CREATIVITY
Vol. 1, Issue 1, 2014
Theories – Research – Applications

Relationships Between Beliefs about Scientific Work and Creative Achievements in Science: A Preliminary Version of the Orientations Towards Scientific Work Scale*

Joanna Szen-Ziemiańska
University of Social Sciences and Humanities in Warsaw, Poland
E-mail address: asia.szen@op.pl

ARTICLE INFO

Keywords:
Creative achievements
Creativity
Orientations towards science
Young scientists
Psychology of science

Article history:
Received 31 January 2014
Received in revised form 29 March 2014
Accepted 9 May 2014

ISSN:
DOI: 10.15290/ctra.2014.01.01.06

ABSTRACT

This study presents preliminary data about the Orientation Towards Scientific Work Scale and demonstrates the relationship between four different orientations toward scientific work (orientation toward quantity, orientation toward quality, orientation toward originality and orientation toward adaptation) and scientific practice as well as creative achievements in the domain of science. Thirty young scientists from Polish universities participated in the study. Correlation and regression analyses demonstrated that different orientations toward scientific work predict scientific activity and creative achievement in science. Thus, these results show the role of individual beliefs about work, for actual accomplishments in science.

INTRODUCTION

Creative achievements depend on the coincidence of intra- and interpersonal factors (Eysenck, 1995). Personality traits such as openness to experience, independence (Batey & Furnham, 2006; Karwowski, 2009, 2010; McCrae, 1987; Nęcka, 2001), creative self-efficacy and creative personal identity (Jaussi, Randel & Dionne, 2007; Karwowski, 2012; Lim & Choi, 2009; Tierney & Farmer, 2002; 2011) and cognitive abilities, i.e. divergent thinking (Carson, Peterson & Higgins, 2005; Cramond, 1994; Plucker, 1999; Kim 2008) as well as an ability to solve problems requiring insight (Szen-Ziemiańska & Karwowski, in preparation) are among the main determinants of creative achievement. Feist (1998) has demonstrated that openness characterizes more creative scientists in comparison to less creative ones. Openness to experience, together with creative thinking increases the chances for creative achievements (King, McKee Walker & Broyles, 1996). In drawing attention to the motivational aspect of creative activity, it is commonly acknowl-

* This article is a part of a larger research project, carried out with funds granted by the Ministry of Science and Higher Education for statutory Decision No. 25504/E-560/M/2013. Project No:WP/2013/B/61.
I thank Maciej Karwowski for his valuable comments.

edged, that intrinsic motivation is required for creative actions (Amabile, 1996), but under certain circumstances (i.e. in professional creativity) extrinsic motivation may also be important for creative accomplishments. It is assumed that motivational synergy fosters creativity (Amabile, 1996; Karwowski & Gralewski, 2011), because of the emergent coincidence of interest and happiness with applause and external gratification. Motivation is obviously linked to individual values, attitudes or orientations. Hubristic motivation, that focuses on the effects which confirm the importance and value of a person (Kozielecki, 1997), is often observed among scientists (Tokarz, 1998). This suggests, that hubristic motivation will be manifested in beliefs and action strategies for this professional group. This article analyzes orientations toward scientific work among young scientists. The term "orientation" concerns a set of individual beliefs about work effects and issues related to a career in science. Orientations may influence the range and level of scientific activity and lead to creative achievements as predicted by socio-cognitive theory (Bandura, 1997; Bandura, Barbaranelli, Caprara & Pastorelli, 2001). Hence, such orientations may also be interpreted as mindsets (Karwowski, 2013) concerning science as a domain of creative activity. Orientations translate into motivation by activation of the processes that enable scientists to accomplish their goals and thus are related to the scope and level of creative achievements i.e. in science. Therefore the article’s goals are: (1) to elaborate and test a new scale measuring orientation towards science among young scientists; and at the same time to examine (2) whether, and to what extent, specific orientations are associated with activity in science and (3) whether, and to what extent, specific orientations are associated with creative achievement in science, such as: publications, attending conferences, creating inventions or winning grants. The study described below was realized among young scientists in order to ensure external validity and to fill a gap observed in the creativity literature. It is hypothesized, that orientations play a predictive role, explaining differences in creative activity and creative achievements, adding significantly to other well-established predictors of scientific accomplishments, such as personality and cognitive factors (Feist, 1993; 1998; 2006).

