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Review of the doctoral thesis of Sadia Zaman
„The Pursue of Multiple Goals Among Women in Science, Technology, Engineering
and Mathematics (STEM)”
prepared under the supervision of dr hab. Katarzyna Byrka, prof. SWPS
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In her dissertation, Sadia Zaman aimed to explain how women manage to pursue of multiple goals, namely being a professional working in science, technology, engineering or mathematics (STEM), and being a feminine woman. In fact, women are less represented than men in STEM and may face challenges related to social stereotypes, despite many changes in the academic, occupational and general societal context. This interesting issue was analyzed from the perspective of identity goals, integrating two theories that explain the functioning of goal systems and the symbolic completion of identity goals. This theoretical approach allowed new insights into the psychological functioning of women in STEM.

From the formal point of view, the dissertation takes the form of a scientific monograph. It is written in English, with a mandatory abstract in Polish. In five chapters it presents a general theoretical introduction at the beginning, a general discussion of the results at the end, and three chapters presenting the empirical part, which contains six studies. Two of the chapters are written as scientific papers prepared for publication, and one chapter contains a paper already published in the *Scandinavian Journal of Psychology*. As mentioned in the text, the conceptual and empirical work of this dissertation was supported by the grant received by the supervisor, and all papers presenting the studies were co-authored by five authors. If the research is part of a larger project carried out by a team, the dissertation should include a statement on the doctoral student's contribution to the dissertation, including a qualitative description of this contribution. Such a statement is missing here. However, as

Sadia Zaman is the first author of all these papers, this suggests that her contribution was significant enough to warrant first authorship.

The theoretical part of the dissertation proposes an interesting perspective that integrates two theories to explain feminine and professional identity goals simultaneously realized by women in STEM. The first is symbolic self-completion theory, which explains how symbols are used to realize identity goals. The second is goal system theory, which explains the realization of multiple goals. This interesting integration of both perspectives allowed for the analysis of identity goal overlap, feelings of completeness (or incompleteness) of these identity goals, symbolic means used to achieve these identity goals, and relationships between identity goal overlap and imposter syndrome. Thus, the research is conducted within a clear theoretical framework and the research methodology is consistent with the chosen theoretical orientation. This theoretical framework provides a new perspective for analyzing the psychological functioning of women in STEM. Since previous research has usually focused on abilities, preferences, and explicit and implicit biases, this dissertation offers a new theoretical lens and contains a significant novelty in relation to existing knowledge. However, this novelty is not explicitly stated in the text. Explaining what new insights could be gained from the theoretical integration and from the research presented and how it extends existing knowledge would ground the research more deeply in the current state of the art and explain how it advances it. In addition, the "hook" of this research should also be strengthened. Why is it important to address these issues? What are the societal consequences of the underrepresentation of women in STEM? Some data on women's employment in STEM are provided in Chapter 4, but they are related to a single country. More data on the gaps in representation, compensation, and recognition of women in STEM, on the differences between subfields (e.g., science vs. technology), and on what we already know from psychological research would make it possible to demonstrate why this issue merits further study.

The first set of empirical studies, presented in Chapter 2, explains how women in STEM respond emotionally to the completeness (or incompleteness) of feminine and professional identity goals. This is a series of three well-designed experimental studies conducted online, two of them with a time lag between measurement and manipulation. One of the studies was preregistered. Specifically, guilt and pride were analyzed as consequences of identity goal completeness/incompleteness in Study 1 and as consequences of identity goal compensation in Study 2. In Study 3, effects of completeness/incompleteness on multifinal symbolizing were tested, and multifinal symbolizing was operationalized as engagement in

the virtual wall-decorating task with posters containing symbols relevant to two identity goals. In all of these studies, as well as others, completion/incompletion of each identity goal was manipulated by writing a text about a personal experience of feeling/not feeling well in a particular role, i.e., as a feminine woman or as a STEM professional. To test the effectiveness of the manipulation, a word count was used, as it is available in LIWC. This is a good solution that does not distort the manipulation effect. In Study 3, LIWC was also used to count words expressing affect, but these additional measures deserve a more detailed description. The results of two studies supported the hypotheses, showing that pride arises from of completeness and guilt from incompleteness of identity goals, and that compensation for identity goals in the other domain results in lower levels of guilt and higher levels of pride. The results of Study 3 did not support the hypothesis that completeness of identity goals in both domains will lead to higher engagement in multifinal symbolizing, and this result was explained in relation to the affect expressed by participants. All of these findings provide an new understanding of the affective consequences of feelings of completeness/incompleteness of identity goals in women in STEM, which may explain their decisions to choose and maintain such a career path.

