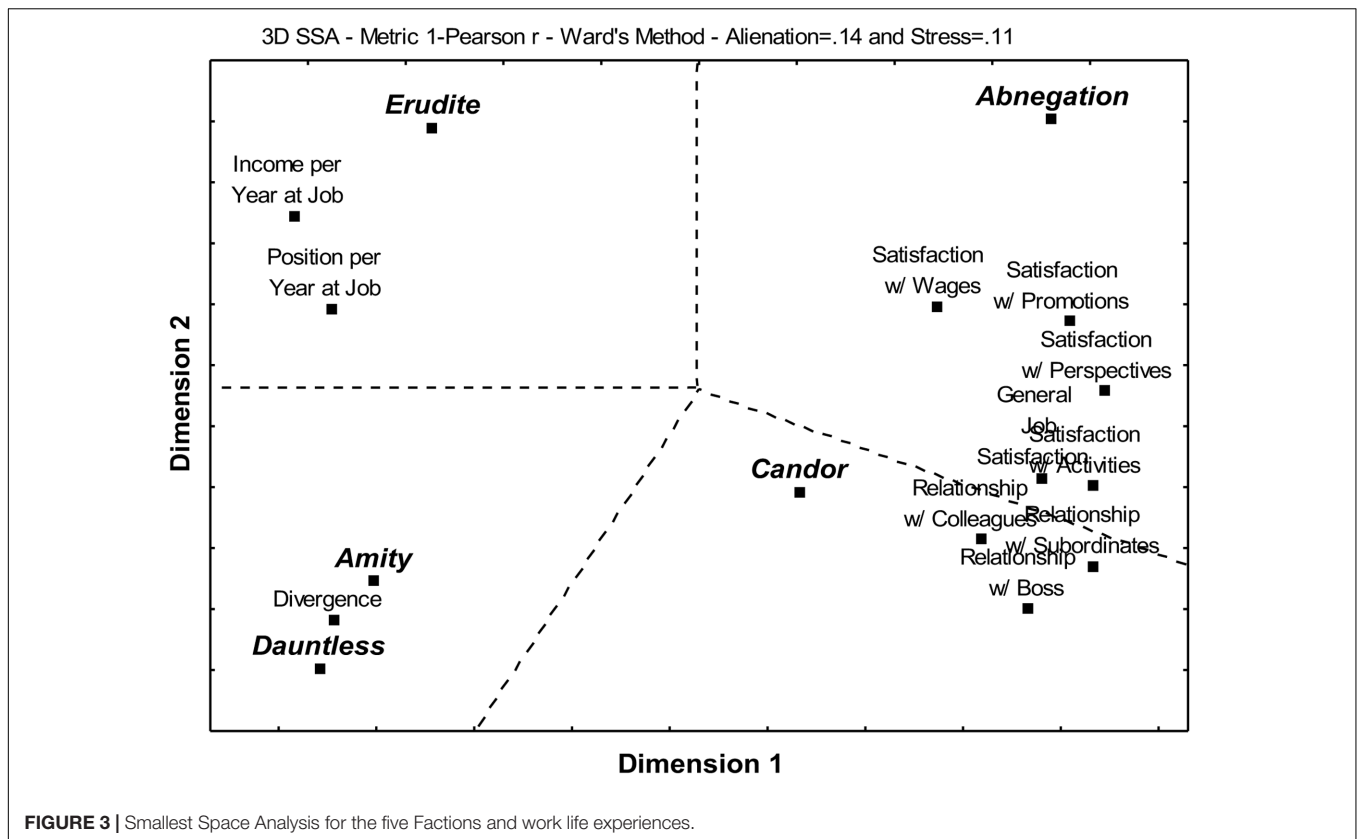
Figure 1 shows that the Amity scores were related to the human values of Belonging (need to be a part of a group and to get along well with others) and Pleasure (hedonism). There was also an association with the time spent sleeping (rest).

The Psychology of Candor

In **Figure 1**, Candor scores were shown to be associated to the Big Five dimension of Extroversion, indicating assertiveness, talkativeness, frankness, and a tendency toward seeking company and attention.

The Psychology of Dauntless

Figure 1 shows Dauntless as linked to the moral values of Power (aspiration to leadership and desire for influence), Prestige (seeks to impress others), emotion (search for excitement) and Sexuality (interest in sex). It was also associated to the time spent on physical exercises and the practice of sports (fitness and athleticism).



The Psychology of Erudite

In **Figure 1**, Erudite was shown to be associated to IQ, Level of Education, Eclecticism, Digital Experience, Digital Precociousness, and Hyperculture (cognitive ability and skills). It was related to the basic values of Knowledge (maintain one's self updated and discovering things about the World), Maturity (attaining one's goals and developing one's full capacity), and Beauty (appreciation of the best of art, music and literature in museums or expositions). There were also links to the Big Five dimension of Openness to Experience (intellectualism, preference for novelty and variety, and appreciation of art). This Faction was likewise associated to the amount of time spent working (perhaps skilled, technical or otherwise intellectual in nature), plus to the time spent on activities other than work, exercise or sleep (possibly studying, creating and/or engaging in intellectual pursuits).

Validation of Faction Psychology and Potential Additional Insights

The findings of the present study strongly suggest the existence of a remarkable similarity between the psychological profile of the Factions as conceived by Roth (2013) and the actual associations that were observed between the results of the Faction Quiz and the various psychological measurements that were made. For each Faction, one can find a statistical link either to variables that are a direct expression of that Faction's stated characteristics and behaviors, or to psychological

mechanisms that clearly explain them. In fact, the Factions were more scattered through the multidimensional space of **Figure 1** than the Big Five dimensions, indicating that former have greater explanatory power than the relatively "clustered" latter.

Furthermore, the radix that was found in **Figure 1** suggests that Amity and Erudite are in direct opposition to each other, as are Abnegation and Candor, with Dauntless playing a prominent role at the center, i.e., positively associated to all of the other Factions. Further studies to determine whether such a structure is circumstantial to the present investigation, as in a characteristic of the particular sample studied, or if it reflects a more generalized characteristic of human personality. In the latter case, it would be necessary to theorize as to the cause, for such a structure is not to be expected directly from Roth (2013), save for the intriguing fact that the plot focuses on Dauntless as the chosen Faction of the main character (which would put it at the center) and that Abnegation and Erudite are the most complex and detailed Factions (making them occupy the greatest portions of the diagram).

Factions and Work

Factions and Social Functions in the Fictional Divergent Universe

In the Divergent trilogy, Roth (2013) assigns specific roles to each of the Factions in the fictional, dystopian and post-apocalyptic city of Chicago (**Table 1**). It is important to be aware that

such designations are made within the context of a simplistic and unrealistic society with equally simplistic and unrealistic organization, production relations, economy, and culture. In a more lifelike scenario (i.e., a far more complex one) there might not be the same links between social functions and Faction personality dimensions as expressed in the literary work. Nevertheless, interesting results in that regard were found in the present study.

Abnegation and Work

Abnegation was associated to working in Commerce (**Figure 2**) and to the satisfaction with the various aspects of work (**Figure 3**), an explanation for which might be found considering the psychological findings regarding this Faction (**Figure 1**).

Psychologically, Abnegation was found to be related to material pragmatism, but also to self-control, discipline and organization, all of which can favor the objective and methodic work commonly found in the jobs in commerce. Besides, this type of activity involves a process of negotiation through which one, to some extent, concedes to the needs of others, this being done within the context of a certain degree of trust between the parties, obedience to common rules, and the support from social mechanism of regulation, all of this resonating with both this Faction's sense of altruism and its need for interpersonal security. On the other hand, the sense of duty and conformity, along with the aforementioned self-control, can lower one's expectations regarding the reward from professional life, or at least one's expression of them, favoring a stronger manifestation of satisfaction at work.

Amity and Work

Amity was linked to having a background in Agrarian and Rural Sciences and/or in Arts, working in Production, and having a Private Sector Job (**Figure 2**), but not with any specific aspect of work life such as satisfaction, relationships or success (**Figure 3**). This is in keeping not only with the psychological profile associated to the Faction (**Figure 1**), but also to its role in the fictional Divergent universe (Roth, 2013).

Amity is explicitly presented by Roth (2013) as the Faction in charge of agricultural production, which is in perfect agreement with the observed tendency for a background in agriculture-related fields and for working in the productive sector. Its members are also described as engaging themselves in art and entertainment, which is in full concordance not only with the empirical observations of the present study regarding a background in arts and work in the private sector, but also with the psychological findings of hedonism.

The lack of association with professional satisfaction, relationships or success can be seen as the consequence of the fact that Amity is not a human dimension that is particularly conducive to great accomplishments in most workplaces, but rather one that is associated to pleasure, conviviality and rest, which, in many cases, may be seen as the opposite of work.

Candor and Work

Candor was associated to being an entrepreneur (**Figure 2**) and to the quality of the relationship with co-workers (**Figure 3**). This

can be considered as consistent with the psychological association found for this Faction (**Figure 1**).

The link found between Candor and Extraversion indicates that this Faction is related to being expansive, energetic and assertive, that is, to wanting to be the focus of attention of others and even to leadership. This may lead to entrepreneurship as a way of occupying center stage and/or for an individual with a high level of this trait to avoid possible conflicts between his or her intense personality and the traditional hierarchical structure of a typical job. The orientation toward social interaction, along with the trust that comes from frankness, can explain the tendency for a good relationship with co-workers.

Dauntless and Work

Dauntless was related to a background in Biological Sciences and Health, and/or to one in a field other than Exact Sciences and Technology, Biological Sciences and Health, Human and Social Sciences, Agrarian and Rural Sciences or Art; it was also associated to Autonomous Work, occupations other than Private Sector Job, Public Sector job or Autonomous Work, and to not working (**Figure 2**), but there was no link to professional satisfaction, relationships or success (**Figure 3**). Such a pattern can be considered as having some relationship to the previously shown psychological findings (**Figure 1**).

The association between Dauntless and the value given to influence and status might explain the decision to take up a prestigious field such as medicine (part of Biological Sciences and Health), whereas the search for danger and excitement, as well as that for physically demanding activities, might drive one for careers in the police or the military (which are not part of the traditional fields of knowledge). Taken to higher level, the thrill seeking and physicality could drive one to more "daredevil" (and, therefore, also less traditional) jobs such as being a professional athlete, mountain climber, stuntman, and so forth, many of which are performed by autonomous professionals. On the other hand, these same characteristics could, under negative circumstances, lead to criminal behavior or prevent one from keeping a job.

Erudite and Work

Erudite was linked to having a background in Human and Social Sciences and/or in Exact Sciences and Technology, working in the Services Segment or in segments other than Services, Commerce and Production, and having a Public Sector Job (**Figure 2**). There was also a relationship with career success at work, as measured by Income per Year at Work and Position per Year at Work (**Figure 3**).

Roth (2013) puts Erudite in charge of all things intellectual, namely, teaching, research, development of technology, medicine and librarianship (**Table 1**), which is in full agreement with the associations of this Faction with a greater depth and breadth of knowledge, a higher level of overall cognitive ability, better insertion into the Information Age, and a constant desire to learn (**Figure 1**). This is also consistent with having a public job, given that, in Brazil, the best universities and research institutes tend to be in the public sector, with working in services having a likewise relationship with being a professor and/or researcher. Furthermore, it resonates with having a background

in science, technology, engineering and mathematics, as well as in psychology, sociology, communication and history, as stated in the Faction's fictional Manifesto (Roth, 2013). It is possible that the finding of a link with working in a sector other than Services, Commerce and Production has to do with being a consultant, which is another professional activity related to knowledge.

The finding that Erudite is clearly associated to job success in terms of climbing positions and pay grades in less time can be explained by the socioeconomic factors such as the strong association between education and income and the emergence of the Knowledge Age, Information Society and Knowledge Economy.

CONCLUSION

The present paper aimed to investigate whether the personality dimensions expressed in the fictional Factions of the Divergent series (Roth, 2013) could constitute a sound, functional and useful psychological framework. For this purpose, a relatively large number of diverse subjects from Recife, Pernambuco, Brazil, were submitted to the Faction Quiz and various instruments that measured Big Five personality traits, basic human values, emotional regulation, cognition, relationship with ICT, sociodemographics, use of time, work choices, and work life experiences.

Multivariate analysis of the dataset using SSA and Facet Theory obtained results that strongly indicate that the Factions, as psychological dimensions associated to the various psychological variables in ways that are very much in agreement with the definitions, descriptions and plot from Roth (2013), perhaps more meaningful than in the case of the Big Five, with regards to associating to a broader scope of variables. Furthermore, they showed specific links to work choices and experiences that are quite consistent with their psychological associations and, to a limited extent, to their social roles in the Divergent universe (Roth, 2013).

It is concluded that the five Factions conceived by Roth (2013) appear to constitute an original set of constructs that not only synthesize various motivational, emotional, cognitive, and behavioral variables in a coherent and meaningful way, but also seem to be of practical value in the understanding of how individuals relate to their work. This suggests that the basic premises underlying the origin and nature of the Factions, that is, as psychosocial responses to the existential threats of selfishness, aggression, duplicity, cowardice and ignorance, might be a valid basis for the development of a new approach to human personality, one with concrete implications for people management in organizations, among other possibilities.

Besides replicating the present study within the context a larger, broader, and more diversified sample, as well as including a wider range of psychological variables, future investigations on the subject should focus on the development of an improved version of the Faction Quiz, capable of more precise and reliable measurements of the dimensions of Abnegation, Amity, Candor, Dauntless and Erudite. It is of even greater importance to create

theories that might explain the causes and functioning of the dimensions in question.

ETHICS STATEMENT

As established by the ethical guidelines for scientific research with human subjects in Article 1, Subsection V, of Resolution no. 510 from the Brazilian National Council on Health, the present study was exempt from registration or evaluation from the country's Council of Ethics in Research and National Council of Ethics in Research due to the fact that no identification of subjects was registered or even asked for, no experimental intervention was done on the participants that might generate any risks above those of daily life, and absolutely no form of diagnosis or counseling was offered either as a consequence of the responses or any other basis. In accordance to international principles regarding research ethics, the participation in the present study was fully informed and strictly voluntary.

AUTHOR CONTRIBUTIONS

Both authors (BdS and AR) equally contributed to all the following issues of the research: conception and design of the work; acquisition, analysis, and interpretation of data; drafting the manuscript and critically revising it; final approval of the version to be published; agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

FUNDING

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: both authors are recipients of the *Bolsa de Produtividade em Pesquisa – PQ* (Research Productivity Scholarship) from the *Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq* (National Council for Scientific and Technological Development) of the Ministério da Ciência, Tecnologia e Inovação (Ministry of Science, Technology and Innovation) of the Brazilian Government (BdS has a Level 2 scholarship and AR a Level 1A).

ACKNOWLEDGMENTS

The authors would like to thank the students of the *Programa de Pós-graduação em Administração – PROPAD* (Graduate Program in Business Administration) of the *Universidade Federal de Pernambuco – UFPE* (Federal University of Pernambuco) that were enrolled in *METHODOLOGY: BASIC STATISTICS* during the 1st semester of 2014, for their help in data collection and tabulation.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Psychocultural Mechanisms of the Propensity toward Criminal Homicide: A Multidimensional View of the Culture of Honor

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OPEN ACCESS

Edited by:

Yael Fisher,
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Specialty section:

This article was submitted to
Theoretical and Philosophical
Psychology,
a section of the journal
Frontiers in Psychology

Received: 27 November 2016

Accepted: 10 October 2017

Published: 01 November 2017

Citation:

Souza MGTC, Souza BC, Roazzi A
and Silva ES (2017) Psychocultural
Mechanisms of the Propensity toward
Criminal Homicide: A Multidimensional
View of the Culture of Honor.
Front. Psychol. 8:1872.
doi: 10.3389/fpsyg.2017.01872

Introduction: Theory of the Culture of Honor is one of the few models in criminology specifically geared toward homicide. It proposes that, in certain societies, men must never show weakness and are required to react violently to any perceived threats to their reputation, thereby increasing their probability of committing a homicide. This has been suggested as the main explanation for the high rates of this type of crime in Brazil, particularly in the Northeast. Underlying this explanation there are complex mechanisms and processes that have yet to be clarified.

Objectives: The present research aimed to investigate the workings of the possible psychocultural mechanisms underlying the culture of honor and the process through which they might affect the individual propensity toward homicide.

Methods: A total of 336 Brazilian adults were assessed regarding a broad range of sociodemographic, psychological, and sociocultural variables, including their attitudes toward homicide. The resulting dataset was analyzed using Smallest Space Analysis and Facet Theory.

Results: It seems that certain cultural elements associated to traditional masculinity and enhanced anger tend to promote negative personality traits and increase one's propensity toward committing homicide.

Conclusion: The findings obtained not only confirm the Theory of the Culture of Honor for the propensity toward homicide, but also explicit and clarify some of the psychocultural processes and mechanisms involved, suggesting a new scientific framework.

Keywords: culture of honor, homicide, homicidal honor, criminology, smallest space analysis, Facet Theory

INTRODUCTION

Homicide is the ultimate form of interpersonal conflict, one that is present in all societies throughout the whole of human history (Durkheim, 1978). Its widespread prevalence in space and time makes it a very relevant social problem with a strong impact on public health, particularly among young males and in developing countries (Dahlberg and Krug, 2002; Pridemore, 2003; Geneva Declaration, 2008; UNODC, 2013; University of Cambridge, 2014).

In Brazil, criminal homicide is a particularly significant problem. According to reports from different sources, the country answers for roughly 10% of the murders on the planet, though it has only some 3% of the population. It is the country with the highest overall incidence of this type of crime, and it is also among the top 10 in terms of occurrences per 100 000 inhabitants (Geneva Declaration, 2008; UNODC, 2013). This reality produces a very significant social and economic burden upon the nation, especially in the Northeastern Region where the rates are highest (UNODC, 2013). Within that portion of the country, the state of Pernambuco has stood out as being one of the most afflicted with the incidence of lethal violence and, though it seemed to experience a 21% drop in the homicide rates between 2007 and 2014 due to specific public policies to address the issue (SEPLAG-PE, 2014), since 2015 there has been a phenomenal rise in spite of the continuation of said policies (Jornal do Comércio, 2015; TV Jornal, 2016). Indeed, even the intellectual authors of the governmental plan against violence in Pernambuco admit that it has significant flaws (Ratton et al., 2014).

There are multiple scientific models attempting to explain the occurrence of homicide, but the Theory of the Culture of Honor is one oriented specifically toward this type of crime and has produced important interpretations in terms of Social Psychology (Cohen, 1996, 1998; Cohen and Nisbett, 1997). It is based on the notion that certain societies develop a culture that demands that its men never show signs weakness and that they react violently to any threats to their reputation, with “honor” being the central point of their life, making homicide an acceptable or even mandatory form of conflict resolution (Reed, 1982). Some authors have pointed to this sociocultural phenomenon as one of the main causes for the alarmingly high levels of violence in the Brazilian Northeast (Alencar, 2006; Magalhães, 2009). Indeed, there is at least one empirical study done in Pernambuco showing that kind of explanation is more successful than competing theories based on socioeconomic frustration, testosterone levels, moral development, basic moral values, emotional attachment, and decision-making processes (Souza et al., 2011, 2016).

The success of the Theory of the Culture of Honor comes, however, with a series of unanswered questions as to the chain of events involved in the interaction between a collective set of mores and individual actions. Though the works of social psychologists Cohen and Nisbett have described differences between young men from locations with or without a strong culture of honor regarding attitudes toward conflict, propensity to anger, and inclination toward violent confrontation (Cohen and Nisbett, 1997), they do not present clear depiction of a specific model for the mechanisms and processes that interlink an individual’s relatively “internal” psychology to the more “external” sociocultural elements in order to produce violent tendencies.

The present paper aims to contribute to the understanding of the psychocultural workings underlying the culture of honor and its tendency to increase an individual’s propensity toward committing homicide. The approach chosen was to

empirically measure one’s internalization of a culture of honor, along with multiple relevant psychological variables (cognition, emotional dynamics, personality) and sociocultural elements (sociodemographics, value assigned to different moral compasses), so as to assess their relationships to each other and to attitudes toward homicide. By using analytical techniques capable of visually expressing the relational structure between multiple variables simultaneously, findings were obtained that can directly inspire a broader scientific model of the phenomenon in question.

A short preliminary version of this work was presented in the 15th Facet Theory Association Conference, 2015, New York, EUA (Souza et al., 2015), the present paper representing a much broader set of theoretical references, empirical results, and theoretical interpretations, as well as the beginnings of a new scientific model.