ORIENTATIONS TOWARDS SCIENTIFIC WORK

Scientists differ not only in terms of their traits and abilities, but also in terms of their beliefs about scientific work. Differences in publishing and research priorities seem to be especially important when attempting to explain different attitudes and styles in scientific practice. So far, no scale measuring orientation towards scientific work has been published. Based on the results discussed below, as well as the informal analysis of the work of young scientists (author's unpublished research), in this study, four orientations have

been distinguished: the orientation toward quantity, the orientation toward quality, the orientation toward originality and the orientation toward adaptation.

Orientation toward quantity focuses on scientific productivity, especially in terms of publishing. Its essence lies more in the quantity, rather than the quality of scientific publications produced. Sometimes there is even the suspicion that quality may suffer and give way to quantity, but this need not be the case – in the long term, quantity may turn into quality in the case of publishing. People who hold this orientation believe that writing articles is a skill, that can be developed. For this reason, orientation may be treated as specific mind-sets, which play a regulative role: when the ability to write scientific articles is perceived as being possible to develop (malleable), the chances for achievements grow, whereas the chances decrease, when the ability is seen as fixed (stable) (Karwowski, 2013). Publishing large numbers of articles leads to a higher standard in subsequent manuscripts. This belief has been confirmed several times by the high correlations that are found between number of publications and their quality or degree of scientific eminence (Buses & Mansfield, 1984; Simonton, 1988) and is reflected in the popular saying „publish or perish". Individuals, who believe that the number of publications has a major meaning, often adopt the "the more, the better" strategy. Those, who are oriented toward quality are focused on a more ambitious goal, with fewer publications. Therefore orientation toward quality manifests itself in a tendency to elaborate. People with an orientation of this kind, set the standards for their work at a higher level and believe, that the quality of their work determines their future career as scientists. Thus they do their best to elaborate the effects of their work. Individuals oriented toward productivity are probably likely to take the risk, sometimes even experimenting, by submitting an imperfect manuscript for review and awaiting comments, which they treat as a form of development. On the other hand, scientists oriented toward quality will not submit a manuscript until it meets their internal standards. Orientations defined this way may constitute opposite poles of the same continuum, but lack of a quantitative attitude does not have to lead to an orientation toward quality and vice versa – if a scholar is not qualitatively oriented, the tendency towards greater productivity does not necessarily increase either.

Orientation toward originality manifests itself in a sensitivity towards problems and a tendency for novelty-seeking. People who are oriented toward originality believe that science develops through discoveries and solving new problems is more likely to make their careers successful. An important aspect of this orientation is to be inspired by experience gained in creative activity in domains other than science itself. This means that they acquire their original approach to scientific problems through an orientation towards

non-scientific activity (like artistic experiences). Artistic activity and the use of experience from other domains allows scientists to cross the borders of their discipline, stimulates scientific discoveries and leads to multiple scientific insights. Creative activity in many domains translates into outstanding achievements in one of them (Root-Bernstein & Root-Bernstein, 2004; Root-Bernstein, Bernstein & Garnier, 1995). Undertaking various activities mediates the relationship between creative potential and achievements. It has recently been demonstrated (Jauk, Benedek & Neubauer, 2013) that fluency, originality and openness to experience predict everyday creativity, which then translates into creative achievements. Therefore the meaning of creative non-scientific activity for scientific effectiveness may not only be inspiring, but may also have developmental importance.

Orientation toward adaptation is not the simple inverse of orientation toward originality, but an expression of another, more pessimistic vision of science. It consists of two elements: first - orientation toward restriction - is an expression of helplessness and the manifestation of a focus on constraints in the scientific environment. With this perspective, creative scientific work is very difficult. Scientific work requires subordination to a superior and it is the environment that decides which problems should be undertaken. People oriented this way also avoid different activities and hobbies, because they believe that other activities distract them from scientific work. Another element is the belief that not every scientist has to be a discoverer: improvements and the compilation of many people's work are important as well. We are therefore faced with the conviction that limitations are inevitable and the lack of a positive attitude towards creative work, which may limit the range of activities and creative achievements.

The orientations described are expected to emerge as an effect of the interaction between scholars' individual characteristics and their environment. On the one hand - traits such as openness to experience, conscientiousness or risk taking, may influence the formation of orientation, e.g. high openness to experience and high risk-taking may have particular importance for the orientation toward originality, while low levels of openness may be associated with an orientation toward adaptation. A relationship between these two orientations with creativity style (Kirton, 1976) is also expected. Correlations between style and personality have already been tested (Gelade, 2002; von Wittich & Antonakis, 2011). Orientation plays an adaptive function - the knowledge of "what to do and how", especially at the early stages of a scientific career, builds a feeling of security and supports motivation towards work. "Know-how" refers to tacit knowledge and may be an expression of practical intelligence (Sternberg & Hedlund, 2002). On the other hand however, the scientific environment forms the attitudes of young scientists, because of external

expectations and standards. Supervisors, superiors and the overall climate influence the orientation adopted by graduate students and postdoctoral researchers. It still remains to be shown, whether and to what extent, these orientations predict scientific activity and achievements.