The second set of empirical studies, presented in Chapter 3 and already published, explains how the overlap of identity goals across domains is related to the symbolic means used to achieve these identity goals. Outfits were chosen as symbols of femininity and/or STEM professionalism. This is a series of two cross-sectional studies, Study 4 and Study 5, which included two measurements. Identity goal overlap was measured based on a sense of belonging to a particular group (feminine woman or STEM professional) in both studies, and a sense of group identification in Study 5. The measures (4 and 12 items each) were completed twice by the participant, separately for each identity. Based on the scores, identity goal overlap was calculated using a formula based on the alignment between items representing each identity. This is an interesting way of capturing the overlap between two sets of items, which allowed the calculation of a single score. Some concerns may arise with respect to the measurement of identity goals in Study 5, in which participants responded twice to a fairly long set of the same items (16 items related to each identity). This raises the question of a common method bias that may overstate the similarity (correlation) between the two identities. This may lead to a lower variance of goal overlap in this study and, in effect, to a lack of statistically significant relationships with outfit choice. On the other hand, an advantage is the precise preparation and evaluation of visual stimuli representing different outfits. The stimulus search process in Study 4 is described in detail. An interesting person-

centered approach was used when the initial classification of symbols/outfits did not work. This provided an alternative and perhaps more valid individualized evaluation of outfits. The results of this series of studies showed that outfits can be used to symbolize the pursuit of identity goals of a STEM professional and a feminine woman, and when these goals overlap, women prefer multifinal symbols and evaluate their preferred outfits as such. This extends findings from the first series of studies devoted to affective responses to the completeness/incompleteness of identity goals among women in STEM.

The third line of empirical research, presented in Chapter 4, examines the relationships between identity goal overlap and imposter syndrome. It consists of a cross-sectional, pre-registered Study 7 in which both women and men took part. The aim was to examine differences between women and men working in STEM in terms of identity goal overlap and its relationships with imposter syndrome. Again, as in the studies described in Chapter 3, the sense of belonging to a particular group and the sense of group identification were the basis for calculating the identity goal overlap scores. In this case, it was feminine woman and STEM professional and the corresponding version for men, masculine man and STEM professional. It is unclear how many items were answered by participants, I calculate 16 for each identity and the author states 24 (p. 112). This again raises the question of a common method bias, which I explained above. In addition, it would be worth checking the measurement equivalence of all measures between men and women. We cannot rule out the possibility that the higher overlap of identity goals among women is an effect of different responses to scales items in each group. This is likely given the social biases associated with STEM careers. The measurement equivalence test allows not only to check whether the mean scores can be compared across groups, but can also provide interesting insights into the way women and men respond to questions related to sense of belonging to a particular group, sense of group identification, and also to items expressing imposter syndrome. The results of this study showed that women express more imposter syndrome than men, but the relationships with identity goal overlap are not always consistent with the hypotheses. I hope that my comments above may shed new light on this issue.

The general discussion of the results presented in Chapter 5 places the findings in a broader theoretical and empirical context. It demonstrates that the dissertation is embedded in the current literature on the topic, and that the author is able to relate the findings to existing knowledge. The results of each line of research are discussed somewhat separately, without a broader picture and integration of all findings. This may be a goal of a next theoretical paper summarizing the contribution of this large research project. The discussion does, however,

include information on the limitations of the research project and a reflection on their potential impact on the results obtained. It also proposes suggestions for further research resulting from this project. What can be added to this part of the text is a proposal for practice and/or societal action, for example, possible interventions based on the insights gained from these studies.

Summarizing the evaluation of the empirical part of this dissertation, it should be emphasized that in all studies the problems and hypotheses have been correctly formulated and justified. The research design (experimental or cross-sectional) was properly chosen to solve the problem posed in a particular study. The groups of participants were properly selected and power analysis was used to determine the minimum sample size. The methodology used is clearly described and the materials are available online in the OSF. The statistical analyses used are in accordance with the standards of the field, and their results have been correctly interpreted and clearly communicated, with appropriate graphical presentations. Two weaknesses, in my opinion, should be mentioned. First, the same measures of identity goal overlap and the same procedures for eliciting identity goal completeness (or incompleteness) were used in all of the studies. On the one hand, this makes the research project very consistent. On the other hand, it limits the generalizability of the findings. Convergence of results obtained in different ways would strengthen the evidence supporting the hypotheses. Second, all data were collected through the Prolific platform. The use of such online data is discussed as a shortcoming of the dissertation, but it is still a solid limitation to the generalizability of the results.

Finally, I have evaluated the dissertation from an editorial point of view. It has been prepared in accordance with the APA standards for the structure and editing. The text is generally well written and clearly explains ideas. I have a few comments on specific points that may be used in preparing publications. First, variables rather than their measures are analyzed, and positive and negative affect rather than the PANAS scale are introduced as covariates (e.g., p. 44). Second, the description of the data analysis strategy is more appropriate in the Methods section (Data analysis subsection) than in the Results section (p. 44). These are just minor editorial comments.

In conclusion, despite the comments made, I give a positive evaluation of the dissertation. The completed research project demonstrates Sadia Zaman's scientific competence, the ability to conduct empirical research, to analyze its results, to draw conclusions and to write scientific texts. The dissertation provides an original solution to a

scientific problem and demonstrates the doctoral candidate's general theoretical knowledge in the discipline of psychology and the ability to conduct independent scientific work.

Concluding that the examined dissertation merits a **positive evaluation**, I recommend that Sadia Zaman be admitted to the further stages of the doctoral procedure.

Monique Lapine