Culture of Honor and Homicide

The Theory of the Culture of Honor

The theory of the Culture of Honor was initially proposed by John Shelton Reed as a means to explain the fact that, in the late 1800s and early 1900s, some counties in Southern United States had a very high rate of homicides, whilst other counties, sometimes very nearby, did not (Reed, 1982). Based on historical records, he observed that in most of these crimes, victim, and killer knew each other previously and both of them understood the reasons for the killing. Reed also noticed that the communities with the highest historical rates of homicide tended to be those where herding was the main productive activity, as opposed to agriculture. From this he hypothesized that, while in agricultural societies cooperation is a necessity and interpersonal threats to one’s livelihood is relatively low, in societies located in highlands, where the soil is dry and herding is the main source of resources, individual herders are more isolated from each other, and subject to a significant risk of losing their herds to some rival or foe. The rationale is that crops require a significant amount of collective work to be planted, tended, and harvested, plus being relatively difficult to steal in relevant amounts, whereas herds could be looked after by one individual, perhaps with help from the immediate family, but could be stolen in their entirety overnight by an equally small number of people. Given the absence of government to enforce property rights of herd animals in such remote places, in order to avoid becoming a target, an individual had to project the image of being strong, potentially dangerous, and willing to react violently to threats. This means having to always be assertive, aggressive, and defend one’s own standing against any type of challenge. For various biological, evolutionary, and sociocultural reasons, this role traditionally falls upon the adult males. Thus, a Culture of Honor emerges where a man’s reputation is the central point of his work and self-esteem, it being imperative for him to guard it, at all costs, against any possible contention.

In the late 1990s, Richard Nisbett and Dov Cohen not only analyzed social data on homicides that seemed to confirm the theory proposed by Reed (1982), but also did a series

of well-designed experimental studies in social psychology where they compared young men from Southern United States (traditionally a region with high levels of the Culture of Honor) to those of Northern United States (considered to have traditionally lower levels of the Culture of Honor) in regards to their propensity toward aggression and violence in response to insults or outrage (Cohen, 1996, 1998; Cohen and Nisbett, 1996, 1997). By employing actors and building specific scenarios of interaction, their investigations showed that, though both Southerners and Northerners were able to respond with violence, the Southern men were significantly more prone to do so, as well as to support the principle of using violence to correct a wrongdoing, the use of corporal punishment, reduced regulation of gun ownership, and so forth. They also found that such a pattern of behavior was something that occurred even in societies where the historical conditions that favor the emergence of the Culture of Honor had significantly changed during the last century or more, indicating the existence of strong sociocultural mechanisms through which such a culture, once existing, is transmitted from one generation to the next by means of tradition.

It is important not to confuse the Culture of Honor, as described by Reed (1982) and Cohen and Nisbett (1997), with the sociocultural phenomenon underlying the so-called “honor killings” (Baker et al., 1999; Awwad, 2007; Abu-Odeh, 2011), as the two are very distinct, even though they both involve “honor” and social standing. The first revolves around a set of mores that compel men to behave violently toward other men in response to perceived physical and/or moral threats, whereas the second refers to societies where males are expected to kill female relatives that are believed to have dishonored the family through what is deemed as immoral behavior of a sexual and/or rebellious nature. The rates of honor killings are difficult to quantify due to the reluctance in certain communities to report or even to classify the crimes as such, but there is strong reason to suspect they have been on the rise for decades (Chester, 2010; Abu-Odeh, 2011), though, worldwide, the vast majority of homicides have men as victims (UNODC, 2013; University of Cambridge, 2014). The focus of the present study is on Culture of Honor Theory, newly applied to a community in Brazil where there is reason to believe that such a model has significant explanatory power.

Culture of Honor and Homicides in the Brazilian Northeast

Northeastern Brazil, a region where the geography is that of dry and hot highlands, with a history of herding as one of the main productive activities, seems like an ideal place to test the framework suggested by Reed (1982) and expanded by Cohen (1996, 1998) and Cohen and Nisbett (1996, 1997). Indeed, there have been studies suggesting that a Culture of Honor might be the best explanation for the high rates of homicide recorded in the area (Alencar, 2006; Magalhães, 2009; Souza et al., 2011).

Alencar (2006) interviewed a group of 20 men in Northeastern Brazil that had been convicted for homicide and asked them about the motives for their crime. The group of males aged between 20 and 49 years not only reported revenge for

humiliation, threats, and/or aggression as their main reasons to kill, but also expressed the belief that, under the circumstances, their actions were morally justified.

Magalhães (2009) analyzed the influence of “shame” in criminally violent behavior in the Brazilian Northeast. His conclusion was that, in the region in question, dishonor, that is, the loss of social standing and reputation, is not acceptable at all for a man under any circumstances, especially when brought about by others. When faced with such a perspective, the only accepted form of avoiding such a shame is to retaliate the offense with severe and symbolic violence, or, preferably, with death. Such a reaction not only removes the negative shadow that was cast upon the individual when he was subject to the dishonor, but also puts him under a favorable light in the eyes of the community.

An empirical study was done in the state of Pernambuco, in the Brazilian Northeast, to test the efficacy of the Theory of the Culture of Honor, along with theories based on socioeconomic frustration, rationality of the decision-making processes, emotional attachment, testosterone, moral development, moral values (Souza et al., 2011, 2016). A total of 160 adult males (57 convicted for homicide, 63 with other convictions, and 40 without criminal conviction) were submitted to a questionnaire, various psychological tests, and right-hand digit ratio measurements (to estimate testosterone levels). Analysis of the data obtained produced findings indicating that, at least for the study population: (a) homicide is a unique type of crime that doesn’t stem from violence or criminality in general, with violent crimes being more closely associated to non-violent crimes than to homicides; (b) there is usually no characteristic profile for a killer in terms of socioeconomic frustration, decision-making process, attachment, moral values, moral development, or testosterone; (c) the main reason for a homicide is the occurrence of an honor-related motivation, with the motivation for material gain being associated with other crimes (with honor and material motivations shown to be mutually exclusive); and (d) logistic regression models using both honor-related and material gain motivations as predictive variables were capable of correctly identifying more than 80% of the killers in a mixed sample of individuals. Such findings force one to discard all of the theories being tested, save only for the Culture of Honor, which was, therefore, considered as an effective model to explain homicide in the sample studied.

Culture of Honor and Homicide: Integrating Collective and Individual Elements

From the Sociology of Culture to Individual Psychology

Murder is a crime committed by a specific individual or set of individuals toward another individual or set of individuals, therefore, for the Culture of Honor to have an impact on a society’s homicide rate it must necessarily influence internal psychological mechanisms involving volition, cognition, emotion, and behavior. This path from the collective to the

individual is recognized in the literature, which mentions material and economic conditions that favor the emergence of certain traditions and institutions associated to social mores that, through feelings of shame, would lead to the activation of anger and rage, thereby producing an increased propensity toward lethal violence as a response to not just physical, but also moral, threats (Reed, 1982; Cohen, 1996, 1998; Cohen and Nisbett, 1996, 1997). However, the specific interplay of these elements, as well as their details and relational structure, have only been described in a broad manner (Guerra, 2009).

The Internalization of the Culture of Honor by an Individual

Rodriguez Mosquera et al. (2008) have created an instrument called the Honor Scale which measures the degree to which individuals feel threatened, that is, feel shame and anger, as a consequence of different kinds of attack to their honor. It is comprised of four subscales, classified according to the type of honor involved: Family (reputation of close relatives), Social (integrity and honesty), Masculine (assertiveness and sexual prowess), and Feminine (propriety and sexual modesty). Souza et al. (2013) have extracted from the Honor Scale a fifth index, based on a combination of Masculine Honor (scored positively) and Integrity (scored negatively), named 'Homicidal Honor,' which has been positively associated to the propensity toward criminal homicide as approximated by individual experience with homicide (knowledge of authors or victims) and degree of personal condemnation for that type of crime (years of penalty that one would assign to the author of murder under various circumstances).

Honor, Society, and Anger

The Culture of Honor refers to the sociocultural and psychological elements that lead the male members of a society to react violently to perceived physical and moral threats (Reed, 1982; Cohen, 1996, 1998; Cohen and Nisbett, 1996, 1997). In terms of individual psychology and from an evolutionary perspective, there are two basic responses to a threat from an adversary: fight (engagement in conflict) or flight (escape or withdrawal from the conflict). Such responses are mediated through emotions that drive behavior, with fear leading to evasion and anger leading to confrontation (Potegal and Novaco, 2010). Therefore, there have to be psychocultural mechanisms in the Culture of Honor that involve anger and rage, as already pointed out. Indeed, culture, society, and emotion have been found to be significantly intertwined (Manstead, 2010), particularly with regards to mechanisms of individualism-collectivism, shame, anger, and violence (Gouveia and Clemente, 2000; Potegal and Novaco, 2010; Wranik and Scherer, 2010), these being the key mediators between social mores and criminal violence (Potegal and Novaco, 2010; Wranik and Scherer, 2010). It is, thus, necessary to ponder what role anger and its dynamics play within the Culture of Honor.

Individual Temperament

If anger is a key mediator between the cultural and the individual in the context of the Culture of Honor and violent crimes, then

the elements associated to the shaping of its internal dynamics, such as emotional regulation and personality, are of importance in the propensity toward homicide. Such elements are also very relevant as to the characterization of individual differences and their role.

Gross and John (2003) created an instrument to measure the degree to which one uses two types of strategy for emotional regulation: Suppression (control of emotional expressions) and Cognitive Reappraisal (changing one's mood through thought). The first modality has been shown to be associated to poorer mental health and social adjustment, whereas the second was observed to be associated to the opposite. There is clear evidence that such mechanisms are related to the dynamics of anger and to homicide (Matsumoto et al., 2012; Robertson et al., 2014).

Personality is the sum of all the traits that comprise an individual and define his or her uniqueness, therefore, it is, by definition, something that includes one's emotional dynamics. One of the most famous models is the 'Big-Five' (Digman, 1990), which establishes personal psychological traits can be grouped into five major categories:

- **Openness to Experience:** Intellectual curiosity, creativity and preference for novelty and variety, its opposite may be called Conventionalism;
- **Conscientiousness:** Tendency to be organized, dependable and self-controlled, its opposite may be called Impulsiveness;
- **Extraversion:** Assertiveness, sociability, talkativeness and expansiveness, its opposite being Introversion;
- **Agreeableness:** Tendency to be compassionate, altruistic and cooperative toward others, its opposite may be called Misanthropy;
- **Neuroticism:** Tendency toward negative emotions, emotional instability and maladjustment, its opposite being Stability.

A meta-analysis of over 60 studies suggests that individuals with a high level of Neuroticism, as well as low levels of Agreeableness and Conscientiousness, are more likely to engage in antisocial behavior, including violent crimes and homicide, though there may be complex interactions with gender and sociocultural variables (Miller and Lynam, 2001).

Moral Compasses

Individual morality, values, and attitudes are guided by several directives provided by sources such as law, religion, family, customs, and personal will, each of which could be labeled a "Moral Compass," with different impacts on the Culture of Honor according to both individual traits and the type of society one is inserted in Reed (1982), Cohen (1996, 1998), and Cohen and Nisbett (1996, 1997). Thus, it is relevant to go beyond the mere acknowledgment that there are societal mechanisms and processes that somehow jointly produce the Culture of Honor and an increased propensity toward homicide. It is required that the researchers in the field strive for an understanding of the specific ways in which each Compass might relate to a greater or lesser degree of said culture, to specific aspects of it, and to an individual's internal

psychology. Preferably, such an understanding is to be grounded on systematic empirical observations, rather than solely on speculation.

Hyperculture

The Digital Revolution is a term that refers to developments in information and communication technologies (ICTs) that became practically omnipresent in daily experience from the last decade of the 20th Century onward. Such developments have radically transformed the productive forces of society, changing its economy, politics, and culture in many ways, leading to novel ways of thinking and acting (Souza et al., 2010, 2012; Souza and Rangel, 2015).

The Cognitive Mediation Networks Theory (CMNT) is a scientific model of human cognition that aims to explain the complex interactions between society, technology, and thought. When applied to the Digital Revolution, it points to the emergence of a Hyperculture consisting of the forms of thinking and acting linked to the ICTs and the sociocultural structures created around them, with impacts regarding:

- **Cognition:** Inclination toward logical-numerical, abstract and visual-spatial reasoning with recombinant/fragmented thinking, leading to increased speed-of-processing, multitasking, emotional-intuitive (ludic) creativity, and overall cognitive performance;
- **Personality:** Greater tendency toward Openness to Experience, Conscientiousness, and Stability (low Neuroticism), as well as to a high degree of intellectualism, and to assign more importance to knowledge, success, maturity, and aesthetics as personal values;
- **Social Interactions:** Increased propensity toward communication, sociability, collaboration, and leadership;
- **Relationship with Technology:** Frequent, intense and broad use of digital technologies in general, along with a high level of mastery in their daily use;
- **Work Life:** Greater levels of professional updating, continued education, professional versatility, and entrepreneurship, as well as a tendency to assign more professional importance to knowledge, individual competence and the mastery of technology, leading to greater economic success.

There is strong empirical evidence of such positive impacts (Souza et al., 2010, 2012; Souza and Rangel, 2015), whereas concerns regarding potential negative effects of ICTs in terms of diminishing the capacity for concentration and contemplation (Carr, 2010) or even *per se* promoting obsessive behavior, addiction and psychopathologies (Aboujaoude, 2011) seem to be either entirely baseless or grossly overstated.

The cognitive, social and personality traits linked to the Hyperculture, as well as its positive association to professional life (Souza et al., 2012; Souza and Rangel, 2015), all seem to indicate that this new form of thinking and acting relates to social adjustment and psychological well-being in general. There is also the fact that society and culture have been shown to significantly influence emotional dynamics and expression, especially regarding anger (Gouveia and Clemente, 2000; Potegal

and Novaco, 2010; Wranik and Scherer, 2010). This suggests that the Hyperculture favors an enhanced tolerance of diversity, social interaction, and dialog, promoting communication, mutual understanding, and peaceful means of conflict resolution, thereby counteracting the mechanisms and processes through which it is considered that the Culture of Honor promotes homicide (Souza et al., 2014).

The Need for a Multidimensional Approach

Even when one focuses on a specific theory such as the Culture of Honor, criminal homicide reveals itself to be a complex phenomenon involving a wide diversity of variables with many possible interactions, including a great amount of covariation, all of which can cause confusion when it comes to data analysis and interpretation using traditional techniques. It appears, therefore, that a study of the propensity toward homicide encompassing a broad set of psychological and sociocultural variables can substantially benefit from the use of sophisticated multivariate analysis techniques.

Study Goals

The present study aimed to investigate the relationships between the different components of the culture of honor and an individual's experience and attitudes toward criminal homicide, with the identification of the roles of internal psychological variables regarding the dynamics of anger, emotional regulation, and personality, as well as the psychosocial elements of Hyperculture and the value assigned to different moral compasses. The main goal was to use SSA and Facet Theory to observe the relational structure of these multiple variables and glimpse the workings of the psychocultural mechanisms underlying an individual propensity toward homicide in light of the Theory of the Culture of Honor.

MATERIALS AND METHODS

Subjects

A total of 336 adult Brazilian subjects from the Metropolitan Region of Recife, 169 men and 167 women, with the mean age of 34.6 years ($SD = 11.13$), 69.6% of which with up to intermediate level education, 23.5% with higher education and 6.8% with a graduate degree.

Instruments

- One form containing 30 questions regarding:
 - Sociodemographics;
 - Degree of experience with victims and authors of homicides;
 - Degree of condemnation of homicides (years of penalty assigned);
 - Importance assigned to law, religion, family, customs, and personal will;
 - Recent experience with anger (intensity, duration, rumination, frequency).

- **Hypercultural Index**, Digital Experience and Digital Precocity (Souza et al., 2012);
- Portuguese language version of the Ten Item Personality Inventory (Gosling et al., 2003);
- Portuguese language version of the Emotional Regulation Questionnaire (Gross and John, 2003);
- Portuguese language version of the Honor Scale (Rodríguez Mosquera et al., 2008).

Procedure

A total of 48 law students from a private higher education institution Recife, Pernambuco, Brazil, approached the subjects in the streets of the Metropolitan Area of Recife, invited them to participate, and applied the instruments to those who accepted, which was done in various locations according to convenience, with the interviewer registering all the responses in previously printed spreadsheets. Each student interviewed a total of seven subjects. Those participants who eventually failed to answer to all the questions and/or to do so in the appropriate format had their data discarded and another subject was selected to replace him/her.

Analysis

SSA and Facet Theory

Facet Theory is a powerful mathematical approach that allows one to juxtapose theory and observations in complex phenomena by means of a meaningful visual holistic representation of the relationships within a dataset. It is based on a particular form of Multidimensional Scaling, called the Smallest Space Analysis (SSA), where the association between two variables is inversely expressed as the distance between them in a graph (the stronger the association, the smaller the distance). Groupings of variables (as in Cluster Analysis), as well as the identification of latent dimensions (as in Factor Analysis), are achieved by means of the geometrical partitioning of the graph into regions that are interpreted as both clusters and constructs. The technique is robust enough to deal with practically any type of data and measure of association between variables. It is no exaggeration to state that it may be one of the most sophisticated and far-reaching forms of multivariate data analysis in existence (Guttman and Greenbaum, 1998; Levy, 2005; de Leeuw and Mair, 2009; Borg et al., 2012). For all of these reasons, SSA and Facet Theory were chosen as the main form of data analysis for the present investigation.

Variables, Indexes, and Scores

Some of the elements analyzed were assessed as direct measurements of a variable as recorded by the instruments used, including:

- **Dynamics of Anger**: The Intensity (1–9 Likert scale), Duration (hours) and level of Rumination (1–9 Likert scale) of the most recent episode of anger, along with the Frequency of episodes (one divided by the time since the last episode);
 - **Moral Compasses**: The importance assigned to Law, Religion, Customs, Personal Will and Family when making a decision, all measured on a 1–5 ordinal scale.
- The psychological measures from the standardized tests had their scores all calculated according to the official instructions, this including:
- **Culture of Honor**: The four components of the Honor Scale, that is, Masculine Honor, Feminine Honor, Social Honor, and Family Honor, all on a 1–7 scale (Rodríguez Mosquera et al., 2008);
 - **Personality**: Scores for the negative versions of the Big Five personality dimensions, that is, Conventionalism, Impulsiveness, Introversion, Misanthropy and Neuroticism, all measured on a 1–7 Likert scale (Gosling et al., 2003);
 - **Emotional Regulation**: Scores for the levels of Cognitive Reappraisal and Emotional Suppression, all on a 1–7 scale (Gross and John, 2003);
 - **Hyperculturality**: The Hypercultural Index (0–1 interval scale), along with Digital Experience (duration of one's experience with ICTs in years) and Digital Precocity (one divided by the age when one began one's experiences with ICTs), all three on interval scales (Souza et al., 2012).
- Three aspects of one's relation with homicides were calculated through scores that were created specifically for the present study, these being:
- **Experience with Homicides**: Close or cursory personal contact with victims homicides, plus personally knowing the authors of a homicide, each measured on a 0–1 dichotomous scale, producing a score expressed as a 0–3 ordinal scale with a Cronbach Alpha of 0.64;
 - **Tolerance of Homicide**: The mean penalty, in years, that one would assign to the author of a homicide under six circumstances (murder of wife due to unfaithfulness, murder of wife's lover, murder of person who disrespected him, murder of man in order to rob him, murder of another man during a fight, murder of a criminal by another criminal) subtracted from the value of 30 years (maximum penalty in Brazil), generating a 0–30 interval scale with a Cronbach Alpha of 0.88;
 - **Homicidal Honor**: Masculine Honor plus the reverse of Social Honor, as measured by the Honor Scale, an index measured on a 1–9 scale that was positively correlated to Experience with Homicides and Tolerance of Homicides.
- All of these dimensions were measured on at least an ordinal scale where equal intervals can be assumed, so that 1-Pearson r can validly be considered as a measure of the distance between them in a SSA.

RESULTS

Smallest Space Analysis

Figure 1 shows the SSA diagram for the variables in the study using as a metric the 1-Pearson r distance, and Ward's amalgamation schedule, yielding a Stress value of 0.18, which very much acceptable for an analysis with 26 variables.

The resulting diagram shows a structure that can be clearly divided into three axial partitions.

Tolerance of Homicides, Experience with Homicides and Homicidal Honor were all placed together in the same region of the graph, defining a partition that may be regarded as Propensity toward Homicide. Given its position in the SSA, Importance of Law was also included in this partition.

All the variables related to anger (Intensity, Rumination, Duration, and Frequency) and personality (Neuroticism, Introversion, Misanthropy, Impulsiveness, and Conventionality), were in a region adjacent to the Propensity toward Homicide. In the same vicinity were also Importance of Personal Will, Importance of Customs, Emotional Suppression, and Masculine Honor. Due to their proximity to the Propensity toward Homicide, which is indicative of a positive association, one may label this partition as Positive Association to Homicide.

In the remaining portion of the SSA plot are Hyperculture, Digital Experience (years of experience with the regular use of computers), and Digital Precocity (reverse of the age in which one began to have regular contact with computers), as well as the Importance of Family and Religion, Cognitive Reappraisal, Family Honor, Social Honor, and Feminine Honor. Due to its distance from Propensity toward Homicide, this partition encompasses elements that seem to be negatively associated to homicides, so it may be called Negative Association to Homicide.

Comparing Men and Women

Table 1 compares the men and women in the sample with regards to honor, emotional regulation, and relationship with homicide.

Men were found to have statistically more Masculine Honor and Emotional Suppression, as well as more Homicidal Honor and less severe penalty assigned to homicides. Women were found to have statistically more Feminine Honor and Cognitive Reappraisal, and marginally more Social Honor.