CREATIVE ACHIEVEMENTS IN SCIENCE

Creative achievement - defined as the sum of creative products generated by an individual during his/her life (Carson, Peterson & Higgins, 2005) - stems from creative thinking and actions, realized through conscious activity and deliberate practice (Karwowski, 2009). In science, creative achievements are elaborated products (Stumf, 1995). The most common approach to establishing a measure of creative achievement used in studies about creativity in science is the number of publications (a measure of the productivity) and the number of citations (a measure of the impact on the field). People at the beginning of their scientific career usually have minor influence on the domain in which they work. In the course of their work and with the passage of time, their chances of making an impact increase. The relationship between productivity and quality or eminence of scientists is positive, with a moderate to strong effect (Simonton, 1988; Stumpf, 1995); productivity translates into quality as assessed by the gate-keepers (reviewers, editors accepting the article, experts granting funding or patents). The productivity indicator is a better measure of scientific achievements at the early stage of a person's scientific career than the citation index. The citation index may increase not only as a result of positive aspects, such as the significance of a finding, but also as an example of a specific methodology or a negative example of errors in contents (Stumpf, 1995). Moreover the citation index de-favours authors publishing in languages other than English.

Despite the exploratory character of the study presented in this article, it is possible to tentatively draw up some hypotheses and to propose a rationale for them. It is hypothesised that the orientation toward quantity is positively related to the actual level of productivity and quantity of creative achievements. This is based on the assumption that people having this orientation are more motivated to finalize as many creative products as possible, because these products guarantee their development and success. Further, it would seem plausible that a more qualitative orientation correlates negatively with the quantity of creative achievements. One direction of conjecture is that excessively high standards may form an obstacle at the initial stage of a person's scientific career. An expected positive relationship between orientation toward originality and achievements is based on the assumption that non-scientific inspirations help to discover new and original research problems and foster achievements. It is also hypothesized that the orientation toward ad-

aptation is negatively correlated with achievements. It is highly probable that interactions will occur between particular orientations, especially between the orientation toward quantity and the orientation toward adaptation. The most favourable conditions for scientific work are likely to be a strong focus on quantity and low orientation toward adaptation and restriction. Orientation toward quantity and quality, as well as the orientation toward originality and adaptation should occur in negative, but weak relationships.

METHOD

Participants

Thirty young scientists (17 women) aged around 30 years (with *M*=29.43, and *SD*=6.91) participated in the study. Graduate students formed the majority of the sample, although it also included 8 postdoctoral researchers and one Associate Professor. All the participants were affiliated to different departments of Social Science and Science at the University of Social Sciences and Humanities (psychology and cultural studies), the University of Warsaw (English philology, philosophy), the Academy of Special Education (pedagogy), the Jagiellonian University in Krakow (mathematics and physics), Warsaw University of Technology (energetics, mechanics and management), the Cardinal Stefan Wyszyński University in Warsaw (philosophy). One participant was affiliated to the Univerisity of Euroregional Economy in Józefów - Warsaw (sociology), one other with the Paris-Sud Univerisity (computer science), and two respondents did not report their affiliation.

The response rate was very low, which indicates that young scientists are a group that are difficult to access. Voluntary participation in a study, especially one concerning creative achievement and scientific career reduces willingness to participate. At the same time, selfless assistance becomes something special in very competitive environments.

Procedure

The study was conducted via the Internet. Snowball sampling was used to complete the group. Participants received an e-mail including an invitation and a link to the study. They were informed about the goals, the subject matter of the study and its pilot nature. Their participation was not rewarded.

They were asked to provide responses on the Scale of Orientation towards Scientific Work first, and afterwards they completed the Profile of Creative Activity together with a demographic and professional description. At the end the participants were asked if they had any comments with regard to the content of the questions or any suggestions for improvement. The whole study took about 5 minutes.

Measures

Two instruments were used for the research:

The Orientation toward Scientific Work Scale (OSWS) is a new scale developed for the purposes of this study. It describes individual beliefs about work and a career in science. Participants used a 5-point scale to describe the extent to which they agreed or disagreed with each of the statements (*1=definitely not, 5=definitely yes*). The initial version of the OSWS consisted of 24 statements, 6 relating to each of the 4 scales: orientation toward quantity, orientation toward quality, orientation toward originality and orientation toward adaptation.

The Creative Activity Profile (CAP) – a scale concerning detailed achievements and productivity in science. Based on the CAP, two indicators were extracted: (1) creative achievements and (2) scientific practice. Creative achievements were defined by means of a total of 14 questions which concerned: the number of published scientific articles (peer-reviewed and published in Polish or English languages), the number of chapters published in edited books, the number of authored books (as author or co-author), the number of utility designs, inventions, patents, implementations i.e. in industry, the number of grants received and active participation in conferences.

Scientific practice was measured in terms of all scientific activities, that foster gaining new experiences and contributing to an increase in competencies. The practice indicator shows the level and range of scientific activity and it includes elements such as: the realization of individual and team research projects, seminar activity, authorship of unpublished research reports, popular publications or preparation of materials for conferences. These important elements of scientific work precede any achievements but can lead to them (the more you work, the greater the chance of achievements, the more research projects realized, the more material you have for publication, etc), but practice alone cannot determine the success of a scientist.

The Creative Activity Profile has been used in the author's earlier research, conducted among graduate students, and obtained good validity (in terms of correlation with a science scale from the Creative Achievement Questionnaire; Carson et al., 2005) and satisfactory reliability. In the current study, the reliability of achievements index was good (α=.79) and for scientific practice it was acceptable (α=.60).

The distribution of scores for creative achievements and scope of scientific activities is usually skewed (Silvia, Kaufman & Pretz, 2009). The minimum value is zero (which may occur in the first year of doctoral studies), but the maximum value has no limit (Carson et al., 2005; Silvia, et al., 2009). Eminent young scientists may have a lot of diverse accomplishments and engage in almost countless scientific activities - two eminent young scientists, whose achievements are clearly higher than the rest of the respondents, participat-

ed in the study. This result reflects the real situation as regards achievements - the presence of eminent young scientists in society is undeniable. In contrast, only one person within the sample demonstrated a lack of achievements.

RESULTS

The structure of the OSWS

Descriptive statistics for the assumed scales were calculated and their reliability was examined in the first step of the analysis. It was found that the reliability was too low (e.g. orientations towards quantity α=.33 and quality α=.45) and the correlations between the scales were ambiguous. Thus despite the small sample, exploratory factor analysis (EFA) with Varimax rotation was conducted. Descriptive statistics and factor loadings for each of the 24 items used for the EFA are shown in Table 1.

TABLE 1

Descriptive statistics for the OSWS

	M	*SD*	*SK*	*F*	*FL*
1. A scientific career depends mainly on the number of publications, not on the rank of the problems undertaken.	2.90	1.15	-.08	I	.796
2. It is better to publish one article in a good journal, than five in a moderate one.	4.13	1.04	-.87	III	.693
3. Scientists should work mainly on new problems, which have not been undertaken (solved) before.	3.27	1.36	-.08	IV,VI,VII	.357-.377.516
4. It is very difficult to create something new in science.	3.73	1.34	-.86	I	.767
5. Quantity becomes quality in the case of publishing.	2.53	1.28	.45	IV	.535
6. It is very time consuming to write an article, every slightest detail counts.	3.90	1.09	-.80	I	.384
7. Experience gained in different domains of life should be used in scientific work.	3.90	.92	-.64	II	.596
8. Science develops, thanks to the compilation of many people's work and not every one of them has to be a great discoverer to be a scientist.	4.03	1.10	-1.41	V	.447
9. Writing scientific articles is an ability that can be developed through writing.	3.87	1.17	-.84	III	-.415
10. One great article is sufficient to be successful in science.	2.77	1.60	.30	VI	.973
11. People should look to apply their non-scientific interests to science.	3.83	1.15	-1.12	II	.929
12. Any non-scientific activity distracts from achieving scientific goals.	2.13	1.36	1.07	IV	.398
13. One needs to write many articles to gain ease in writing.	3.57	1.33	-.43	IV	.499
14. The number of articles published is less important than their quality for success in science.	3.77	1.13	-.57	III	.756
15. A scientific article should be original and provide something new to the domain.	4.23	.89	-2.03	II, III, VI	-.422.530-.358