DISCUSSION

A Proxy for the Propensity toward Homicide

The presence of Homicidal Honor, Tolerance for Homicides and Experience with Homicides in close proximity to each other in the same region of the SSA diagram indicates that these three variables have something in common between them, the most obvious element here being homicide itself. Indeed, it is quite reasonable to assume that individuals with a high level of all three is more likely to commit a homicide than one who has low levels of the same. The rationale here is that Homicidal Honor would lead to an inclination toward killing

as a way of dealing with conflict, Tolerance for Homicides would indicate the acceptance of homicide as an alternative of action, and Experience with Homicides would be a source of habituation, and, therefore, a level of indifference, toward this sort of crime.

Prima facie, the presence of the Importance of Law in this partition seems strange, as homicide is universally illegal. However, it is known that in places with intense levels of the culture of honor, such as the southern portion of the United States, following rules of manners, politeness and propriety, which are frequently a significant part of the traditional charm and hospitality of such places, is a way to reduce the probability of fatal conflict, something which may include abiding to the law in general (Reed, 1982; Cohen, 1996, 1998). Also, it may be that, within the context of a culture of honor, murdering someone is considered as a valid form of resolution for conflicts involving matters of honor, thus, it would not be seen as a violation of the law, but rather an obedience to it or to some higher principle (e.g., "natural law," "divine right," "moral principle").

Factors with Positive Association to Homicide

Within the partition of Positive Association to Homicide in the SSA were the strength of Masculine Honor (assertiveness), the Importance of Personal Will ("alpha male"), the Importance of Customs (tradition and propriety), and Emotional Suppression (no display of fear, anxiety, or pity), all of which describe fairly well the moral imperatives for men in the culture of honor (Reed, 1982; Cohen, 1996, 1998).

Also within Positive Association to Homicide were all of the variables related to the dynamics of anger and all the negative dimensions of personality, both types appearing in the SSA as being fairly intermixed with each other, indicating that these emotional and dispositional elements are positively related to each other and the propensity to commit murder. This is very much in agreement not only with the literature on the role of emotion and personality in violent crimes (Miller and Lynam, 2001; Matsumoto et al., 2012; Robertson et al., 2014), but also with the phenomena described in the Theory of the Culture of Honor (Reed, 1982) and in the experimental findings regarding the responses to conflict, insult and outrage in such cultures (Cohen and Nisbett, 1996, 1997).

The finding of a single partition for both the aforementioned sets of elements suggests that the mores of the culture of honor in terms of how one must react violently to insult and conflict have psychological repercussions upon the individual in terms of personality and the dynamics of anger, thereby promoting violent and potentially lethal behavior.

Factors with Negative Association to Homicide

Within the partition labeled Negative Association to Homicide were Social Honor, Feminine Honor, and Family Honor, along with Cognitive Reappraisal. This suggests that such values are associated to adopting emotional regulation strategies based on

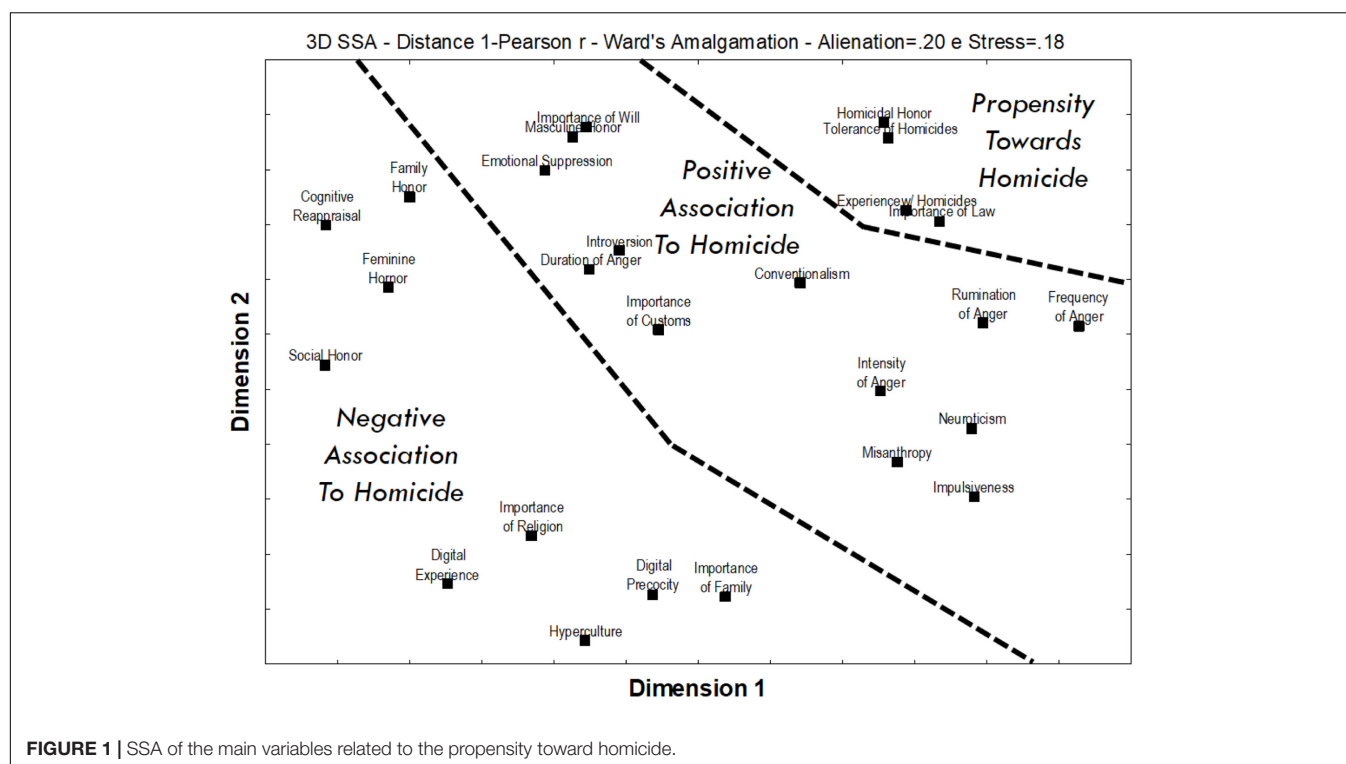


TABLE 1 | Comparison between men and women as to honor, emotional regulation, and homicide.

Psychocultural element		Men ($n = 169$)		Women ($n = 167$)		Mann-Whitney U (p -value)
		Mean	SD	Mean	SD	
Honor (Likert 1–9)	Family	7.71	1.261	7.65	1.292	0.74
	Social	7.62	1.269	7.87	1.083	0.06
	Masculine	6.58	1.462	6.33	1.32	0.01
	Feminine	4.59	2.027	6.00	2.034	<0.01
Emotional regulation (Likert 1–7)	Reappraisal	4.96	1.353	5.26	1.291	0.05
	Suppression	4.30	1.473	3.99	1.491	0.04
Homicide	Experience (Ordinal 0–3)	1.24	0.961	1.17	0.948	0.48
	Penalty assigned (years)	15.70	8.257	19.27	7.937	<0.01
	Homicidal honor (1–9)	4.48	0.785	4.23	0.729	<0.01

internal resolution, rather than the mere controlling of external manifestations, with this combination tending to reduce the predisposition toward lethal violence.

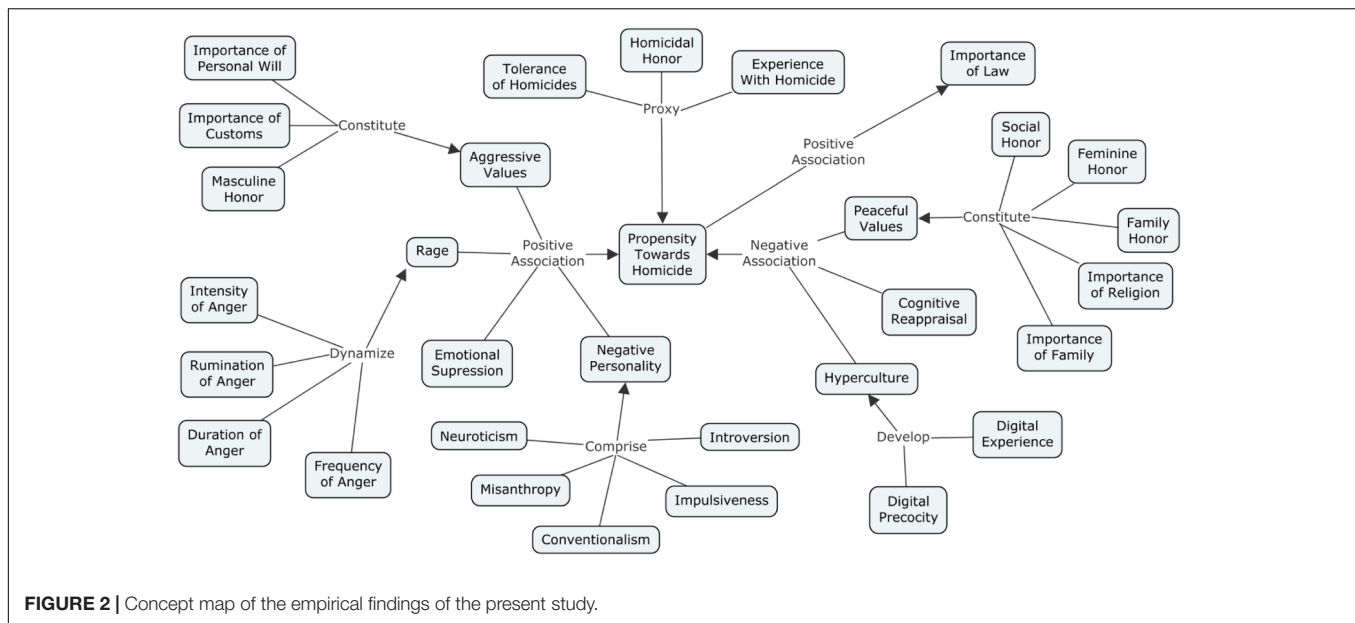
Also inside Negative Association to Homicide were Hyperculture, Digital Precocity, and Digital Experience. They presented themselves fairly close to each other, which is in agreement with the predictions and findings of the CMNT that the greater the amount of interaction with the digital culture and the earlier this process begins, the greater will tend to be an individual's internalization of the Hyperculture (Souza et al., 2012). Likewise, their opposition to the tendency to commit homicide is in agreement with the theoretical expectation that hypercultural values favor peace and understanding (Souza et al., 2014).

Interestingly, the Importance of Religion and the Importance of Family as moral compasses were yet also present in Negative

Association to Homicide, and situated very closely to the variables related to digital culture. It may be the case that religion tends to value peace and non-violence, while family favors the acceptance, protection and safety of its members, all of these being things that would reduce the propensity toward lethal violence. Such values would also be in alignment with those of the Digital Age and Hyperculture (Souza et al., 2014).

Overview of the Mechanisms and Processes Observed

Tolerance of Homicides, Homicidal Honor, and Experience with Homicides are all associated to one another and proxies of an individual's tendency to commit murder, i.e., his or her Propensity toward Homicide, the central point of this investigation.



With positive association to Propensity toward Homicide, one finds:

- Importance of Personal Will, Importance of Customs and Masculine Honor, all of which would constitute Aggressive Values;
- Intensity, Rumination, Duration and Frequency of Anger, all of which are the parameters for the dynamics of Rage;
- Neuroticism, Misanthropy, Conventionalism, Impulsiveness and Introversion, which are the opposite of, respectively, Stability, Agreeableness, Openness, Conscientiousness and Extraversion, thereby comprising Negative Personality;
- Emotional Suppression.

With negative association with Propensity toward Homicide, one finds:

- Social Honor, Feminine Honor, Family Honor, Importance of Religion and Importance of Family, all of which would constitute Peaceful Values;
- Digital Experience and Digital Precocity, that lead to the development of an individual's Hyperculture;
- Cognitive Reappraisal.

There was a positive association between Propensity toward Homicide and the Importance of Law, the latter probably as a consequence of the former because it is a means of preventing unnecessary conflicts and/or an expression of the belief that honor-motivated homicide is righteous.

Figure 2 presents a concept map that summarizes the elements that have positive or negative associations to the Propensity toward Homicide, expressing a synthesis of the main empirical findings of the study.

In light of the Theory of the Culture of Honor and the additional frameworks regarding cognition, emotion, moral

values and personality that have been approached in the present paper, it is possible to interpret such observations so as to suggest a model for the phenomenon under consideration.

It would appear that a culture that values male assertiveness tends to produce moral values favoring aggression and violence as a means of conflict resolution, with an emotional dynamic where one unsuccessfully attempts to suppress anger, leading to rage that manifests itself in the form of negative personality. In those with a high degree of internalization of such mores, a relevant social occurrence triggering this ensemble of mechanisms, such as an insult or confrontation, tends to favor the arising of an intention to kill, both as an emotional reaction and as an obedience to a code of conduct. This, in turn, tends to eventually translate into actual homicidal behavior.

Inversely, the internalization of standards of honor regarding demureness, propriety and integrity, particularly stemming from family and religion, favor moral values that favor peaceful forms of conflict resolution, mediated by the more effective mode of emotional regulation that is Cognitive Reappraisal. The Digital revolution and the emergence of the Hyperculture, which are associated to strong social interaction and collaboration, seem to likewise favor peaceful forms of resolving conflicts. This tends to reduce the probability of one engaging in lethal violence.

If the mechanisms and processes that promote homicide surpass those that inhibit it, apparently a heightened valuing of the law emerges, most likely as a form of moderating what would be otherwise an endless streak of lethal violence.

A summary of such a model can be expressed by the concept map in **Figure 3**.

This view constitutes a framework that goes beyond the scope of the Theory of the Culture of Honor, describing both

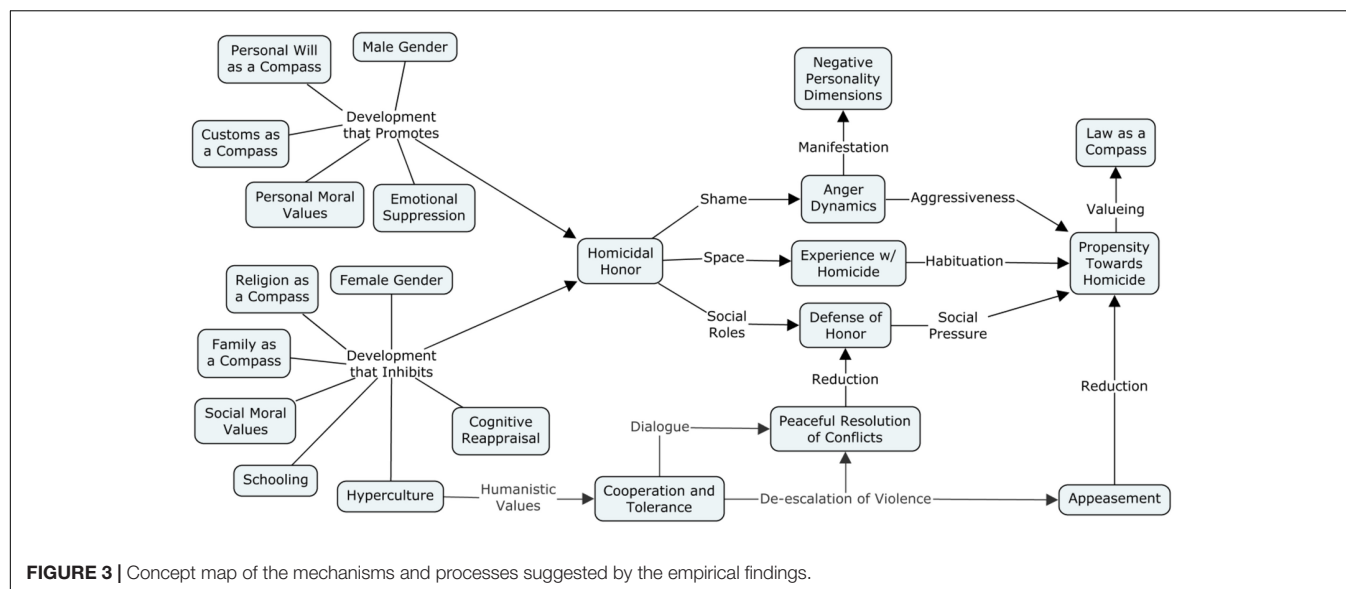


FIGURE 3 | Concept map of the mechanisms and processes suggested by the empirical findings.

psychological and sociocultural dimensions of the phenomenon of homicide.

Men vs. Women

The differences observed between the genders as to the intensity of the different types of honor were consistent with the traditional social roles prescribed by the culture of honor (Reed, 1982), i.e., that men should be assertive (Masculine Honor) and women should be demure (Feminine Honor) and virtuous (Social Honor). This seems to have translated into males being more prone than females to adopting Emotional Suppression as a means of emotional regulation, whereas females were observed to be more prone to Cognitive Reappraisal than males.

From the Theory of the Culture of Honor (Reed, 1982; Cohen, 1996, 1998), as well as the literature on emotion (Miller and Lynam, 2001; Matsumoto et al., 2012; Robertson et al., 2014), one would expect the observed difference between men and women to lead to a greater propensity toward homicide, which was the case as measured by the Condemnation of Homicides and Homicidal Honor (Experience with Homicides showed no difference, due to the fact that it depends on one's location rather than gender).

These findings confirm not only the psychocultural mechanisms and processes emerging from the present investigation, but also how they function for men and women as a consequence of the traditional social roles for each gender. This appears to be a viable explanation for the great predominance of male authors and victims of homicide that is observed worldwide (UNODC, 2013).

CONCLUSION

The present study aimed to empirically explore the relational structure of various psychological and sociocultural elements involved in an individual's tendency toward committing murder in light of the Theory of the Culture of Honor.

The findings obtained by means of using proxies for the propensity toward homicide along with adopting a multidimensional analytical approach (SSA and Facet Theory) and comparisons between genders suggest that:

- A culture of honor based on the need to be assertive is associated to a traditional masculinity and enhanced anger which is poorly managed, leading to negative personality traits, all of which tends to increase one's propensity toward committing homicide;
- The internalization of the culture of the Digital Age, along with valuing family and religion as moral compasses, improved emotional regulation, and a non-aggressive sense of honor seem to disrupt the mechanisms and processes that promote homicide, leading to a reduced propensity toward that type of crime;
- The specific gender roles assigned by the culture of honor tend to put into motion the above psychological and sociocultural elements so as to make men much more prone to homicide than women.

It seems that present study appears to not only confirm the Theory of the Culture of Honor for the propensity toward homicide, but also explicit some of the psychocultural processes and mechanisms involved, thereby producing the beginnings of a new scientific model of the phenomenon.

Future studies on this topic should study a broader and more diversified sample of individuals, as well as additional variables of interest, such as measures of basic moral values and nuances of one's attitudes toward homicide.

ETHICS STATEMENT

As established by the ethical guidelines for scientific research with human subjects in Article 1, Subsection V, of Resolution no. 510

from the Brazilian National Council on Health, the present study was exempt from registration or evaluation from the country's Council of Ethics in Research and National Council of Ethics in Research due to the fact that no identification of subjects was registered or even asked for, no experimental intervention was done on the participants that might generate any risks above those of daily life, and absolutely no form of diagnosis or counselling was offered either as a consequence of the responses or any other basis. In spite of that, such official registration was done through the Committee of Ethics in Research of the Federal University of Pernambuco (CAAE: 18036213.0.0000.5208) and a favorable decision was obtained (DECISION: 930.677). In accordance to international principles regarding research ethics, the participation in the present study was fully informed and strictly voluntary.

AUTHOR CONTRIBUTIONS

All authors (MGTCs, BCS, AR, and ESS) equally contributed to all the following issues of the research: conception and

design of the work; acquisition, analysis, and interpretation of data; drafting the manuscript and critically revising it; final approval of the version to be published; agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

FUNDING

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: both authors are recipients of the *Bolsa de Produtividade em Pesquisa – PQ* (Research Productivity Scholarship) from the *Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq* (National Council for Scientific and Technological Development) of the Ministério da Ciência, Tecnologia e Inovação (Ministry of Science, Technology and Innovation) of the Brazilian Government (BdS has a Level 2 scholarship and AR a Level 1A).