	M	*SD*	*SK*	*F*	*FL*
16. Scientific work requires sacrifice and full concentration - it should be both work and hobby.	2.67	1.27	.25	IV,VI	.384.412
17. The more publications, the greater the chance of success in science.	3.63	1.03	-.38	IV	.675
18. It is better to carefully refine one article, than write two or three quickly.	4.17	.95	-1.39	III,IV,VII	.592-.475.408
19. It is better to have a few group publications, than a single independent one.	2.70	1.05	.66	V	-.930
20. Artistic activity (drawing, playing a musical instrument) is an inspiration to scientific work.	3.83	1.04	-.66	II	.803
21. It is easier to improve something in scientific work, than to invent something new.	3.90	1.15	-.80	VI,VII	.475-.391
22. It is better to have one independent publication, than several as co-author.	3.27	1.08	-.22	V	.855
23. Attempting to tackle completely new research problems is the main way of fostering a career in science.	3.37	1.19	-.39	VII	.847
24. Problems undertaken by scientists mostly depend on pressure from their superiors or current tendencies in the particular domain.	3.30	1.18	-.36	I	.798

Note. M - mean, SD - standard deviation, SK - skewness, F - Factors, FL - Factor Loadings. Percentage of the variance for each of the factors: I - 10.92, II - 9.65, III - 9.24, IV - 8.82, V - 8.78, VI - 8.41, VII - 7.98.

The analysis extracted 7 factors, explaining 64% of the variance. Only the items with loadings equal or higher than .40 were analysed. Because of the small sample size, a liberal limit of acceptable skewncss of data (+/-2) was set. Only statement 15 was found to be above this limit and thus it was removed from further analysis.

Content analysis of the factors

The analysis of the factors obtained generally confirmed the assumed structure of the OSWS, but the number of items in each of the scales was reduced. Factor IV was considered as the orientation toward quantity and included items: 5, 13, 17. Items belonging to factor III - orientation toward quality - which were confirmed by the EFA are: 2, 14, 18. Orientation toward originality was only partially confirmed and is reflected by factor II (items: 7, 11, 20). These statements focus on the role of creative activity in different domains, so the factor label was changed to "orientation toward non-scientific activity". The orientation toward adaptation was less consistent with theoretic predictions, although the obtained structure was indeed interesting (factor I). Items that loaded on this factor showed a rather pessimistic vision of scientific work, a negative evaluation of own scientific activities and helplessness. This scale consisted of statements (1, 4, 24) concerning superiors' pressure, the low ranking of problems undertaken, and the view that scientific work is time-consuming and highly difficult; therefore, the obtained factor was re-named as "orientation toward restrictions". This factor needs to be clarified and retested in further

studies. The reliability of the four main factors is presented in Table 2. Further work is also required in the case of the next factor, which consisted of two parallel statements concerning individual and group publishing, and statement 8 concerning compilation of work and exploration. Nevertheless, in this case the reliability was acceptable (α=.761); it is likely that reformulation of statement 8 to a more unequivocal statement is necessary. The remaining two (among seven) factors elicited by the analysis show complexity of content, which makes their interpretation difficult, therefore they will not form part of the further analysis.

TABLE 2

Structure and the Reliability of the OSWS after item reduction

Item	**Orientation toward quantity**	**α = .667**
17	The more publications, the greater the chance of success in science.	
13	One needs to write many articles to gain ease in writing.	
5	Quantity becomes quality in the case of publishing.	
	Orientation toward quality	**α = .725**
14	The number of articles published is less important than their quality for success in science.	
2	It is better to publish one article in a good journal, than five in a moderate one.	
18	It is better to carefully refine one article, than write two or three quickly.	
	Orientation toward non-scientific activity	**α = .799**
11	People should look to apply their non-scientific interests to science.	
20	Artistic activity (drawing, playing a musical instrument) is an inspiration to scientific work.	
7	Experience gained in different domains of life should be used in scientific work.	
	Orientation toward restrictions	**α = .799**
1	A scientific career depends mainly on the number of publications, not on the rank of the problems.	
24	Problems undertaken by scientists mostly depend on pressure from their superiors or current tendencies in the particular domain.	
4	It is very difficult to create something new in science.	

Orientations, achievements and the range of scientific practice

The main purpose of this study was to explore the possible relationships between orientation toward science and the actual level of creative achievements and scientific practice among young scientists. Distributions and descriptive measures of creative achievements and scientific practice are shown in Figure 1-2 and Table 3. To examine whether the obtained orientations (qualitative, quantitative, orientation toward non-scientific activity and orientation toward restrictions) are related to creative achievements and scientific practice, a correlation analysis was conducted. Orientation toward restriction correlated nega-

tively and strongly, both with quantity of creative achievements (the sum of published writing, conferences and inventions) and with scientific activity (practice). Orientation toward quantity correlated positively with creative achievements (Table 3).

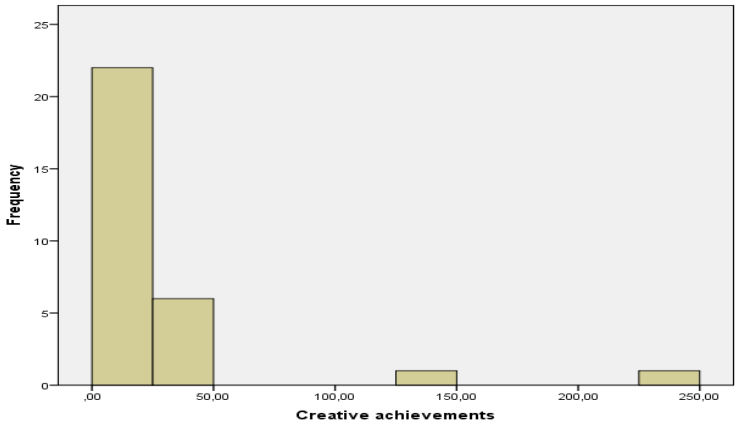

Figure 1 Distribution of creative achievements.

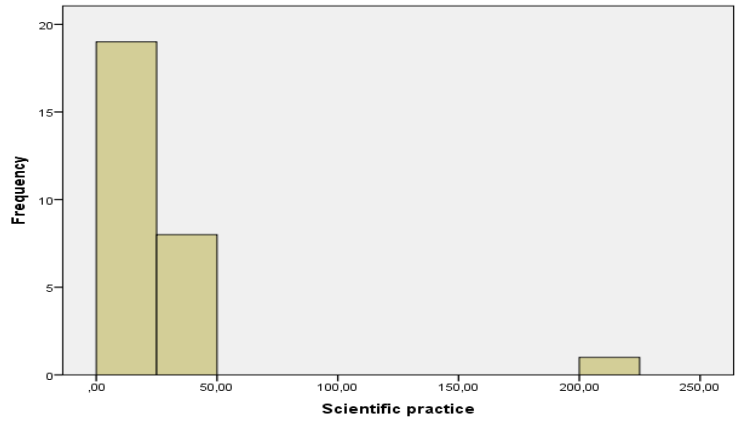

Figure 2 Distribution of scientific practice.

TABLE 3
Intercorrelations between orientations, achievements and scientific practice

	M	*SD*	*1*	*2*	*3*	*4*	*5*	*6*
1. creative achievements	25.9	46.57	1	.88**	.38*	-.24	.05	-.39*
2. scientific practice	24.78	39.02		1	.34^	-.26	-.04	-.46*
3. orientation toward quantity	9.73	2.84			1	-.09	.06	.17
4. orientation toward quality	12.07	2.52				1	.06	-.24
5. orientation toward non-scientific activity	11.43	2.59					1	-.02
6. orientation toward restrictions	9.93	3.11						1

Note. N=30 *p<.05, **p<.01, ^p< .10

Two regression analyses were conducted to determine whether orientations predict creative achievements in science and scientific practice. The significant predictors of quantity of creative achievements were: orientation toward quantity (β=.44; p<.01), orientation toward quality (β=-.33; p<.05) and orientation toward restrictions (β=-.55; p<.001). The model was significantly better than the predictions based on the means (F(4,25) =5.55; p<.01) and explained 39% of the variance for creative achievement. A similar pattern was observed in the case of scientific practice. Statistically significant predictors were: orientation toward quantity (β=.42; p<.01), orientation toward quality (β=-.36; p<.05) and orientation toward restrictions (β=-.64; p<.001). The model demonstrated a good level of fit F(4,23)=6.55; p<.001, corrected R^2=.45.

The theoretical assumptions and results of linear regression suggested, that there may be more complex relationships between orientations, scientific practice and creative achievements. Due to the small sample size, separate regression analyses with interaction were conducted. The initial results from the study showed that the relation between orientation toward quantity and creative achievements is moderated by orientation toward quality. The interaction effect for high orientation toward quality (+1SD: B=1.97, SE=3.55, p=ns), mean level (B=6.87, SE=2.79, p<.01) and low level (-1SD: B=11.78, SE=4.25,p=.01) shows, that strong orientation toward quantity with low orientation toward quality increases the chances for scientific achievements. The model demonstrates good fit F(3,26)=3.31; p<.05 (R^2 interaction coefficient=.09). Similar results were also obtained for scientific practice. The findings suggest, that the positive relationship between orientation toward quantity and scope of scientific activity grows stronger with decreasing levels of orientation toward quality (+1SD: B=-0.32, SE=2.93, p=ns; mean: B=5.84, SE=2.39, p<.05; -1SD: B=12.00, SE=3.72, p=.01, interaction coefficient R^2=.19).The model showed good fit, F (3,24)=4.28; p<.05. The results of particular interactions are shown in Figures 3 and 4 (Aiken & West, 1991).