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Comprehending Adverbs of Doubt and Certainty in Health Communication: A Multidimensional Scaling Approach

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OPEN ACCESS

Edited by:

Federica Scarpina,
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Reviewed by:

Laurent Pezard,
Aix-Marseille Université, France
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Specialty section:

This article was submitted to
Psychology for Clinical Settings,
a section of the journal
Frontiers in Psychology

Received: 09 December 2015

Accepted: 05 April 2016

Published: 03 May 2016

Citation:

Segalowitz NS, Doucerain MM,
Meuter RFI, Zhao Y, Hocking J and
Ryder AG (2016) Comprehending
Adverbs of Doubt and Certainty in
Health Communication: A
Multidimensional Scaling Approach.
Front. Psychol. 7:558.
doi: 10.3389/fpsyg.2016.00558

This research explored the feasibility of using multidimensional scaling (MDS) analysis in novel combination with other techniques to study comprehension of epistemic adverbs expressing doubt and certainty (e.g., *evidently*, *obviously*, *probably*) as they relate to health communication in clinical settings. In Study 1, Australian English speakers performed a dissimilarity-rating task with sentence pairs containing the target stimuli, presented as “doctors’ opinions.” Ratings were analyzed using a combination of cultural consensus analysis (factor analysis across participants), weighted-data classical-MDS, and cluster analysis. Analyses revealed strong within-community consistency for a 3-dimensional semantic space solution that took into account individual differences, strong statistical acceptability of the MDS results in terms of stress and explained variance, and semantic configurations that were interpretable in terms of linguistic analyses of the target adverbs. The results confirmed the feasibility of using MDS in this context. Study 2 replicated the results with Canadian English speakers on the same task. Semantic analyses and stress decomposition analysis were performed on the Australian and Canadian data sets, revealing similarities and differences between the two groups. Overall, the results support using MDS to study comprehension of words critical for health communication, including in future studies, for example, second language speaking patients and/or practitioners. More broadly, the results indicate that the techniques described should be promising for comprehension studies in many communicative domains, in both clinical settings and beyond, and including those targeting other aspects of language and focusing on comparisons across different speech communities.

Keywords: health communication, epistemic adverbs, multidimensional scaling, semantic space, cultural consensus, uncertainty in health communication, physician-patient relations

INTRODUCTION

How people understand expressions of uncertainty, especially as they relate to discussing medical risk, is a challenging area of study in physician-patient communication (Berry, 2004; Gigerenzer, 2008; Pryor and Hewitt, 2010; Jones, 2013; Pilnick and Zayts, 2014). Consider the following example (adapted from Shah, 2014, p. 801):

[Patient] “It’s a lung infection, right, Doc?”

[Physician] “*Perhaps*, . . . But it could *possibly* be something more serious.”

[Patient] “Why do I need another test? Can’t this one tell you what I have?”

[Physician] “We need a more detailed picture, which will *likely* reveal the diagnosis.”

The physician is using the adverbs *perhaps*, *possibly*, and *likely* to convey the lack of absolute certainty about outcomes (see also Skelton et al., 1999). Such adverbs are inherently vague and may be open to misinterpretation, with potentially serious consequences in situations such as obtaining informed consent or delivering bad news (Babrow et al., 1998; Fox, 2000). Even quantifying uncertainty in terms of probabilities can be open to misinterpretation (Gigerenzer and Edwards, 2003). For this reason, health communication researchers need tools for studying how speakers handle the subtleties of key expressions such as adverbs of uncertainty and doubt. Our goal in this paper is to explore the feasibility of using one particular set of tools for this purpose, with a primary focus on health communication in clinical settings.

We focus on multi-dimensional scaling (MDS) (Kruskal and Wish, 1978; Takane et al., 2009; Armstrong et al., 2014), a class of techniques for analyzing dissimilarity judgments about a set of objects, including words. For example, suppose people are asked to rate how far apart they believe pairs of cities to be (i.e., how “dissimilar” the cities are in location). MDS can translate the judgments into locations in a multidimensional space, where the reported dissimilarities are represented as distances within that space. In this example, it is likely that the cities would be spread out across a 2-dimensional (psychological) space in a pattern corresponding roughly to their geographic distances on a map. Moreover, MDS can be used to discover psychological distances between objects even when the “true” distances and dimensionality of the space are not known, for example, in the case of judgments about word meanings. MDS also reports how well the objects fit into a space of a predetermined number of dimensions. With certain constraints in mind, one can interpret MDS solutions as reflecting how observers mentally organize information about the objects. Here we use MDS to examine how speakers mentally organize meanings associated with uncertainty adverbs relevant to health communication.

Our goal here is to explore some possibilities and limits of using MDS in the context of health communication. Our contribution is twofold. Conceptually, we provide evidence on how native speakers of English in two different English-speaking communities appear to cognitively organize adverbs expressing doubt and certainty. Methodologically, we demonstrate with

health-communication relevant stimuli how MDS, when suitably supplemented with other data analysis techniques, can be used to study group-level language phenomena while taking into account inter-individual variability, thus making it possible to study potential group differences in health communication.

In the past, language researchers have used MDS to study how people represent the meanings of *single* words in a variety of domains, including in the context of intercultural comparisons (Hermann and Raybeck, 1981). These include studies of emotion words (Shubert, 1999), verbs, adjectives, and nouns (Arnold, 1971; Segalowitz and de Almeida, 2002; Bybee and Eddington, 2006), household objects (Ameel et al., 2009), politeness terms (Pizziconi, 2007), and—in the health domain—pain descriptors (Janal, 1995). The advantage of using MDS is that one only needs to obtain dissimilarity judgments; participants do not need to explicitly report their understanding as would be the case in direct tests of comprehension. For these reasons, MDS may be useful for studying sources of misunderstanding in health communication contexts. In this study, we examine the basic feasibility of applying MDS to study comprehension of uncertainty adverbs.

The research we report provides a methodological backdrop for future studies of comprehension in health communication in two ways. First, it breaks new ground in being the first to apply MDS to people’s understanding of uncertainty adverbs. Second, also for the first time to our knowledge, the task involves presenting stimulus words in explicit health communication contexts by embedding them in carrier sentences (i.e., not as decontextualized, single words). This is important because without explicit contexts participants may create their own frameworks for judging stimuli, including those unrelated to health communication, resulting in unwanted variability in the data. An important methodological aim, therefore, was to see whether using sentences rendered MDS unsuitable for studying comprehension of specific words. The research also looks at the degree of intragroup (within-community) consensus on the meanings of uncertainty adverbs. People belonging to a given language community (say, English speakers) may nevertheless vary in how they use uncertainty adverbs, notwithstanding what a formal linguistic analysis might indicate about how such words are normatively used in that language. Measures of the range of variability in a reference group’s use of these words can provide a useful reference point for understanding intragroup variability observed in some other group, for example, second language speakers or speakers of another variety of the language, indicating whether that variability is outside the range normally expected according to the performance of some reference group of speakers.

There are several different types of MDS analyses available and these reflect a tension between simpler group-level solutions and concern for individual differences. Classical MDS analysis (C-MDS; also called two-way MDS) is conducted on a single group-level matrix of proximities (dissimilarity ratings), which represents the aggregated data of all participants’ responses. MDS methodologists have argued, however, that such averaging across participants is problematic because it obscures differences in the structure of the data among participants (Ashby et al.,

1994). For example, individuals might differ in terms of which dimensions make up their semantic spaces as revealed by MDS analyses. Another possibility is that they might differ in terms of the importance accorded to each dimension. Weighted MDS (W-MDS; also called three-way MDS, or Individual Difference Scaling—INDSCAL) was developed to address these kinds of issues. This approach analyzes an array of proximity matrices (one matrix for each participant) and yields a group solution as well as individual weights indicating how closely a participant's personal solution matches the group solution. W-MDS analyses thus provide measures of the degree to which an individual departs from the central tendency of the group as a whole. Such measures can be useful for determining the generalizability of results across a community of speakers and for examining variations across different language groups.

As mentioned earlier, our ultimate goal is to investigate how people understand uncertainty adverbs in health communication contexts where misunderstandings are likely to arise, especially between first and second language speakers. However, in the studies reported here, we focus only on first language English-speakers in order to explore possible methodological limitations of MDS and the extent of variability or consensus among native speakers. In doing so, we hope it will be possible to identify appropriate ways to extend the methodology to other populations and to draw lessons for the design of future research.

The target adverbs studied here come from Wierzbicka (2006; Chapter 8: *Probably*) and include such words as *apparently*, *possibly*, *probably*, *supposedly*. These were chosen for several reasons. First, there exists a linguistics literature that may shed light on what differentiates one from another (Guimier, 1988; Hoyer, 1997; Wierzbicka, 2006). Second, these words are easily embedded in carrier sentences to highlight the health communication context. Third, there exists a literature regarding similar expressions in other languages (e.g., French: Guimier, 1996; Celle, 2009; Mandarin: Lau and Ranyard, 1998; Spanish: Ramón, 2009; Hennemann, 2012).

These words are sometimes referred to as *epistemic adverbs* because, in addition to communicating information about uncertainty, they convey something about the speaker's personal commitment (stance) in relation to that information (Babrow et al., 1998; Gray and Biber, 2012). This stance can include, among other things, level of agreement with what is being asserted, confidence in its truth value, or something about how the information came to be known (see also Guimier, 1988; Hoyer, 1997; Wierzbicka, 2006). For example, consider the statement "*This is _____ an allergic reaction,*" where the blank is to be filled with an adverb such as *definitely*, *possibly*, *obviously*, or *reportedly*, etc. These adverbs signal that the speaker is affirming the basic situation (presence of an allergic reaction). However, they also signal something about the speaker's stance. *Definitely* and *possibly* convey different degrees of confidence in the speaker's mind, whereas *reportedly* suggests that the knowledge did not come from firsthand experience. The term *obviously* appeals to the listener by suggesting that anyone with the same knowledge as the speaker would logically draw the same conclusion. Thus, native-like understanding of these adverbs involves being able to understand what they convey

about the speaker's beliefs and feelings about the information. An important research goal would be to capture how people actually do understand such expressions. MDS may provide insight into such understanding without asking people to explicitly report their knowledge of these nuances.

To obtain MDS-appropriate data, we asked native speakers to provide dissimilarity judgments on pairs of sentences cast as two different "doctors' opinions." The sentences differed only in the adverb of uncertainty used. In Study 1, we collected data from an Australian sample and investigated the potential and limitations of MDS for use with these stimuli, starting with W-MDS and then turning to cultural consensus theory (Romney et al., 1986), a framework and methodology developed in anthropology to address issues of group consensus and inter-individual variability. In Study 2, we replicated the procedure with a Canadian sample and compared the results across the two English-speaking populations. Finally, we briefly consider the implications of the results for studying language barriers in health communication involving second language speakers.

STUDY 1

In this study, we used MDS to investigate how native English-speakers represent epistemic adverbs expressing certainty and doubt in sentences relevant to health communication. We addressed the following questions: First, would W-MDS analysis, when applied to dissimilarity judgments of target words *embedded in sentences*, reveal statistically acceptable solutions (low stress and a high level of explained variance)? The issue here is whether carrier sentences would add noise and mask any underlying structure in response patterns. Second, would W-MDS reveal intragroup consensus within a community of first language English speakers? The issue here was whether MDS with judgments about adverbs could reveal intragroup consistency. Third, would W-MDS analysis reveal interpretable semantic distinctions and would these correspond to those identified in formal linguistic analyses?

Materials and Methods

Participants were 69 English speakers recruited from the student participant pool at a major university in Brisbane, Australia. Those retained for this study reported English as their first or dominant language and rated their English language speaking and listening abilities as "4" or "5" on a 5-point Likert-type scale where "1" indicated *no ability at all* and "5" indicated *fluent ability*. In addition, we excluded participants reporting strong knowledge of another language (abilities reported as ≥ 3). The initial total sample was 128, of which 92 provided usable data, 74 of these qualified as native or dominant English speakers, and 69 reported no strong knowledge of another language ($M_{\text{age}} = 21.33$ years, range = 18–55; 55 females). All participants received course credit for participating.

Stimuli

The target words were the following 12 adverbs: *apparently*, *certainly*, *clearly*, *definitely*, *evidently*, *likely*, *obviously*, *probably*, *possibly*, *presumably*, *reportedly*, and *supposedly*. These were

combined to produce 66 different pairs, each adverb occurring 11 times across the sets of pairs. The members of each pair were then embedded in a carrier sentence to express two medical opinions (e.g., *This possibly means you pulled a muscle*; *This presumably means you pulled a muscle*). No adverb appeared in the same carrier sentence more than once. The sentences within a pair were ordered as a First *Opinion* and Second *Opinion*, with each adverb occurring approximately half the time (5 or 6 times out of 11) in First and in Second opinions. For each sentence pair there was a 9-point Likert-type dissimilarity rating scale, ranging from “not different at all” to “extremely different.”

Eight more expressions were used in warm-up and filler trials. These explicitly reflected meanings that could, in theory, separate the sentences in a given pair. Key elements in these sentences were: *I'm sure, I'm positive, from what I've heard, from reports I've seen, it makes sense that, it's logical that, from my experience, from what I know.*

The sentence pairs were organized into a sequence of 98 trials, of which 66 involved target adverb comparisons, 28 involved filler pairs, and four were warm-up trials. To create variety, 33 different carrier sentences were used, each associated with one filler and two adverb expressions (one with only two adverb expressions). Materials were quasi-randomized so that no carrier sentence and no adverb occurred in consecutive trials. Eight more sentence pairs were created for use in instructions, six of which contained filler expressions and two contained adverbs. There were three equally spaced rest breaks, each with three anagram puzzles for distraction.

Language Background Questionnaire (LBQ)

The LBQ is a short questionnaire eliciting basic demographic information about gender, age, knowledge of first and second languages, educational history with respect to known languages, and self-reported proficiency in speaking, listening, reading, and writing skills in each language.

The Final Questionnaire

All materials were placed into SelectSurvey for online access (SelectSurvey, 2014). Order of materials was: (a) Consent Form; (b) Main task—Instructions, 98 sentence pairs, each accompanied by a 9-point rating scale, plus rest pauses; where instructions were to read the pair of medical opinions and rate how different they were, and (c) the LBQ and two catch questions to detect inattentive responding.

Procedure

Participants answered the questionnaire online from home or other location. This study was carried out in accordance with the recommendations of Concordia University Research Ethics Committee and the Queensland University of Technology's University Human Research Ethics Committee, with informed consent from all participants indicated online.

Analysis and Results

The SelectSurvey data were downloaded and cleaned by removing ineligible and incomplete data, including catch question failures, leaving 69 usable questionnaires. Data from

the 66 trials containing the target adverbs were extracted from the larger dataset and a weight matrix was created to handle the missing data (0 for missing responses and 1 for valid responses). The data were submitted to exploratory multidimensional scaling (MDS) using the `smacofIndDiff` function in the `smacof` package in R (version 1.7-0; De Leeuw and Mair, 2009; Borg et al., 2013), set for ordinal data and the `indscal` constraint (Borg et al., 2013). To aid interpretation of the semantic space produced by W-MDS, the MDS configuration of adverbs was then analyzed using hierarchical cluster analysis. Where possible, the more robust median (\tilde{m}) and median absolute deviation (MAD) are reported instead of the mean and SD (see Leys et al., 2013). Means and standard 95% confidence intervals (95%CI) are also reported where appropriate. Confidence intervals based on bootstrapped (simulated) data show 2.5th and 97.5th percentiles of the empirical distribution.

Data Cleaning

We retained data from participants meeting the language eligibility requirements, completing all items, and passing the catch questions. Initial data screening revealed errors in stimulus construction. Four trials (four sentence pairs), involving eight different adverbs, had been accidentally duplicated and four different trials had these same eight adverbs missing from appropriate pairwise combinations. For all participants, the second occurrence of each repeated trial was deleted and the four omitted trials were weighted “0” as prescribed for `smacof`. As noted in Borg et al. (2013, p. 28), this small amount of missing data should not distort the final outcome in a meaningful way. Thus, for each participant four of 66 data trials were missing—just one data point out of 11 for each of the eight adverbs concerned.

Statistical Acceptability

In a first pass, we set the number of dimensions to three, the maximum number of stable dimensions to be found with 12 stimuli (Kruskal and Wish, 1978). In a second pass, we set the number of dimensions to two in order to compare the outcome with a 3-dimension solution. For each pass, we used Kruskal's stress (group *Stress-1*), median stress-per-subject (*SPS*), and median squared correlation coefficient (*RSQ*; Popper and Haymann, 1996, p. 167) to evaluate model fit at both group and individual levels. *Stress-1* is a standard MDS “badness of fit” statistic characterizing the group solution, and *SPS* provides a stress value for each participant's solution. *RSQ* is the proportion of explained variance in the scaled data (scaled dissimilarity ratings) by the corresponding distances in the MDS solution (the model distances). *RSQ* values are provided for each individual solution (see Table 1).

As noted by Giguère (2006), there are no guidelines for interpreting stress values from W-MDS (in contrast to classical MDS for which there exist well-established benchmark values). To assess the statistical acceptability of the model fit values, we resorted to computer simulations. We computed as a comparison measure the stress value that would be obtained if the data had been random and lacked inherent structure (Borg et al., 2013, p. 26). The median model fit values obtained from the

TABLE 1 | Model fit results for study 1.

Model	Group Stress-1 [95% CI]	\bar{m} SPS (MAD), [95% CI]	\bar{m} RSQ (MAD), [95% CI]
3-DIMENSIONAL SOLUTION			
Real data (full, $N = 69$)	0.170	0.188 (0.020)	0.479 (0.129)
Random data (1000 iterations)	1.756 [1.740; 1.772]	0.206 [0.203; 0.209]	0.231 [0.209; 0.256]
Real data (trimmed, $N = 62$)	0.166	0.184 (0.021)	0.511 (0.123)
2-DIMENSIONAL SOLUTION			
Real data (full, $N = 69$)	0.235	0.257 (0.035)	0.506 (0.155)
Random data (1000 iterations)	2.53 [2.508; 2.555]	0.299 [0.294; 0.303]	0.218 [0.194; 0.241]
Real data (trimmed, $N = 62$)	0.229	0.254 (0.031)	0.519 (0.139)

\bar{m} SPS, median stress-per-subject; \bar{m} RSQ, median R-squared; MAD, median absolute deviation.

real data should be substantially lower (i.e., better fit) than that obtained from a random simulation. For this purpose, we created 1000 arrays of random dissimilarity matrices, each containing 69 random assignments (the number of participants we had) of the 66 inter-adverb dissimilarity measures, for 2- and 3-dimensional (2D, 3D) solutions (we note that these simulations took several weeks to complete on a modern laptop, which may be beyond the computational stamina of most researchers conducting health communication research).

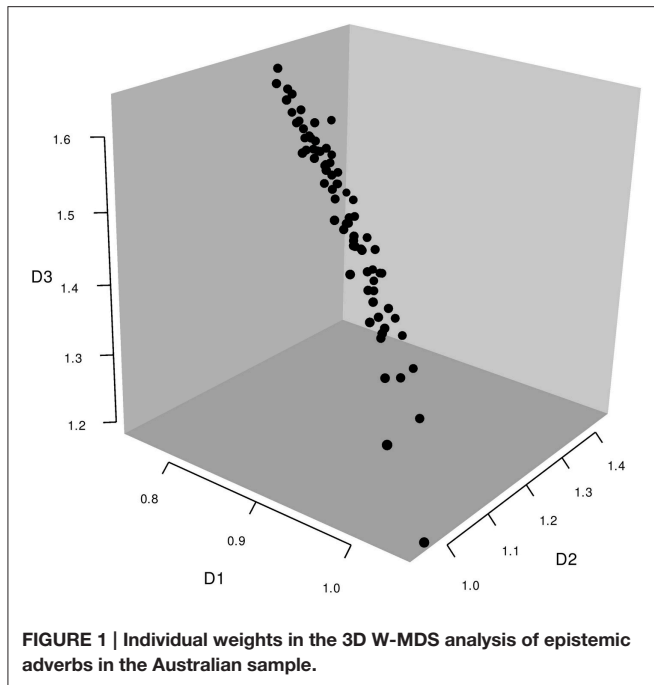
As shown in **Table 1**, the group *Stress-1* values for 3D and 2D solutions lie well below the corresponding random simulation values and outside the associated 95%CI for the random simulations, indicating *Stress-1* values markedly better (lower) than for the random data. Similarly, median stress per subject (SPS) values for 3D and 2D solutions are outside the corresponding 95%CIs for random simulations, indicating better fit to the data than on simulated random models. Also, median *RSQ* (*R-Squared*) values for 3D and 2D solutions are larger than corresponding *RSQ* values for random simulations and outside the associated 95%CIs, indicating that the MDS model distances accounted for more variance in the scaled data than in random simulations. Note, however, that the median *RSQ* was slightly higher for the 2D solution, suggesting that a 3D solution did not improve on the explained variance. In contrast, *Stress-1* and median SPS values were lower for the 3D than 2D solution, suggesting that a 3D solution may be providing additional useful information. It is, unfortunately, difficult to fully objectively determine the number of dimensions to accept (Borg et al., 2013, pp. 70–74). Therefore, given the exploratory nature of this study, we opted for a 3D solution where feasible, while recognizing its provisional nature. Together these results suggest that using sentences to deliver the stimulus words did not interfere with obtaining statistically acceptable results.

Unfortunately, W-MDS does not offer the MDS equivalent of “winsorizing” participants for dealing with outliers. The group solution reflects the data of all participants equally, even those contributing most to badness of fit. For this reason, and given that configuration weights did not reveal clear subgroups of participants, we re-ran the 3D W-MDS analysis after eliminating the 10% of participants with the lowest *RSQ* values (see **Table 1**, trimmed sample). As can be seen, model fit increased slightly, especially for *RSQ* values, indicating robust configurations.

Individual Differences and Intra-Group Consensus

The second goal was to assess intragroup consensus and the extent of individual differences. In addition to a group solution reflecting a pattern characteristic of the entire sample, the W-MDS analyses also yielded configuration weights reflecting individual differences in how much importance each participant attributed to each dimension of the group solution. Weights of 1 on a given dimension indicate that the participant is in perfect agreement with the group solution on that dimension, whereas weights less than 1 indicate that the person attached less importance to the dimension than did the group as a whole and vice versa for weights larger than 1. An individual whose weights on all three dimensions coincided exactly with the group solution would be located at [1, 1, 1] in a 3D space showing participants' weights on each dimension.

When each person's weight for each dimension was plotted in a 3D space (see **Figure 1**), individual weights showed substantial deviation from the point defined by coordinates [1, 1, 1]. This indicates that most participants departed from the group solution in some way or other. The pattern, however, was not random, which would have indicated idiosyncratic solutions and a lack of intragroup consistency. Also, the pattern of deviations did not yield identifiable clusters, such as some points near [1, 1, 1] and others clustering elsewhere, which would have indicated subsets of the population systematically attaching different levels of significance to the dimensions. For example, in a classical W-MDS study of body parts by Jacobowitz (1973), reported by Takane et al. (1977), individual weights formed two clear clusters corresponding to adults and to children. Here, rather, weights were distributed along a relatively clear flat plane, suggesting that although the data were not random, neither were there clear subgroups within the sample. Thus, individual deviation from the group solution may reflect noise more than systematic variability. This outcome is consistent with the idea of general intragroup consensus. Also supporting this interpretation, the geometric distance between individual configuration weights (points in the 3D weight space) and the coordinate point [1, 1, 1] correlated well ($r = -0.56$) with individual *RSQ* values (proportion of variance in the scaled data accounted for by the MDS model), indicating that the more a person's perceptions approached the group solution, the greater the accounted-for variance in their pattern of responses. This geometric distance also correlated



moderately with SPS values ($r = 0.43$), especially for dimension 1 (D1), the correlations for the three dimensions being -0.55 , 0.27 , and 0.46 respectively. The evidence, therefore, is generally consistent with the idea that members of this Australian group of English-speakers interpreted adverbs of uncertainty in similar ways, and that departure from the group solution indicated noise rather meaningful individual variation.

A potential problem with the analyses reported so far is that the group solution given by W-MDS accords equal weight to all participants, despite indexing individual variability in weights associated with each dimension. W-MDS might, therefore, be better suited to addressing individual differences as a principal goal than it is to providing information about the group's consensus after taking into account individual differences. Indeed, most studies using a W-MDS approach then focus on understanding what characteristics of individuals can account for variations in emphasis given to the different dimensions, as in Takane et al.'s (1977) examination of adults vs. children. Our goal here was different; we sought to find the intersubjective normative cultural representation of epistemic adverbs among Australians (i.e., the dominant representation members of this cultural group generally believe to be widely shared in the culture Wan et al., 2007). In that sense, a C-MDS (classic MDS) was conceptually closer to our goal. C-MDS is also easier from a practical point of view to implement. There exist well-established benchmark values to estimate model fit when using C-MDS, whereas with W-MDS we had to resort to computer simulations to interpret the stress values we obtained. As noted earlier, these simulations took several weeks to complete on a modern laptop, a serious limitation. However, we share other MDS researchers' (e.g., Ruette and Speelman, 2014) concerns about simply aggregating data by computing mean ratings across all participants. Rather, we are interested

in "meaningful aggregation." Now, when we try to estimate a cultural intersubjective norm, we have to take into account that participants will vary in their knowledge of this norm and so we need an aggregation method that takes into account individual differences in this knowledge. In short, our interest was in a practical method to study intragroup consensus that takes into account individual variation in knowledge of this consensus. We turned therefore to cultural consensus theory (Romney et al., 1986) as an alternative way to address the second research question. As presented below, we used a cultural consensus approach supplemented by classical MDS (C-MDS) to analyze data aggregated across participants. This allowed us to enter individual difference results from the cultural consensus analysis into the C-MDS analysis.

Developed in anthropology, the cultural consensus framework distinguishes two sources of variability: cultural variability (the existence of different "subcultures" or clusters of people) and variability in individual differences in knowledge competence (knowledge of the core, culturally dominant information) (Borgatti and Halgin, 2011). Further, this framework postulates that estimates of participants' knowledge of a cultural intersubjective norm can be estimated from levels of agreement among people. This approach can help establish whether there is one core, consensual semantic representation for the adverbs within the speaker sample. Second, provided no subgroups are identified, a cultural consensus approach allows one to assess how much each person conforms to or knows about the consensual representation. Measures of individual differences in this knowledge can then be used to more precisely characterize the group consensus by taking into account these individual differences when using C-MDS.

Methodologically, consensus analysis uses factor analysis on participants as units of analysis rather than items or scales as is typically the case (Weller, 2007). The factor loadings so derived are conceptualized as "competence scores," that is, measures of the extent to which participants "know" the cultural consensus. These scores can be used in two ways. First, they provide a metric to eliminate from analysis those participants who depart excessively from the group consensus. Second, they can be used as weights in the computation of the group aggregated data that is then analyzed through C-MDS: i.e., instead of all participants contributing equally to the group average, those with higher factor loadings (indexing greater "knowledge" of the consensus) contribute to the group average more strongly than those with lower loadings. In short, C-MDS paired with cultural consensus analysis allows us to assess a cultural intersubjective norm while taking into account individual variation in knowledge of this consensus—which is our goal here. To our knowledge, this study is the first one using this step-wise approach.

We conducted a consensus analysis by performing a minimum residuals factor analysis (Weller, 2007) on participants using the *fa* function in the *psych* package (v. 1.5.6; Revelle, 2015) in R. Factor analysis requires a rows-to-columns ratio of at least 5:1 (Gorusch, 1983), with higher ratios being preferable. Thus, with 66 similarity judgments (rows), our factor analysis should include no more than 13 participants at a time. We had 69 participants. We resolved this by factor analyzing a

randomly selected subset of 10 participants at a time (a ratio of almost 7:1), repeating the procedure 1000 times and retaining median values from these 1000 repeats (this simulation took only minutes). We used participants' factor loadings (cultural competence scores) as weights in computing a group-level weighted average dissimilarity matrix, where participants with higher factor loadings contributed more than participants with lower loadings. This single matrix of aggregated data was then analyzed using the `smacofSym` function (with the ordinal constraint) of the `smacof` package in R, which performs a C-MDS analysis.

Results of the Consensus Analysis

The existence of a group consensus was supported by a ratio of first-to-second factor eigenvalues >3.0 (following standard recommendations, Weller, 2007). This indicates that splitting participants into a second “group” (or factor, given this was a factor analysis of participants) accounted for proportionally little additional variance compared to keeping only one “group” (or factor). We obtained a ratio of 7.73 (ratio of first: second eigenvalues = $3.69:0.48$), well above the conventional recommendation of a 3:1 ratio. The factor loadings on the 1-factor solution provided individual cultural competence scores indexing the degree to which each person's data correlated well with the factor (Weller, 2007). The median competence score was 0.62 ($MAD = 0.14$), above the recommended 0.50 average (Weller, 2007), indicating that there was a single consensual representation of the target adverbs. As a rule of thumb, competence scores below 0.30 are considered to indicate considerable departure from consensus (Weller, 2007), a value also cited as a lenient rule-of-thumb cutoff value in exploratory factor analysis (more precisely, 0.32; Tabachnick and Fidell, 2001). In this sample, eight participants had competence scores under 0.30 and so were eliminated. We then computed a group-level weighted average dissimilarity matrix using competence scores as weights.

Statistical Acceptability of the Weighted-Data C-MDS Results

Table 2 reports model fit values for both 2D and 3D solutions. For comparison purposes, we report fit values for both weighted and unweighted (i.e., with no adjustment by factor loadings, using simple mean aggregation) analyses. As can be seen, using weighted data improved the model fit over unweighted data, the weighted data yielding higher *RSQ* and lower *Stress-1* values, supporting the use of consensus analysis. All results reported next refer to the weighted data analyses. According to Kruskal and Wish (1978), *Stress-1* values below 0.05 are considered excellent, between 0.05 and 0.10 are good, between 0.10 and 0.20 are fair, and above 0.20 are poor. For *RSQ*, the minimum acceptable value is 0.60. In this sample, model fit indices for the weighted analysis favored a 3D solution (*Stress-1* = 0.075, *RSQ* = 0.867) over a 2D solution (*Stress-1* = 0.112, *RSQ* = 0.862). The semantic analyses reported next, therefore, are based on the 3D solution.

Semantic Analysis

Our third research question was whether MDS analysis would yield interpretable semantic distinctions. Figure 2, shows the

TABLE 2 | Model Fit Results for Study 1 with the Australian sample using Classical MDS with and without weighted data derived from cultural consensus analysis (see text for details).

Model	Australian Sample	
	<i>Stress-1</i>	<i>RSQ</i>
3-DIMENSIONAL SOLUTION		
Weighted data	0.075	0.867
Unweighted data	0.068	0.842
2-DIMENSIONAL SOLUTION		
Weighted data	0.112	0.862
Unweighted data	0.123	0.855

RSQ, R-squared.

3D group solution based on the consensus/MDS analysis. Interpreting an MDS configuration involves subjective and qualitative approaches that take into account the existing literature (see Borg et al., 2013). This is because specific dimensions serving as plot axes can be arbitrarily rotated (including obliquely) and so there is no guarantee that the dimensions will be meaningful. To aid interpretation, the coordinates for each adverb, taken from the group solution in the weighted-data C-MDS analysis, were submitted to hierarchical cluster analysis, using the R package “`fpc`” (flexible procedures for clustering; Hennig, 2015) with `clustermethod=hclustCBI`, `method=ward.D2`, `k=4`, and 100 bootstrap replications (for other examples combining MDS with cluster analysis, see McLaughlin et al., 1991; Leonard and Ashley, 2012). Figure 2 also reports the clustering patterns that emerged from this analysis and their Jaccard similarity values (see Hennig, 2007). A Jaccard similarity value = 0.75 is considered to indicate a “valid, stable cluster” and = 0.85 indicates a “highly stable” cluster (Hennig, 2015, p. 30).

Figure 2 shows that D1 reflects a contrast between adverbs expressing higher levels of confidence (*certainly*, *clearly*, and *definitely* on the left side of the plot along D1, members of cluster 2) vs. lower levels of confidence (*probably* and *possibly*, on the right side of D1, members of cluster 4). The cluster analysis also reveals a set of words (cluster 1) referring to the speaker's information source—*reportedly*, *apparently*, *presumably*, and *supposedly*, all of which convey that the information source is at some “distance” from the speaker. Cluster 3 contains the words *evidently*, *likely*, and *obviously* which reflect a “close” information source, indicating that were the listener in possession of the same background information as the speaker then he or she would logically draw the same conclusion.

Discussion

The results answered the three research questions in the affirmative. First, MDS analysis proved feasible for use with dissimilarity ratings on adverbs embedded in carrier sentences. This feasibility was supported by the high level of variance accounted for by the MDS solution (*RSQ* values) and the low level of stress (*Stress-1* values below that of randomized data). This result occurred in both W-MDS and in weighted data

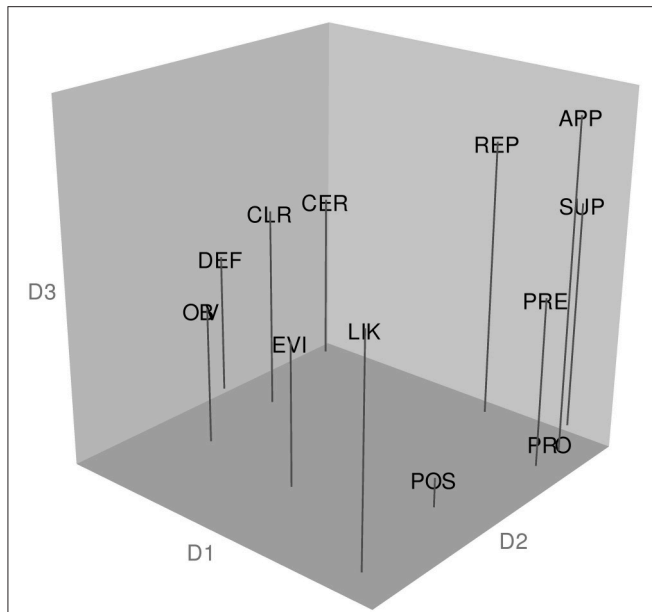


FIGURE 2 | Configuration of target adverbs in the Australian sample and the results of a hierarchical cluster analysis of the coordinates from the MDS spatial configuration. The abbreviations for the 12 target adverbs are: APP, apparently; CER, certainly; CLR, clearly; DEF, definitely; EVI, evidently; LIK, likely; OBV, obviously; POS, possibly; PRE, presumably; PRO, probably; REP, reportedly; and SUP, supposedly. The analysis revealed the following clusters: Cluster 1 (Jaccard similarity value = 0.960): apparently, presumably, reportedly, supposedly; Cluster 2 (Jaccard similarity value = 0.856): certainly, clearly, definitely; Cluster 3 (Jaccard similarity value = 0.795): evidently, likely, obviously; Cluster 4 (Jaccard similarity value = 0.865): possibly, probably.

C-MDS analyses. Importantly, the results were stronger with the weighted data C-MDS analysis (RSQ values >0.80). These results not only extend the use of MDS to epistemic adverbs, a semantic domain not before studied this way, but they also indicate one can use carrier sentences to ensure stimuli are understood as intended. Second, there was evidence for intragroup consistency (consensus), seen in the strong fit when weights derived from the consensus analysis were used with the C-MDS analysis.

Finally, the meaning structure revealed by the MDS solution was interpretable and corresponded to analyses found in the linguistics literature. For example, a major contrast emerged between adverbs expressing higher confidence (Wierzbicka, 2006) or conviction (Hoye, 1997) vs. lower confidence or conviction (cluster 2 vs. 4). Interestingly, Wierzbicka also includes *evidently* in the “confident” category whereas our data and Hoye’s (1997) analysis do not (more on *evidently* later in Study 2). The data also revealed a group of words—cluster 1: *apparently, presumably, reportedly, supposedly*—conveying a personal stance about the speaker’s knowledge source, namely, the knowledge is from evidence that does not come from direct experience. Note that evidentials—adverbs referring to knowledge supported by evidence—can also convey a level of conviction or of doubt. Hoye (1997) points out, for example, that *apparently* is a lower conviction adverb than are *clearly* and *obviously* because it conveys doubt in the sense that “what is

said can only be understood as the speaker’s interpretation rather than as a personal assessment of a particular state of affairs” (p. 192). Our data support this distinction between adverbs explicitly indicating that knowledge is indirect knowledge—*reportedly, supposedly, apparently* (knowledge through hearsay), and *presumably* (a conclusion that goes beyond what the speaker could directly know; Wierzbicka, 2006, p. 257)—vs. those indicating either more direct knowledge based on some form of thinking about the matter (cluster 3: *evidently, likely, and obviously*) or not indicating any information about source (cluster 4: *possibly, and probably*). Furthermore, while *evidently, likely, and obviously* (cluster 3) do appear to express high confidence, that confidence is based only on thinking about the matter (logical deduction based on other knowledge) and thus contrasts with *certainly, clearly, and definitely* (cluster 2; Wierzbicka, 2006, pp. 274–275). What we see here, then, is a range of subtle variations in how people can use adverbs of uncertainty to not only convey certainty or doubt, but also to express level of confidence, source of the information, manner by which one came to the opinion, or some combination of these. While linguistic analyses can reveal how languages—in principle—provide different ways to package these nuances, the augmented MDS analysis conducted here was able to empirically demonstrate that English-speakers are indeed guided by knowledge of such nuances, thereby further supporting the feasibility of using MDS to study how people mentally represent adverbs of uncertainty.

In summary, the results of this study demonstrated the feasibility of employing MDS together with a form of cultural consensus analysis and cluster analysis to reveal meaningful patterns in the way a group of speakers understand health-communication relevant epistemic adverbs (Figure 3 summarizes the analysis steps). Given the success of this application of MDS to dissimilarity ratings obtained from one English-speaking community, it would be valuable to see if the results can be broadly replicated with another English-speaking community and whether subtle differences between the two communities can also be discerned in the data. That was the goal of the next study.

STUDY 2

This study builds on Study 1 by replicating the data collection and analysis procedures with a new sample of native English-speakers from Canada. There were two main research questions. First, with a new sample would the MDS approach yield overall acceptability of results in terms of low Stress-1 values, high RSQ values, intragroup consensus, and semantic interpretability? Second, would it be possible to extend the analysis to compare the Australian and Canadian result patterns?

Materials and Methods

Participants were native speakers of English recruited from the participant pool at a major university in Montreal, Canada. The initial sample numbered 160, of which 69 qualified as dominant in English. As in Study 1, we excluded those reporting strong knowledge of another language. The final sample retained

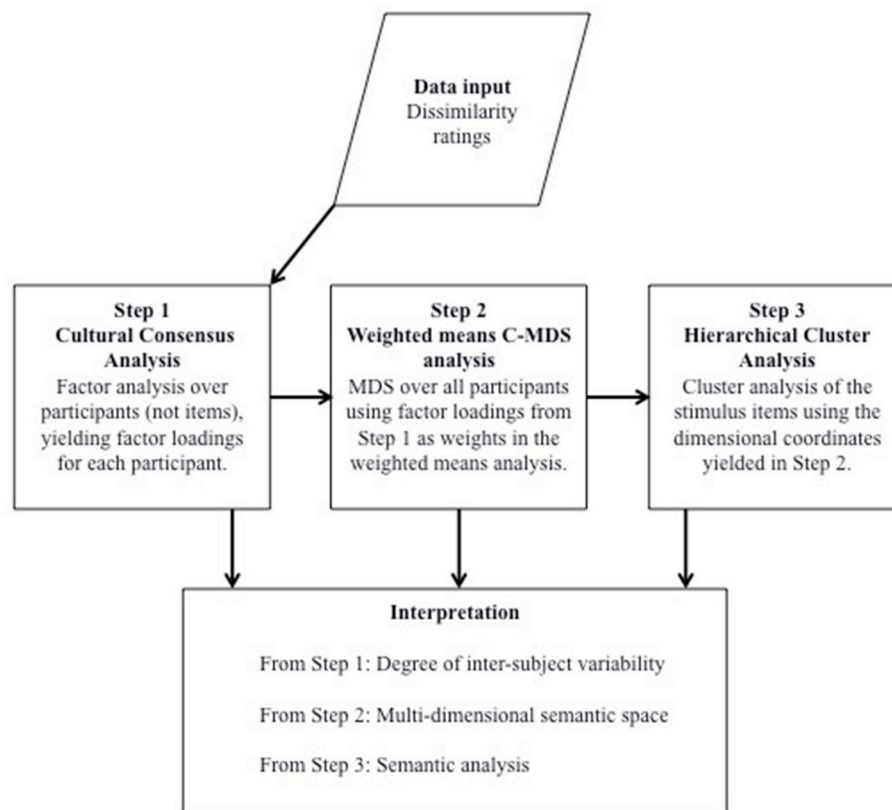


FIGURE 3 | Summary of the steps involved in the augmented classic multi-dimensional scaling (C-MDS) analysis employed in this study (see text for details).

consisted of 19 participants ($M_{\text{age}} = 23.05$ years, range = 18–40; 15 females). All received course credit for participating.

Materials

The materials were identical to those described in Study 1.

Procedure

Data were collected in parallel with Study 1, using identical procedures.

Results

Data were cleaned and prepared for analysis as in Study 1. For the first research question on the overall statistical acceptability of the results, we conducted a three-phase analysis: consensus analysis (factor analysis over participants), followed by C-MDS analysis on the single matrix of aggregated data (once with weighted data and once without), and semantic analysis using hierarchical cluster analysis (based on the coordinates from the C-MDS solution). For the second question on comparing results from the Australian and Canadian samples we used semantic analysis and a stress decomposition procedure as described below.

Overall Statistical Acceptability of Results

The three phases of the analysis for addressing the overall statistical acceptability of the results are now described in turn.

Consensus Analysis

As described in Study 1, we conducted a minimum residuals factor analysis (Weller, 2007). We factor analyzed a randomly selected subset of 10 participants from the sample of 19, repeating this procedure 1000 times. Each participant's median factor loading across the 1000 repetitions was interpreted as a cultural competence score, that is, as a measure of that person's degree of consensus with the group solution. These loadings were used to weight each participant's data in the C-MDS analysis applied to the data (see next section).

The consensus analysis (factor analysis) yielded a ratio of first-to-second eigenvalues of 5.77 where 3.0 is the desired minimum (eigenvalues were 3.59 and 0.62, respectively), and strong cultural competence scores (consensus with the group, operationalized as factor loadings on the single factor solution) with a median of 0.62 ($MAD = 0.173$), where 0.50 is the desired minimum (Weller, 2007). These results indicate that there was a consensual representation among the Canadian participants. There was, however, also variability across participants in their loadings, with scores ranging from 0.055 to 0.775, including scores under 0.30 for three participants. We eliminated these three participants when computing the group-level weighted average dissimilarity matrix using weighted data based on the loadings. These results indicate overall consensus across the group of Canadian English-speakers in their responses to the target adverbs.