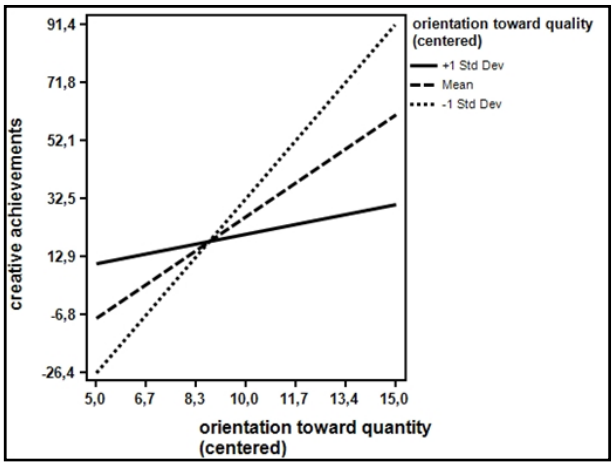

Figure 3 Interaction between orientations toward quantity, orientation toward quality and creative achievements.

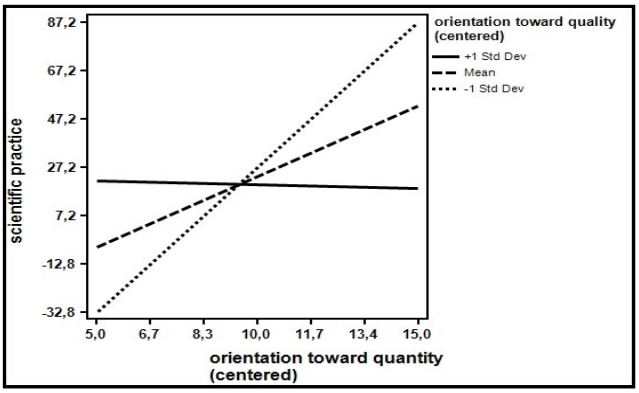

Figure 4 Interaction between orientations toward quantity, orientation toward quality and scientific practice.

The next two analyses reflected, that orientation toward restriction is also a moderator. Orientation toward quantity is positively associated with creative achievements for low orientation toward restriction (-1SD: B=13.79, *SE*=2.44, *p*=.001) and mean (B=6.08, *SE*=2.00, *p*=.001) and it is not associated with creative achievement for high helplessness and restrictions (+1SD: B=-1.64, *SE*=2.90, *p*=ns).

The relationship between orientation toward quantity and scientific practice is not significantly different from zero for high orientation toward restriction (+1SD: B=-3.03, *SE*=2.07, *p*=ns). In circumstances where pessimistic attitude is at either low or mean levels, the relationship between orientation toward quantity and range of scientific practice is positive and significant (-1 SD B=11.68, *SE*=1.66, *p*=.001; mean B=4.32, *SE*=1.44, *p*=.001). Both models show good fit (creative achievements: *F* (3,26)=14.97; *p*<.001 and scientific practice: *F* (3,24)=26.48; *p*<.001). It is particularly important, that in the case of the interaction of orientation toward quantity and orientation toward restriction the percentage of explained variance is quite high (27%, 36%). The results are illustrated in Figures 5 and 6. The results of testing orientation toward non-scientific activity were not significant.

Both the calculations and graphs were achieved with the aid of Interaction, version 1.7.2211 available at: http://www.danielsoper.com/Interaction.

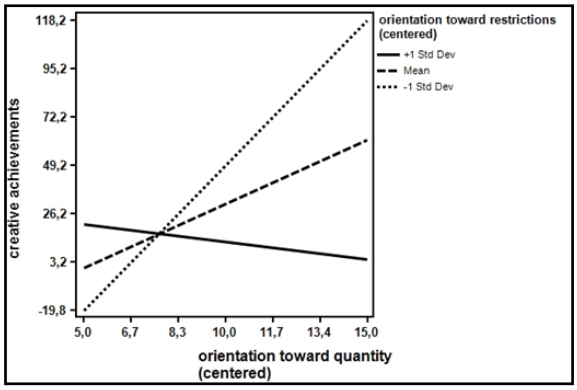

Figure 5 Interaction between orientations toward quantity, orientation toward restriction and creative achievements.