C-MDS Analyses

Table 3 reports model fit values for 2D and 3D solutions obtained with the C-MDS analysis using *SmacofSym*, using unweighted data and weighted data based on the factor loadings obtained in the consensus analysis. As can be seen in **Table 3**, both the unweighted and weighted analyses yielded statistically acceptable results, namely low *Stress-1* values (all <0.11) and high *RSQ* values (all >0.88). These values indicate fits as good as or better than that obtained in Study 1 (compare with **Table 2**). The results justified 3D solutions from both the weighted and unweighted C-MDS analyses. As can be seen in **Table 3**, the weighted data analyses yielded superior fits of the model data to the dissimilarity ratings compared to the unweighted analyses (lower *Stress-1* values and higher *RSQ* values). For this reason, the analyses presented below are based on the 3D solution with the weighted data analysis.

Semantic Analysis

Figure 4 shows the 3D configuration yielded by the weighted C-MDS analysis and reports the results of hierarchical cluster analysis using the *fpc* package, based on the coordinate values from the C-MDS analysis, and showing both the cluster patterns and the corresponding stability measures. The results reveal a cluster of “confident” adverbs—*certainly*, *clearly*, *definitely*, and *obviously* (cluster 2, Jaccard similarity value = 0.869). The analysis also reveals a cluster generally referring to the speaker’s information source—*apparently*, *possibly*, *presumably*, and *supposedly* (cluster 1, Jaccard similarity value = 0.823), conveying information that could be seen as having its source at some distance from the speaker. Cluster 3 (Jaccard similarity value = 0.814) consists of the words *evidently*, *likely*, and *probably*, which convey confidence but not great certainty. The final “cluster” (cluster 4) has only *reportedly* as its member and a low Jaccard similarity value (0.635), the interpretation of which Hennig (2015) indicates would be difficult to make and “highly doubtful” (p. 30).

Overall, the results indicate successful replication of Study 1 with a new sample, in terms of strong community consensus, low *Stress-1*, high *RSQ*, and generally stable and interpretable semantic outcomes. The semantic analysis revealed some differences compared to the semantic outcomes reported in Study 1, and these are considered in the next section.

TABLE 3 | Model Fit Results for Study 2 with the Canadian sample using Classical MDS (C-MDS) with and without weighted data derived from cultural consensus analysis (see text for details).

Model	Canadian Sample	
	<i>Stress-1</i>	<i>RSQ</i>
3-DIMENSIONAL SOLUTION		
Weighted data	0.046	0.941
Unweighted data	0.053	0.919
2-DIMENSIONAL SOLUTION		
Weighted data	0.088	0.892
Unweighted data	0.109	0.886

RSQ, R-squared.

COMPARISON OF THE CANADIAN AND AUSTRALIAN SAMPLES

The two steps for comparing the Australian and Canadian results are now described in turn.

Semantic Analysis

As revealed above and in Study 1, each set of speakers differentiated a similar set of “confident” adverbs (cluster 2) from the rest. Interestingly, the Canadian sample included *obviously* in its cluster 2 whereas the Australian sample did not; nevertheless, *obviously* was located near cluster 2 in that sample’s 3D semantic space. This distinction (cluster 2 vs. the rest) seems to reflect D1. If one orders all items along D1 in the respective 3D solutions, the correlation between the Australian and Canadian sets is very strong—Spearman $\rho = 0.91$ ($p < 0.0001$). However, the first four items on this dimension (the higher confidence level items) appear to be more tightly clustered in the Canadian set than in the Australian set (see the respective MDS spaces). Both Canadian and Australian participants also seem to group together three adverbs expressing indirect knowledge (*presumably*, *apparently*, *supposedly*) but differ in terms of a fourth adverb in this cluster—*possibly* in the Canadian and *reportedly* in the Australian data (compare cluster 1 from each sample). In the Canadian set *reportedly* did not enter into a valid, stable cluster. Despite these

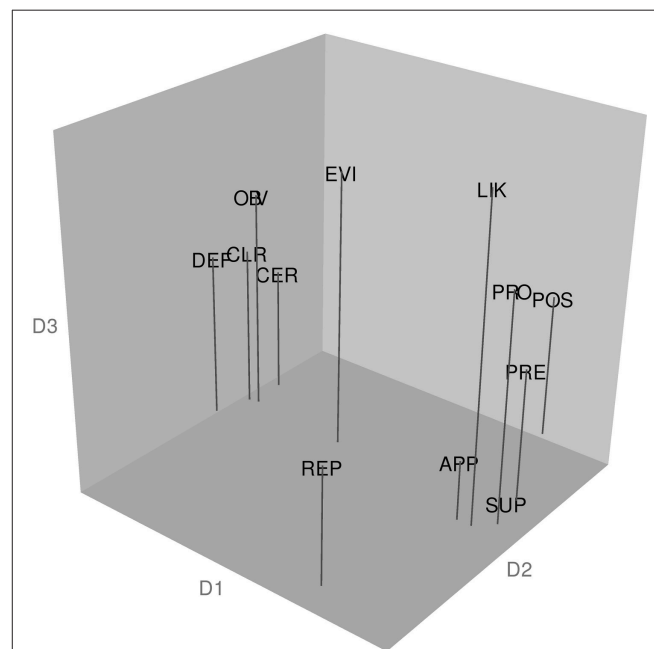


FIGURE 4 | Configuration of target adverbs in the Canadian sample and the results of a hierarchical cluster analysis of the coordinates from the MDS spatial configuration. The abbreviations for the 12 target adverbs are: APP, apparently; CER, certainly; CLR, clearly; DEF, definitely; EVI, evidently; LIK, likely; OBV, obviously; POS, possibly; PRE, presumably; PRO, probably; REP, reportedly; and SUP, supposedly. The analysis revealed the following clusters: Cluster 1 (Jaccard similarity value = 0.823): apparently, possibly, presumably, supposedly; Cluster 2 (Jaccard similarity value = 0.869): certainly, clearly, definitely, obviously; Cluster 3 (Jaccard similarity value = 0.814): evidently, likely, probably; Cluster 4 (Jaccard similarity value = 0.635): reportedly.

differences, the two groups appear to generally resemble each other on these two aspects of underlying meaning of uncertainty adverbs.

Stress Decomposition Analysis

We also compared the two data sets by decomposing *Stress-1* values, looking at each adverb's stress-per-point (*SPP*) as a percent of total stress. These decomposition values reflect how easily each adverb fit into the solution space (Figure 5). In each data set, 10 of the 12 adverbs accounted for 13% or less of the stress, with many accounting for 5% or less. The similarity of values indicates that most adverbs contributed to the overall picture in much the same way, and their low values indicate the participants had little difficulty making the ratings. The latter is not surprising, given that all were native speakers of English. For each data set, however, two adverbs did not fit as easily as the other 10. In the Australian sample *certainly* and *evidently* were outliers (*SPP* = 23 and 25%, respectively) and in the Canadian sample *apparently* and *evidently* were outliers (*SPP* = 19 and 24%, respectively).

Discussion

This study replicated the basic results of Study 1 with a new sample of participants, showing that classical-MDS, when combined with consensus analysis and complemented by hierarchical cluster analysis, can reveal statistically acceptable and linguistically meaningful results regarding the comprehension of epistemic adverbs presented in sentence contexts. In addition, the results showed that it was possible to compare results from two different speech communities. Goodness-of-fit values, semantic space solutions, stress decomposition analysis and cluster stability measures all indicated strong similarities between the groups as well as some differences.

One interesting group similarity is that the same word—the adverb *evidently*—turned out to be an outlier for both speech communities in terms of its high *SPP* value (how poorly it fit into the spatial solution), as seen in Figure 5. Wierzbicka (2006, p. 271) observed that *evidently* indicates that the source of a speaker's confidence derives from “thinking rather than knowledge” and conveys the message that “if other people thought about this evidence, they would have come to the same conclusion.” Hoyer (1997, p. 192), somewhat differently,

argues that *evidently* signals an element of doubt because it indicates a conclusion based on interpretation and not directly experienced knowledge. Guimier (1988) makes a similar point. Thus, there appear to be at least two nuances underlying the word *evidently*, one related to an indirect knowledge source and the other to an element of doubt. Interestingly, in the Australian sample *evidently* appears in a cluster along with *obviously* whereas in the Canadian sample it occurs together with *probably*. These appear to reflect the two different interpretations of the word identified by the linguists cited above, suggesting that Australian speakers emphasize the indirect knowledge element of its meaning whereas Canadian speakers emphasize the doubt element of its meaning. Unfortunately it was beyond the scope of this study to explore this speaker-group difference more deeply but, now that this difference has been revealed in speakers' comprehension of sentences using the word, future research on this difference seems merited. Finally, it should be noted that, of the 12 adverbs, *evidently* occurs the least frequently in the English language (Davies, 2008). Perhaps, then, the high *SPP*-values for *evidently* reflect response inconsistency arising from these different considerations.

With respect to group differences, the adverb *apparently* had a high *SPP*-value in the Canadian sample but not the Australian, whereas the reverse was true for *certainly*. Wierzbicka (2006, pp. 277–278) points out that *apparently* has three possible interpretations, one related to *it appears that*, another indicating hearsay as the information source, and a third conveying a noncommittal stance regarding the truth of the statement. All three could have been evoked by the stimulus sentences used in this study. Perhaps the two communities differ in how likely each meaning comes to mind. For example, if Canadian participants typically accessed any or all three whereas the Australian participants focused on only one or two, this could account for the asymmetry in *SPP* values. Similarly, the adverb *certainly* has multiple nuances. Wierzbicka (2006) indicates it can convey assent or agreement, especially in sentence initial position and also “the speaker's full (not merely subjective) certainty (p. 286)” about the information. Hoyer (1997) also distinguishes between possibility and necessity, a distinction that may have affected interpretations of *certainly* in the present research. For example, expressions conveying possibility (*this could certainly*

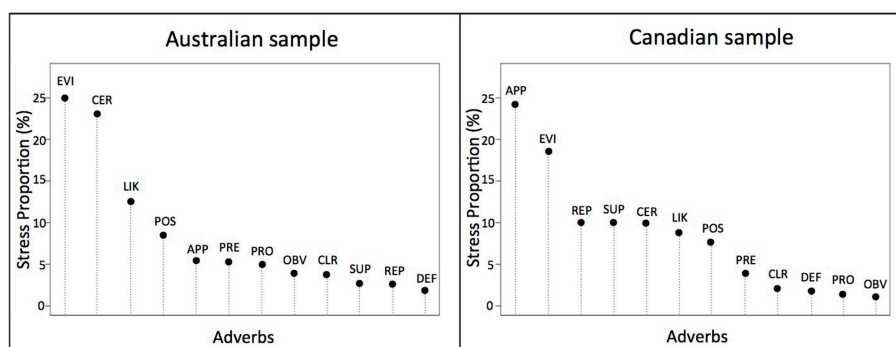


FIGURE 5 | Stress decomposition per adverb (percent contribution to overall stress by each adverb) in each of the Australian and Canadian data sets.

The abbreviations for the 12 target adverbs are: APP, apparently; CER, certainly; CLR, clearly; DEF, definitely; EVI, evidently; LIK, likely; OBV, obviously; POS, possibly; PRE, presumably; PRO, probably; REP, reportedly; and SUP, supposedly.

mean ...) occurred 4/11 times, those conveying necessity (*this certainly means ...*) occurred 6/11 times, and one example might have conveyed assent (in sentence initial position, *Certainly, ...*). Again, there might have been speech community differences in how these alternative interpretations affected responding.

The important conclusion here is that methodologically it was possible to reveal similarities and differences between the two speech communities in their comprehension of these epistemic adverbs, indicating the potential utility of MDS for future study of language barriers in health communication, including where second language speakers are involved.

GENERAL DISCUSSION

Our main goal was to explore the feasibility of using MDS to study word comprehension relevant to language barriers in health communication. For this purpose, we focused on adverbs of doubt and certainty and on data from two different communities of first language speakers of English. The logic of this approach was that if MDS did not work well with first language speakers it could not be expected to work well with other groups, such as second language speakers. In addition, it was important to discover if presenting target words in sentences that highlight the health communication context would in some way undermine the use of MDS. We also wanted to explore obtaining group-based solutions that took into account individual variability. The results of the two studies reported here supported the feasibility of using MDS. In particular, the results demonstrated a three-step approach to be useful. First, the dissimilarity rating data were submitted to a cultural consensus analysis (factor analysis over participants, not items) to obtain factor loadings indicating how much each person performed in accord with the group as a whole. Second, these factor loadings were used to weight the dissimilarity ratings in a classical multidimensional scaling (C-MDS) analysis where the weighted ratings were averaged over participants to yield a single data matrix. Third, the coordinates for each adverb in the semantic space generated by the C-MDS analysis were used in a hierarchical cluster analysis to reveal underlying patterns of stable clusters that helped to interpret the structure within the semantic space. This three-phase analysis yielded solutions that strongly met statistical acceptability criteria in MDS research, it generated an interpretable semantic space for the target adverbs, and it demonstrated the possibility of making comparisons across speech communities. This three-phase approach proved to be more feasible than an individual differences W-MDS (INDSCAL) approach and made it possible to avoid some of the limitations of W-MDS analyses, including the need to run lengthy simulations with random data.

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In sum, the results provided a backdrop supporting the use of MDS, supplemented by cultural consensus and cluster analyses, for future studies. The techniques described here should be of special value for the study of language barriers due to cultural differences between patient and physician or to language discordance, that is, where patient and physician speak different first languages. Language discordant physician-patient encounters are becoming increasingly frequent because of the growing mobility of populations, both in terms of the linguistic diversity of patients (immigrants, national linguistic minorities) and growing reliance everywhere on health practitioners coming from other countries (Jacobs et al., 2006; Segalowitz and Kehayia, 2011). Such intercultural and language discordant situations may be especially vulnerable to miscommunication, with obvious possible serious consequences given that health issues are involved. The techniques described here have theoretical applications for probing the nature of misunderstanding that can arise in health communication. They also can be of value as a tool for assessing individuals and groups in the context of practical measures taken to provide language and/or cultural sensitivity training for health practitioners.

AUTHOR CONTRIBUTIONS

NS, RM, YZ, JH, and AR were responsible for the original conception and design of this research and for the data acquisition. MD had the lead role in conducting the statistical analyses, working together with NS and JH. NS and MD were primarily responsible for writing the manuscript but all co-authors contributed substantially to the final version. All were involved in the interpretation of results.

FUNDING

The authors would like to thank the Australian Research Council for a Discovery Project grant (DP130104164) awarded to RM, Cindy Gallois, NS, and AR, which supported this research. We also thank Health Canada for an earlier grant to McGill University's Training and Retention of Health Professionals (TRHP) project and subaward to NS and AR of the Health-Care Access for Linguistic Minorities (H-CALM) research team in support of earlier work leading up to this study.

ACKNOWLEDGMENTS

The authors would also like to acknowledge the contribution of Catherine Ouellet-Courtois for earlier honors thesis work that made the present research possible.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Visualizing Psychological Networks: A Tutorial in R

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Networks have emerged as a popular method for studying mental disorders. Psychopathology networks consist of aspects (e.g., symptoms) of mental disorders (nodes) and the connections between those aspects (edges). Unfortunately, the visual presentation of networks can occasionally be misleading. For instance, researchers may be tempted to conclude that nodes that appear close together are highly related, and that nodes that are far apart are less related. Yet this is not always the case. In networks plotted with force-directed algorithms, the most popular approach, the spatial arrangement of nodes is not easily interpretable. However, other plotting approaches can render node positioning interpretable. We provide a brief tutorial on several methods including multidimensional scaling, principal components plotting, and eigenmodel networks. We compare the strengths and weaknesses of each method, noting how to properly interpret each type of plotting approach.

OPEN ACCESS

Edited by:

Sergio Machado,
Salgado de Oliveira University, Brazil

Reviewed by:

Ilya Zhbannikov,
Duke University, United States
Claudio Imperatori,
Università Europea di Roma, Italy

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Specialty section:

This article was submitted to
Quantitative Psychology and
Measurement,
a section of the journal
Frontiers in Psychology

Received: 19 June 2018

Accepted: 28 August 2018

Published: 19 September 2018

Citation:

Jones PJ, Mair P and McNally RJ
(2018) Visualizing Psychological
Networks: A Tutorial in R.
Front. Psychol. 9:1742.
doi: 10.3389/fpsyg.2018.01742

Keywords: network analysis, network psychometrics, psychopathology, multidimensional scaling, graph theory

Psychologists have witnessed an explosion of research utilizing network analysis to measure psychological constructs (see Fried et al., 2017 for a review). Networks, which consist of nodes connected to each other by edges, are a useful tool for visualizing and interpreting relational data. Diverse statistical procedures can be applied to analyze network structures. For example, researchers can determine which nodes are most highly connected or whether the network clusters into separate communities of nodes.

Unlike social networks where one directly observes connections between individuals (e.g., friends, enemies; Burt et al., 2013), the edges in psychological networks require statistical estimation, often partial correlations reflecting the strength of association between nodes. In visualizations, green (or blue) edges represent positive associations, and red edges represent negative associations. The thickness of an edge corresponds to the strength of association. Dubbed “network psychometrics,” (Epskamp et al., 2016; Fried et al., 2017), this approach has stimulated many studies estimating networks of various psychological constructs.

In contrast to traditional approaches to psychopathology that regard symptoms as reflecting the presence of a latent disease entity that causes their emergence and covariance, network researchers view mental disorders as emerging from interactions among symptoms (Cramer et al., 2010; Borsboom and Cramer, 2013; Borsboom, 2017). Researchers have therefore endeavored to model disorders as causal systems. Theory motivating this type of analysis posits that mental disorders are phenomena emerging from the causal associations between biological, social, and affective components (Jones et al., 2017).

However, network analysis has not been confined to abnormal psychology. Researchers have applied network analysis in studies on personality (Cramer et al., 2012; Costantini et al., 2015a,b, 2017) and attitudes (Dalege et al., 2016), arguing that traits and attitudes may be better represented as emergent properties of complex networks rather than as underlying latent

variables (e.g., dimensional personality factors). Indeed, as this approach becomes more widely known, it is likely that many more psychological constructs will soon be characterized as emergent properties of complex networks (e.g., Barabási, 2011). Thus, understanding the nuances of network analysis is of growing importance in psychology.

In this article, we explore several methods for visualizing networks. Each has advantages and disadvantages. Some foster intuitive spatial interpretation of network structure, whereas others provide little spatial information, but facilitate clarity and aesthetics of network edges. Our tutorial applies exclusively to network visualization; network computation procedures such as node centrality remain identical regardless of the visualization method one uses. We provide brief, simple explanations and examples suitable for psychological researchers who plan to use or interpret network analyses. As this article is not an advanced statistical tutorial, we relegate formulas and other detailed information to an **Data Sheet 1 (Appendix)**. We provide accompanying R code (R Core Team, 2018) in the text throughout this tutorial (**Data Sheet 3**).

VISUAL (MIS)INTERPRETATION OF NETWORKS

Networks enable the visualization of complex, multidimensional data as well as provide diverse statistical indices for interpreting the resultant graphs (e.g., McNally, 2016; Haslbeck and Waldorp, 2017; Jones, 2017; van Borkulo et al., 2017). However, depending on how the network is plotted, visual interpretation of the position of nodes can easily lead one astray. Four misunderstandings about the spatial placement of nodes are common.

First, researchers may assume that the graphical spacing of two connected nodes signifies the magnitude of their association. This is not always true. Depending on the plotting method, two strongly associated nodes may appear far apart, whereas two weakly associated nodes may appear close together.

Second, researchers may mistakenly assume that a node's placement along the X and Y axes signifies a meaningful position on a coordinate plane. For example, consider a network in which OCD symptoms cluster on the right and depression symptoms cluster on the left. A researcher might erroneously conclude that the depression symptoms nearer to the right are "more OCD-like" than those toward the left. The X and Y position of nodes cannot always be interpreted in this way; position of nodes does not necessarily correspond to a meaningful coordinate plane.

Third, researchers may erroneously conclude that a node positioned in the center of the network is a *central* node. Node centrality metrics measure the "importance" of a node in a network, not its physical position in the graph. For example, strength centrality reflects the number and magnitude of connections a node has to other nodes in the network. A node with many strong connections may appear anywhere in the graph, not necessarily in its center. Conversely, nodes appearing

near the center of a graph need not be highly central in the network.

Fourth, researchers may incorrectly assume that a network study failed to replicate because the network in the new study appears dramatically different than the original one. Not all plotting methods are stable, and some can be rotated arbitrarily. This can lead to networks that appear wildly different, even though their statistical structures are similar.

Depending on the visualization method, any or all of these assumptions may be incorrect. Researchers can minimize misinterpretations by careful choice of visualization methods and raising awareness about how to interpret each type of visualization accurately.

TWO PRACTICAL EXAMPLE DATASETS

In order to demonstrate different types of visualizations, we will use two example datasets from the literature. Both datasets contain information on symptoms of obsessive-compulsive disorder (OCD) and depression. OCD and depression are frequently comorbid (Millet et al., 2004). Moreover, comorbid depression is associated with aggravated OCD symptoms and higher rates of suicide (Torres et al., 2011; Brown et al., 2015). Understanding the complex relationships among OCD and depression symptoms may provide valuable insight for clinicians and researchers.

McNally et al. (2017) used network analysis to examine OCD and depression symptoms in adults. A dataset of these symptoms in 408 adults is available in the *MPsychor* package (Mair, 2018). The 26 symptoms were recorded using Likert style self-report scales (Y-BOCS, QIDS-SR; see McNally et al., 2017 for details). Let's load the data (**Data Sheet 2**).

```
library("MPsychor")
data(Rogers)
dim(Rogers)
[1] 408 26
```

Jones et al. (2018) replicated this analysis in a smaller sample of adolescents. This dataset is also included in the *MPsychor* package (Mair, 2018). This replication dataset of 87 adolescents provides an opportunity to compare and contrast visualizations with the sample from McNally et al. (2017).

```
data(Rogers_Adolescent)
dim(Rogers_Adolescent)
[1] 87 26
```

To preserve space in network visualizations, we will assign a number to each variable for the labels. Numbering and variable descriptions can be found in **Table 1**.

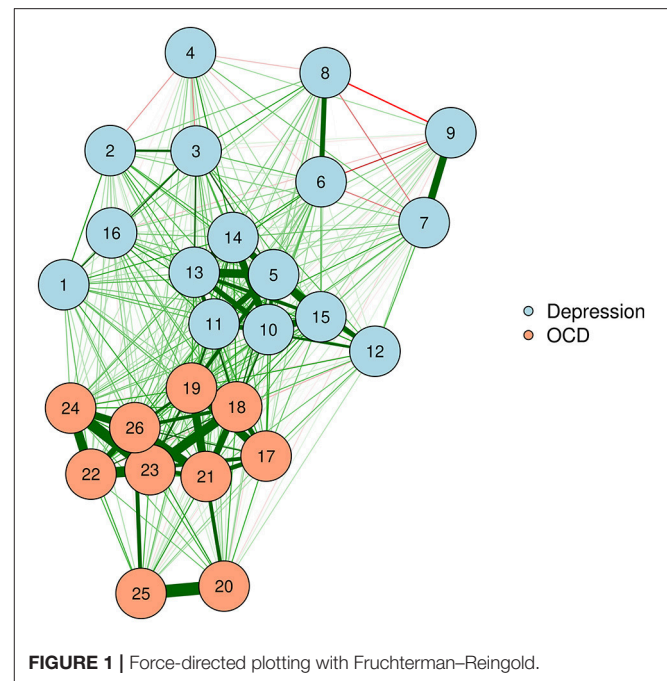
```
colnames(Rogers)
<- colnames(Rogers_Adolescent) <- 1:26
```

FORCE-DIRECTED ALGORITHMS (e.g., FRUCHTERMAN-REINGOLD)

Most network studies in psychopathology have used the Fruchterman-Reingold (FR) algorithm to plot graphs

TABLE 1 | Nodes in Adult and Adolescent OCD & Depression Networks.

Number	Symptom (Depression)	Number	Symptom (OCD)
1	Sleep-onset insomnia	17	Time consumed by obsessions
2	Middle insomnia	18	Interference due to obsessions
3	Early morning awakening	19	Distress caused by obsessions
4	Hypersomnia	20	Difficulty resisting obsessions
5	Sadness	21	Difficulty controlling obsessions
6	Decreased appetite	22	Time consumed by compulsions
7	Increased appetite	23	Interference due to compulsions
8	Weight loss	24	Distress caused by compulsions
9	Weight gain	25	Difficulty resisting compulsions
10	Concentration impairment	26	Difficulty controlling compulsions
11	Guilt and self-blame		
12	Suicidal thoughts, plans, or attempts		
13	Anhedonia		
14	Fatigue		
15	Psychomotor retardation		
16	Agitation		

**FIGURE 1** | Force-directed plotting with Fruchterman-Reingold.

(Fruchterman and Reingold, 1991). The FR algorithm is a force-directed graph method (see also Kamada and Kawai, 1989) akin to creating a physical system of balls connected by elastic strings. An elastic string connecting two nodes pulls them closer together, while other nodes draw them apart in other directions. This results in a visually appealing graph where nodes generally do not overlap and edges have approximately the same length.

The aim of force-directed algorithms is to provide aesthetically pleasing graphs by minimizing the number of crossing edges and by positioning nodes so that edges have approximately equal length. Importantly, the purpose of plotting with a force-directed algorithm is *not* to place the nodes in meaningful positions in space. Rather, the intent is to position nodes in a manner that allows for easy viewing of the network edges and clustering structures.

When plotting with the FR algorithm or another force-directed method, one must refrain from making any spatial interpretation. Erroneous interpretations based on spatial arrangement are a common trap as it is difficult to ignore space in a visualization.

The FR algorithm is a default plotting method in the *qgraph* R package (Epskamp et al., 2012), and is thus very easy to implement. We will demonstrate by using a zero-order correlation network of adults with OCD and depression. The resultant network appears in **Figure 1**.

```
library("qgraph")
adult_zeroorder <- cor(Rogers)
qgraph(adult_zeroorder, layout="spring",
       groups = list(Depression = 1:16,
                     "OCD" = 17:26),
       color = c("lightblue",
                 "lightsalmon"))
```

Force-directed algorithms produce visually appealing plots in which nodes rarely overlap. It is important to keep in mind that the positioning of nodes in a force-directed algorithm cannot be interpreted.

MULTIDIMENSIONAL SCALING OF NETWORKS

Multidimensional scaling (MDS) has a long history and has been applied in a wide variety of academic arenas (Torgerson, 1958; Kruskal, 1964; Borg and Groenen, 2005; Borg et al., 2018). MDS represents *proximities* among variables as distances between points in a low-dimensional space (e.g., two or three dimensions; Mair et al., 2016). Proximity is an umbrella term for “similarities” between variables (e.g., correlation) or “dissimilarities” (e.g., Euclidean distance). Because MDS helps represent complex data in low-dimensional space, it dovetails precisely with the goal of visual presentation of complex psychological networks. That is, we can use MDS to represent proximities in a two-dimensional space (e.g., X & Y) to produce two-dimensional network plots. MDS is particularly useful for understanding networks because the distances between plotted nodes are interpretable as Euclidean distances. That is, highly related nodes will appear close together, whereas weakly related ones will appear far apart.

In MDS, we consider a matrix of proximities between objects (in our case, nodes). The input data for MDS can be either *directly observed proximities* or *derived proximities* (for details see Mair et al., 2016). Most psychometric networks provide us with a ready-made matrix of *derived proximities* (in this case, *similarities*): the network edges. Network edges are usually zero-order or partial correlations between pairs of nodes. Here, we will again use a zero-order correlation network as our weights matrix.

```
adult_zeroorder <- cor(Rogers)
```

Because the *smacof* R package (De Leeuw and Mair, 2009) requires dissimilarities (rather than similarities) as input, we will convert the correlation matrix into a dissimilarity matrix (Gower and Legendre, 1986; see the **Data Sheet 1 (Appendix)** for a formula). The result is a symmetric dissimilarity matrix Δ with $n(n-1)/2$ dissimilarities (in the lower diagonal portion).

```
library("smacof")
dissimilarity_adult <-
  sim2diss(adult_zeroorder)
```

After determining our dissimilarity matrix, we then locate points (configuration matrix) in a two-dimensional space such that the distances between the objects (nodes) approximate a transformation of the dissimilarities as closely as possible, given the constraints of a two-dimensional solution. The configuration matrix for this specific application will be a matrix X of dimension $n \times 2$ with elements that represent Cartesian coordinate points with which to plot the nodes. The MDS configuration matrix provides the basis for visualization, not for any network calculations. Although in this tutorial we always constrain the configuration matrix to two dimensions (for two-dimensional plots), it should be noted that MDS can also be used to generate configurations in higher dimensions.

```
adult_MDS <- mds(dissimilarity_adult)
head(round(adult_MDS$conf, 2)) # top of
# configuration matrix
```

	D1	D2
1	-0.21	0.53
2	-0.80	0.03
3	-0.70	0.33
4	0.25	-0.77
5	-0.53	-0.07
6	0.07	0.78

Transformations

The configuration matrix is fit on a transformation of the input dissimilarity matrix. There are several different types of transformations available. It is useful to have a variety of options for transformation so that we can choose a transformation which fits our network data. Some common transformation functions include ordinal MDS, interval MDS, ratio MDS, and spline MDS. Ordinal MDS uses a monotone step function. Ratio MDS uses a linear regression with an intercept of 0. Interval MDS is also linear but allows the intercept to vary. Spline MDS uses a monotone integrated spline. These transformations are described in greater detail in Mair et al. (2016).

In the case of psychometric networks, where we can reasonably assume that there is some metric information in the proximities, we can choose the transformation from a data-driven perspective. As with fitting any distribution, one should choose a transformation function which is both parsimonious and provides a good fit to the data. Ordinal MDS usually provides the best goodness-of-fit, but is the least parsimonious. In contrast, ratio MDS is parsimonious, but may fit poorly to some networks. We can use Shepard diagrams (**Figure 2**) to visualize MDS fit and

to determine the preferred transformation function (Mair et al., 2016).

```
adult_MDS_ordinal <- mds(dissimilarity_adult,
  type="ordinal")
plot(adult_MDS_ordinal, plot.type = "Shepard",
  main="Ordinal")
text(1.1,0.3, paste("Stress =",
  round(adult_MDS_ordinal$stress,2)))

adult_MDS_ratio <- mds(dissimilarity_adult,
  type="ratio")
plot(adult_MDS_ratio, plot.type = "Shepard",
  main="Ratio")
text(1.1,0.3, paste("Stress =",
  round(adult_MDS_ratio$stress,2)))

adult_MDS_interval <- mds(dissimilarity_adult,
  type="interval")
plot(adult_MDS_interval, plot.type = "Shepard",
  main="Interval")
text(1.1,0.3, paste("Stress =",
  round(adult_MDS_interval$stress,2)))

adult_MDS_mspline <- mds(dissimilarity_adult,
  type="mspline")
plot(adult_MDS_mspline, plot.type = "Shepard",
  main="Spline")
text(1.1,0.3, paste("Stress =",
  round(adult_MDS_mspline$stress,2)))
```

Shepard diagrams allow us to visualize how well our MDS configuration fits our dissimilarity matrix. When the dissimilarities align in a linear fashion, a ratio or interval MDS is most appropriate. In other cases, a nonlinear transformation such as ordinal MDS or spline MDS may be more appropriate. In this case, we decided to use a spline MDS. The normalized stress values (plotted in each graph) can help guide us in deciding which transformation provides the best fit.

A value known as *stress* indicates how well one's data can be represented in two-dimensions [see **Data Sheet 1 (Appendix)**]. In this tutorial, we will use the *stress-1*, which is a normalized version of stress. When the stress is low, the graph is interpretable. That is, the spacing between two nodes approximately signifies the strength of their association. When the stress is higher, we must be much more cautious about these types of interpretation. A high stress indicates that the nodes cannot be accurately spaced in just two dimensions. For additional guidance on interpreting stress, see Mair et al. (2016).

```
adult_MDS_mspline$stress
[1] 0.189
```

The final product of an MDS configuration is a two-dimensional space in which distance between nodes represents the approximate dissimilarity of nodes based on their edges. For example, in our zero-order correlation network, the distance between two nodes varies inversely with their strength of association. Hence, strongly associated nodes appear close together, while weakly associated or negatively associated nodes appear far apart.

We can produce such a plot by entering the MDS configuration into the "layout" argument of *qgraph* or *plot.igraph*

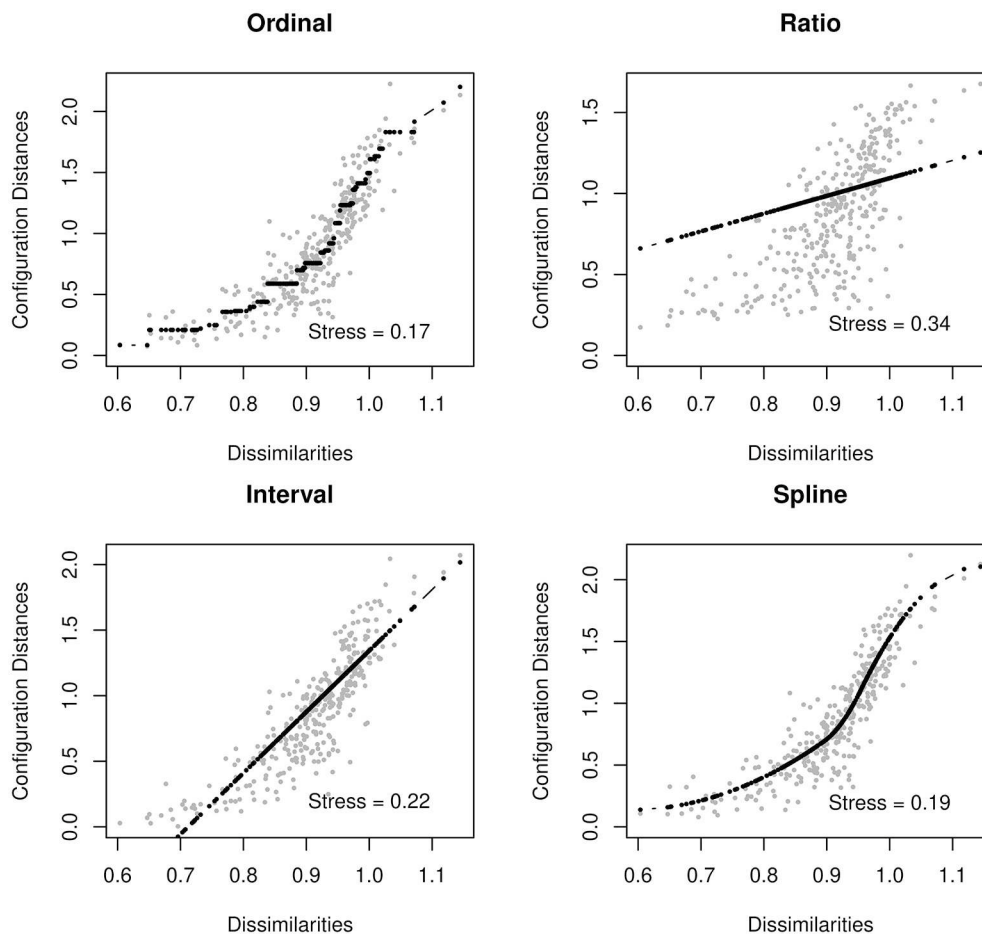


FIGURE 2 | Shepard Diagrams.

(Csardi and Nepusz, 2006; Epskamp et al., 2012). We will also put the stress-1 value as text on the plot, for easy reference. The result appears in **Figure 3**.

```
qgraph(adult_zeroorder,
       layout=adult_MDS_mspline$conf,
       groups = list(Depression = 1:16,
                     "OCD" = 17:26), color = c("lightblue",
                                               "lightsalmon"), vsize=4)
text(-1,-1, paste("Stress=",
                  round(adult_MDS_mspline$stress,2)))
```

McNally et al. (2017) examined a network of OCD and depression symptoms in adults. Here, a zero-order correlation network of symptoms is graphed according to a spline MDS configuration. The distance between nodes represents how close they are in terms of the zero-order correlations.

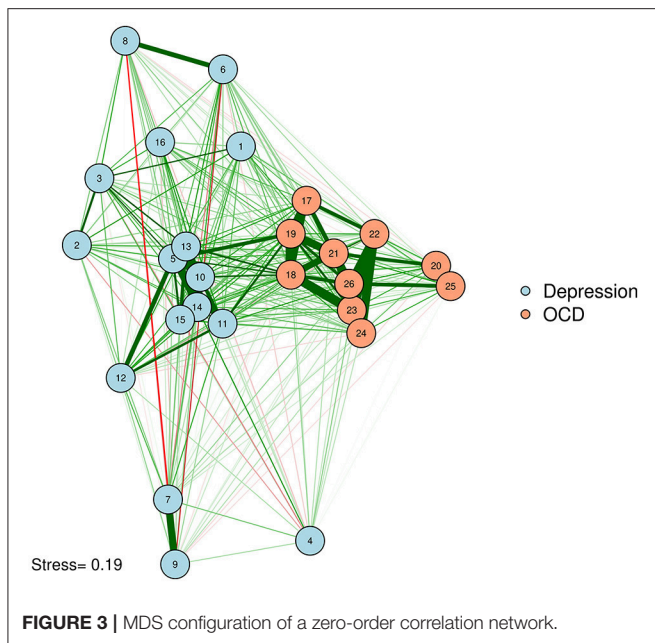
One problem with **Figure 3** is that some of the strongly associated nodes overlap, obscuring the edges between those two nodes. Researchers concerned about overlap obscuring important information can reduce the size of the nodes or use points instead of circles to represent variables. Let's produce a plot with points (instead of circles) for nodes. We will use the *textplot*

function in the *wordcloud* R package (Fellows, 2014) to ensure that node labels do not overlap (See **Figure 4**).

```
library("wordcloud")
qgraph(adult_zeroorder,
       layout=adult_MDS_mspline$conf,
       groups = list(Depression = 1:16,
                     "OCD" = 17:26),
       color = c("lightblue", "lightsalmon"),
       vsize=0, rescale=FALSE, labels=FALSE)
points(adult_MDS_mspline$conf, pch=16)
textplot(adult_MDS_mspline$conf[,1]+.03,
         adult_MDS_mspline$conf[,2]+.03,
         colnames(adult_zeroorder),
         new=F)
```

This figure is identical to **Figure 3**, but uses points to plot nodes. This avoids overlap, although some edges may remain difficult to see if the points are very close together.

Multidimensional scaling can be applied purely on the edge values in the network. This technique can be used for both psychometric networks and directly derived (e.g., social) networks. In other words, one can generate an MDS network

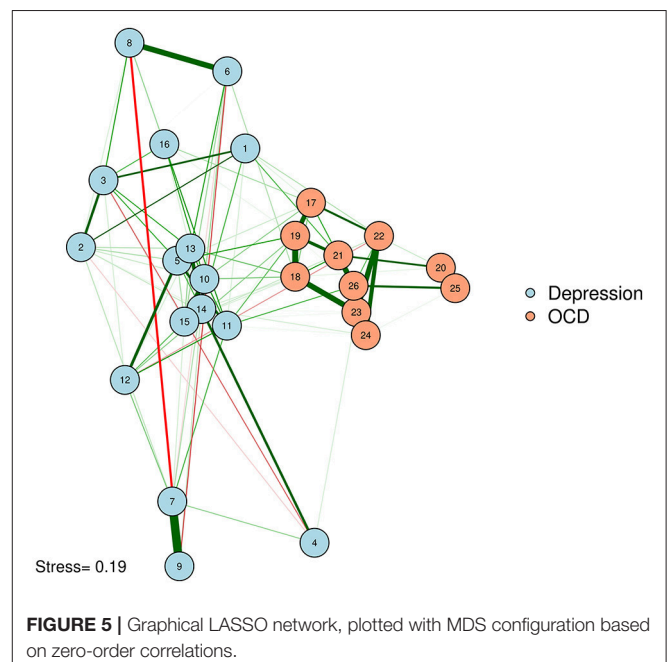
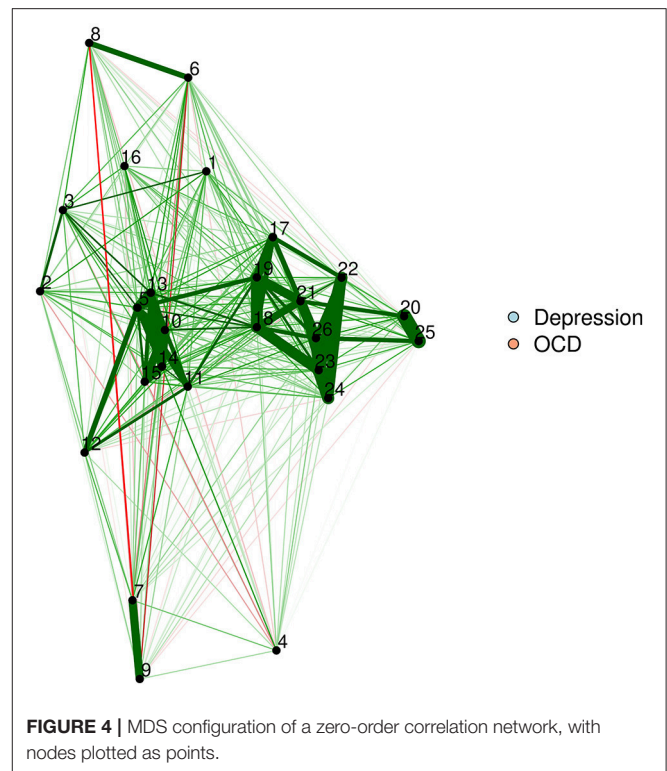


plot based purely on the network edges, without having access to original participant data.

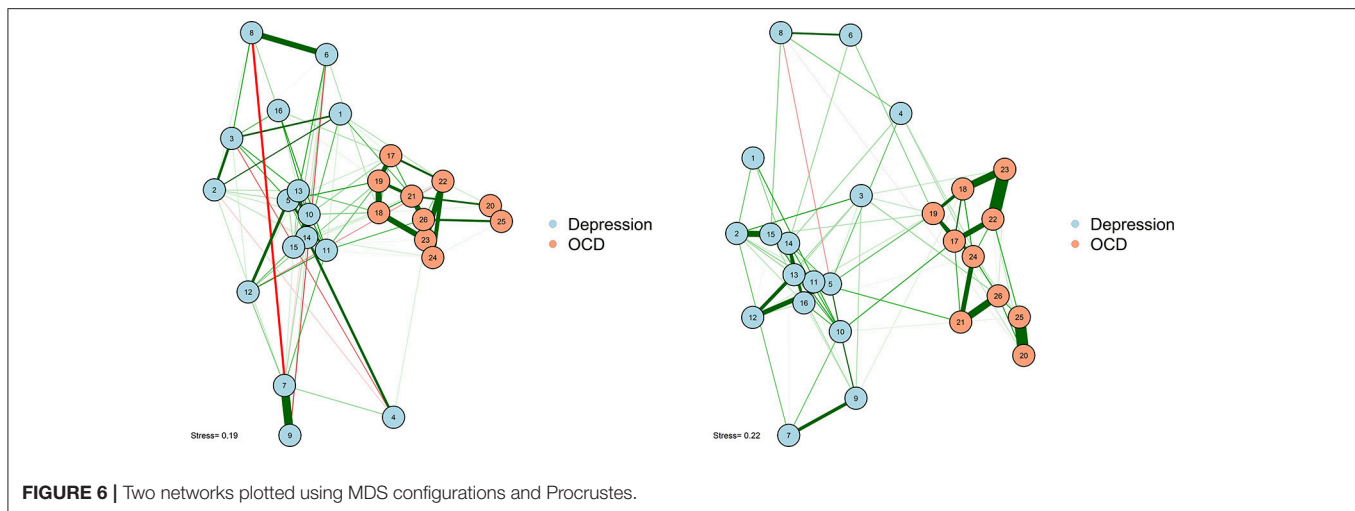
If one computes an MDS configuration based on the edges, the spacing between nodes is proportional to the strength of the edges. Thus, the information provided by the node spacing is redundant – represented once in the edge thickness, and yet again by the node spacing. This redundancy can facilitate quick and intuitive interpretation, but does not add new information to the plot.

If researchers want to provide *additional* information with the spacing of their nodes, they can base their MDS on a *different* type of similarity matrix derived from the original data. For example, a network could be plotted with edges that represent *partial correlations*, with spacing based on *zero-order correlations*. In other words, we could plot our partial correlation network, complete with edges, in a zero-order correlation space. The reverse is also possible; one could use zero-order correlations as edges, and convert a partial correlation matrix into dissimilarities as input for an MDS plotting configuration. The researcher thus maximizes the data conveyed by the graph by using the space to indicate information that is not given in the edge structure. As an example, let's compute a graphical LASSO network of the adult network, as was done by McNally et al. (2017), but use the zero-order MDS configuration from before to plot the positioning of the nodes (See Figure 5).

```
adult_glasso <- EBICglasso(cor(Rogers), n=408)
qgraph(adult_glasso,
  layout=adult_MDS_mspline$conf,
  groups = list(Depression = 1:16,
    "OCD" = 17:26),
  color = c("lightblue", "lightsalmon"),
  vsize=4)
text(-1,-1, paste("Stress=",
  round(adult_MDS_mspline$stress,2)))
```



Network of OCD and depression symptoms in adults (McNally et al., 2017). Here, we plot edges according to a *graphical LASSO* network, but use the graphical space between nodes to convey how closely associated nodes are in terms of the *zero-order correlations* based on an MDS configuration. In other words, nodes that are close together are similar in terms of zero-order



correlations; nodes that share a thick edge are similar in terms of regularized partial correlations.

Procrustes

As noted earlier, one particularly challenging aspect of node placement is providing an accurate visual comparison between two networks. Two or more configurations can be brought into a similar space and compared by using the Procrustes algorithm [see **Data Sheet 1 (Appendix)**; see also Davison, 1985]. This procedure, named after Poseidon's son in Greek mythology ("Procrustes, the stretcher"), removes statistically "meaningless" differences (i.e., they do not change the fit of an MDS solution) between the two configurations. We can use the Procrustes algorithm to bring together the adult network from McNally et al. (2017) with the adolescent network in Jones et al. (2018). This visual comparison is presented in **Figure 6**.

```
adolescent_zeroorder <- cor(Rogers_Adolescent)
dissimilarity_adolescent <-
  sim2diss(adolescent_zeroorder)
adolescent_MDS <- mds(dissimilarity_adolescent,
  type="mspline")
fit_procrustes <- Procrustes(adult_MDS_
  mspline$conf, adolescent_MDS$conf)
adolescent_glasso <- EBICglasso(cor
  (Rogers_Adolescent), n=87, gamma=0)
qgraph(adult_glasso, layout=fit_procrustes$X,
  groups = list(Depression = 1:16,
    "OCD" = 17:26),
  color = c("lightblue", "lightsalmon"), title=
    "Adults, n=408", vsize=4)
text(-1,-1, paste("Stress=",
  round(adult_MDS_mspline$stress,2)))
qgraph(adolescent_glasso,
  layout=fit_procrustes$Yhat,
  groups = list(Depression = 1:16,
    "OCD" = 17:26),
  color = c("lightblue", "lightsalmon"),
  title="Adolescents, n=87", vsize=4)
text(-1,-1, paste("Stress=",
  round(adolescent_MDS$stress,2)))
```

This algorithm not only creates interpretable plots; it can also be statistically evaluated in terms of how well the MDS solution replicates across different samples. The Procrustes method provides a way to compare two network plots in a highly meaningful way, where the position of nodes directly corresponds to similarities or dissimilarities between the two networks. We can even quantify the degree to which the MDS replicates between the two networks by using a congruence coefficient. A congruence coefficient is a measure of the similarity of two configurations. It is similar to a correlation coefficient, but does not extract the mean, and computes a correlation about the origin (the point [0,0]), rather than the centroid (the point around which the data are centered). This results in more favorable properties than a simple correlation for determining geometric similarity (Borg and Groenen, 2005). The congruence coefficient is generally very high, so users should not overemphasize the magnitude.

```
round(fit_procrustes$congcoef, 3)
[1] 0.930
```

An original graphical LASSO empirical network configuration and a replication in a distinct sample (Jones et al., 2017) are presented with MDS-configured networks on the zero-order correlation structures with a Procrustes transformation.

PRINCIPAL COMPONENTS AND EIGENMODELS

A potentially useful alternative approach is to plot nodes within a coordinate system based on two extracted dimensions. MDS is possibly the most useful method when one wishes to meaningfully interpret the distances between nodes. In contrast, using a coordinate system provides information on how each node scores on an X criterion and a Y criterion. In a coordinate system, nodes are interpretable in terms of their "X distance" and "Y distance" from one another, but cannot be meaningfully

interpreted in terms of their Euclidean distance from one another (i.e., the distance if one drew a straight line between nodes).

In principal components plotting and eigenmodels, nodes are plotted by their loadings on extracted dimensions. To be clear, these extracted dimensions do not represent latent causes. Rather, they represent aggregations of variance in the data. In some select cases, the underlying dimensions are interpretable, making the absolute position of nodes meaningful in accordance with some theoretical dimension (e.g., a dimension from physiological to nonphysiological symptoms). Because the dimensions represent aggregated variance in the data, plotting according to extracted dimensions may be useful for visualization, even if the dimensions themselves are not interpretable. Thus, a researcher may be theoretically opposed to the idea of latent dimensions as causal mechanisms of mental disorders, but still use a principal components or eigenmodel plotting approach to present a network or compare multiple networks in an easily interpretable format.

It is unavoidable that information will be lost as we attempt to represent multidimensional data in two-dimensions. This limitation is true for *all* types of network plots. In our specific application of principal components analysis (PCA) and eigenmodels, information for the graph is derived from the first two components or dimensions, and information from any additional components or dimensions is ignored.

Principal Components Analysis

Principal components analysis is an excellent method for extracting meaningful dimensions on which to plot nodes. PCA and its associated rotation methods will be accessible to most psychological researchers as common methods within psychology [see **Data Sheet 1 (Appendix)** for technical details]. Indeed, classical MDS (e.g., Torgerson, 1958) and PCA are closely related methods. PCA can be performed in two ways: using a singular value decomposition on a dataset containing n observations on a set of variables (centered and divided by $\sqrt{(n-1)}$), or using an eigenvalue decomposition of the covariance (or correlation) matrix. From a network perspective, standard PCA is thus limited to psychometric networks (i.e., networks based on derived proximities) and is not designed for relational input data as in social networks.

Unlike in an MDS configuration, the graphed Euclidean distance between nodes (i.e., the distance if one drew a straight line between nodes) is not meaningful in a network plotted with PCA. However, the X distance and the Y distance are *each* meaningful (e.g., how far away nodes are in horizontal space, and how far away they are in vertical space), and represent the difference between nodes on each extracted principal components. A PCA solution can be either rotated or unrotated, depending on one's preference (Jolliffe, 2002). These components might or might not be meaningfully interpreted, depending on the theories regarding the network. Regardless, using the principal components as plotting mechanisms is useful to position nodes in a way that should remain largely stable across successful replications.

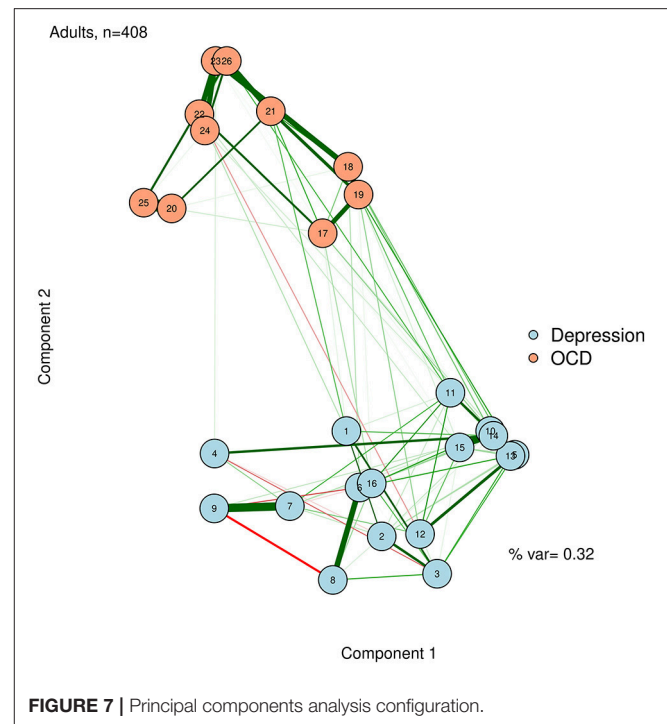


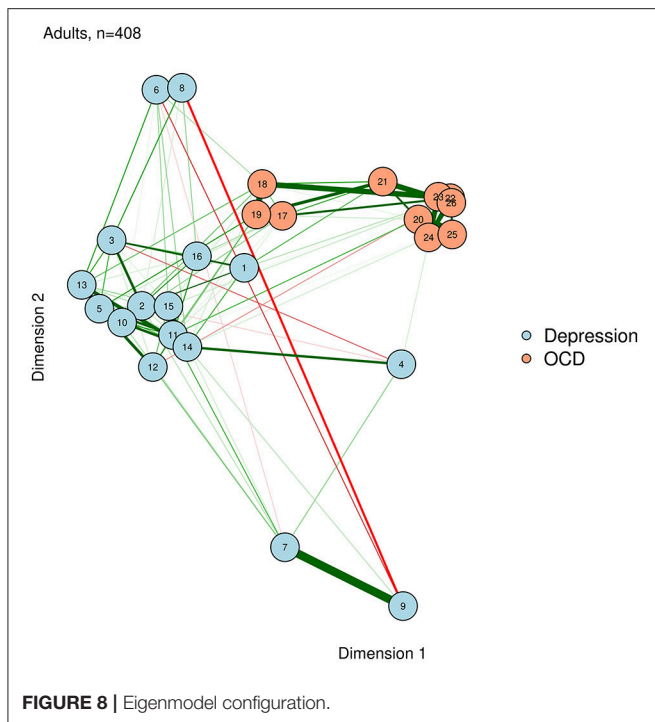
FIGURE 7 | Principal components analysis configuration.

We demonstrate this by using a varimax-rotated PCA implemented in the *psych* R package (Revelle, 2014) based on the zero-order correlation structure for the adult network (McNally et al., 2017). This visualization is presented in **Figure 7**.

```
library("psych")
PCA_adult <- principal(cor(Rogers),
                      nfactors = 2)
qgraph(adult_glasso, layout=PCA_adult$loadings,
       groups = list(Depression = 1:16,
                     "OCD" = 17:26),
       color = c("lightblue", "lightsalmon"),
       title="Adults, n=408",
       layoutOffset=c(.3,.1), vsize=4)
```

To facilitate interpretation, we can also add the percent variance accounted for by the first two principal components, and label the axes as “Component 1” and “Component 2.” Like the stress value in MDS, the variance accounted for by the two components can gauge how well we are capturing the complexity of the network in a two-dimensional solution. In the case of **Figure 7**, we accounted for a relatively low proportion of variance. Thus, even though nodes 10 and 14 are very similar in terms of the first two dimensions, we must be cautious about this interpretation, because they may differ on dimensions not captured in this plot.

```
text(1.5,-.8, paste("% var=",
                    round(sum(PCA_adult$values[1:2]/
                             length(PCA_adult$values)),2))
title(xlab="Component 1",
      ylab="Component 2")
```

The component loadings of variables (nodes) on the first two extracted dimensions from a principal components analysis can be used as the X-Y coordinates for plotting the nodes. The second component likely captures a dimension of depression vs. OCD. The first component is less clear, but after examining specific nodes, we hypothesize that it is perhaps capturing a dimension of behavioral vs. internally experienced symptoms.

Eigenmodel Networks

Eigenmodels are a type of latent variable model for symmetric relational data such as undirected networks (Hoff, 2008). They are a generalization of other popular latent variable models, such as latent class and distance models. Although eigenmodels have not yet been applied to modeling psychometric constructs, they are popular in other fields, including social network analysis (Hoff et al., 2002). Eigenmodels are extracted purely on the network structure by using a model-based eigenvalue decomposition and regression [see **Data Sheet 1 (Appendix)**]. The parameters are estimated through Markov chain Monte Carlo (MCMC). That is, for each parameter we extract a posterior distribution by means of which we can compute posterior means (or modes) and corresponding credibility intervals.

Eigenmodels allow for many interesting statistical possibilities, including attractive methods for identifying clusters (e.g., communities) of nodes. Eigenmodels also allow the researcher to study the effect of covariate variables on the structure of the weights matrix: for example, Kolaczyk and Csárdi (2014) used eigenmodels to study whether a shared office location (a plausible covariate) affected the network structure of collaborations among lawyers. Here, we emphasize that eigenmodels can provide a convenient method for the visual

representation of networks in which nodes are plotted in a meaningful space. Because eigenmodels are based solely on the weights matrix (i.e., the edges), they can be computed for any network, and are not limited to psychometric networks. We demonstrate this, based on the graphical LASSO networks of the adult network, using the *eigenmodel* package (Hoff, 2012). The resultant visualization is shown in **Figure 8**.

```
library("eigenmodel")
diag(adult_glasso) <- NA ## the function
# needs NA diagonals
p <- 2 ## 2-dimensional solution
fitEM <- eigenmodel_mcmc(Y = adult_glasso,
  R = p, S = 1000, burn = 200, seed = 123)
EVD <- eigen(fitEM$ULU_postmean)
evecs <- EVD$vec[, 1:p] ## eigenvectors
# (coordinates)
qgraph(adult_glasso, layout=evecs,
  groups = list(Depression = 1:16,
    "OCD" = 17:26),
  color = c("lightblue",
    "lightsalmon"),
  title = "Adults, n=408", vsize=4)
title(xlab="Dimension 1", ylab="Dimension
  2")
```

Eigenmodels extract latent dimensions directly from the weights matrix of a network. The first two dimensions determine the X and Y position of each node, respectively. For example, a node on the right side has a high loading on dimension 1, while a node near the top has a high loading on dimension 2.

COMPARING VISUALIZATION METHODS: WHAT TO USE WHEN?

In this tutorial, we presented four types of methods for visualizing network models: force-directed algorithms, multidimensional scaling, principal components analysis, and eigenmodels. Each of these methods has certain benefits and drawbacks. We present a summary of these costs and benefits in **Figure 9**.

Force-Directed Algorithms

Perhaps the main benefit of force-directed algorithms is clean aesthetics. The nodes in a force-directed plot will rarely overlap, and relatively equal distance between nodes allows for easy viewing of the edges. The main drawback of force-directed methods is that the spacing between nodes is uninterpretable. This can lead to problems, especially when researchers or readers are unaware of this drawback, and make erroneous interpretations based on the node placement.

Multidimensional Scaling (MDS)

The primary benefit of multidimensional scaling is that the distances between nodes are interpretable. In other words, nodes that are close together are closely related, and nodes that are far apart are less closely related. The stress-1 value provides a helpful estimate of *how* interpretable the distances are (e.g., how well the network is reducible to two dimensions). A low

	Force-Directed	MDS	PCA	Eigenmodel
Node placement is meaningful	X	✓	✓	✓
Useful for comparing replications*	X	✓	✓	✓
Distances between nodes is interpretable	X	✓	X	X
X/Y placement of nodes is interpretable	X	X	✓	✓
Can be based on any network**	✓	✓	X	✓
Central nodes in the center***	X	X	X	X

FIGURE 9 | Comparison of visualization methods. *If force-directed methods are used to compare networks, the layouts should be constrained to be identical for both networks. Although this does not facilitate any spatial interpretation, it allows for easy comparison of edges. In both PCA and eigenmodels, caution should be taken in comparing networks, as the exact extracted components/dimensions will differ between datasets. **PCA relies on a correlation matrix or a set of observations. ***Although central nodes will sometimes be found near the center, we are not aware of any plotting method in which this assumption always holds.

stress value means that the distances are highly interpretable, and a high stress value means that the distances are not very interpretable, due to the network's high dimensionality. MDS can be used to visually compare replications of networks via the Procrustes algorithm. One drawback of MDS (compared to force-directed algorithms) is that nodes may sometimes be placed very close together, making edges harder to see. This drawback can often be alleviated by reducing the node size or by using points rather than circles to represent nodes.

Principal Components Analysis (PCA)

The primary benefit of principal components analysis plotting is that the placement of nodes on the X and Y axes becomes interpretable. In other words, nodes that are far to the right differ in some dimension (i.e., component), compared to nodes on the left. The percent of variance accounted for by two components provides a helpful estimate of how interpretable the node positions are. PCA relies on a correlation matrix or a set of variable observations. Thus, one possible drawback of principal components analysis is that it specifically applies to psychometric networks (i.e., networks relying on a correlation matrix), but not to directly derived networks (e.g., social networks, where the data are not amenable to computing PCA). In PCA, edges may also be difficult to see if nodes score very similarly on both components.

Eigenmodels

In terms of plotting and interpreting networks, eigenmodels are similar to PCA. The X and Y placement of nodes is interpretable in terms of latent dimensions of the network. One main benefit of the eigenmodel plotting approach compared to PCA is that

eigenmodels can be computed from any network structure, and do not rely on the correlation matrix.

A brief comparison of the benefits and costs of different visualizations.

CONVENIENCE FUNCTIONS

We hope that this tutorial provides researchers with an understanding of the methodology and rationale for using multidimensional scaling, PCA, and eigenmodels in addition to force-directed algorithms as attractive visualization methods in network analysis. In addition to using these methods as explained in the R code provided above, we have created convenience functions for these plotting methods, which facilitate ease of use at the expense of some flexibility (Jones, 2017).

```
library("networktools")
adult_glasso <- EBICglasso(cor(Rogers),
                           n=408)
adult_qgraph <- qgraph(adult_glasso)
MDSnet(adult_qgraph, MDSadj = cor(Rogers))
PCAnet(adult_qgraph, cormat = cor(Rogers))
EIGENnet(adult_qgraph)
```

SUMMARY

Although it is difficult to represent highly complex data in two dimensions, there are a variety of well-established methods that can accomplish this goal. Although two-dimensional representations can never fully convey the true complexity that underlies high-dimensional data, they can provide interpretable visualizations. In addition, many of these methods

are capable of providing reasonable and interpretable visual comparisons across networks derived from different samples. We recommend that network researchers carefully consider the benefits and costs of each method and utilize methods that best accomplish their specific aims. We also recommend that researchers explicitly state their rationale for using certain visualization methods and provide clear instructions for how to interpret these visualizations. As researchers follow these recommendations, they will be able to furnish interpretable visualizations that clearly communicate their data to others. Perhaps more importantly, researchers will avoid misinterpretations of visualized data that lead to erroneous conclusions.

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AUTHOR CONTRIBUTIONS

PJ and PM conceived of the presented idea and developed the relevant code. PJ wrote the initial draft of the manuscript. PM wrote the initial draft of the appendix. RM supervised the project. All authors participated in critical editing and revision of the manuscript.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2018.01742/full#supplementary-material>

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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