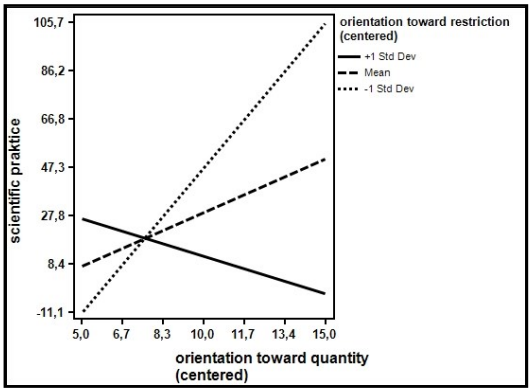

Figure 6 Interaction between orientations toward quantity, orientation toward restriction and scientific practice.

Finally, it is worth mentioning that no significant relationships were observed when Spearman rank-order correlations were used, or when creative achievement and scientific practice were log-transformed. The skewness for the distribution of the scores for both achievements and practice indicates, that we might be dealing with Poisson distributions (Silvia, et al., 2009), which impedes data analysis using simple correlational or regression methods. Regression analyses, using a log-transformed creative achievements indicator, demonstrated a significant relationship only with the orientation toward restrictions ($\beta = -.42$; $p < .05$), although orientation toward quantity was marginally significant ($\beta = .31$; $p = .09$).

DISCUSSION

Orientations toward quality, quantity, originality and adaptation express different beliefs and mind-sets (Karwowski, 2013) related to scientific work: writing articles and solving problems. Orientations may influence the range and level of scientific practice and creative achievements (Bandura, 1997; Bandura, Barbaranelli, Caprara & Pastorelli, 2001). Discovering the way in which people think about their work and its results, may form an important direction in studies about the determinants of creativity. Orientations or attitudes of scientists have so far not been defined clearly enough to allow their psychometric measurement (Root-Bernstein, Bernstein & Garnier, 1995). Research conducted among students concerning perception of scientific work (Eijck van, Hsu & Roth, 2009) also differ from the approach proposed in this paper, where it is assumed that orientations are flexible, and amenable to being shaped by the environment.

The results obtained are only partially coherent with the initial model. However, after the reduction of the variables, the remaining items reliably measured orientations toward quality and quantity in scientific work. Orientations toward adaptation and originality, were only partially reconstructed. In the case of orientation toward originality, only the component which concerns non-scientific activity was confirmed, therefore the name "orientation

toward non-scientific activity" would seem to be more adequate. The orientation toward adaptation also showed a different character than that expected, and hence the obtained factor was named "orientation toward restrictions". The small number of statements for particular scales leaves space for further work, although the brief nature of the instrument should be treated as an advantage - short research instruments require less time and guarantee reliability of results (Jonason & Webster, 2010; Karwowski, Lebuda & Wiśniewska, in press).

Orientation toward quantity confirmed its predictive validity towards creative achievements in both correlation and regression analyses. The young scientists examined, who regard publishing as a crucial aspect of scientific work and a skill that may be developed with practice, demonstrating awareness that their career depends on the number of articles published, are characterized by higher creative achievements. The belief that quantity becomes quality, may form one of the correlates of success in science. Orientation toward restrictions showed a negative relationship with both scientific practice and creative achievements. The vision of science that characterizes less active and less effective scientists consists of the following elements: perception of a career in science as being dependent only on productivity and not the rank of the problems undertaken; the choice of direction in research being influenced externally and evaluation of creative work as highly difficult. These associations are quite strong and require deeper reflection: are such beliefs a result of actual experience in the work environment, that influence orientation and inhibit work? Or perhaps people, who for some reason do not work effectively enough, are looking for reasons in the specificity of scientific work? Causal relationships should be examined in future research, but significant interaction effects between orientations are an important step towards a better understanding of the problem. The interaction of orientation toward quantity along with low self-constraints and external influence is beneficial for practice and performance in science. This means, that beliefs about the specifics of scientific work manifest themselves in decisions concerning how to work and the effects of these actions.

Neither orientation toward quality, nor orientation toward non-scientific activity correlated with creative output. The orientation toward quality showed marginal negative tendencies in correlations, which became even stronger in regression analysis. This suggests that too strong a need to elaborate and excessively high ambitions do not necessarily foster practice and achievements. The results of the further regression analyses confirm the importance of orientation toward quality. Its interactive relationships with orientation toward quantity indicate that recognition of productivity as a way for developing a person’s

own skills and as an important element in fostering the development of a scientific career together with low orientation toward quality and elaboration, leads to a higher number of creative achievements in science. The results illustrate, that science is a highly competitive work environment, in which the principle: "more, faster", leads to success.

Limitations and Future Studies

This research was conducted on a small sample and should be treated as a pilot study. Such a small group may cause instability in the results of the factor analysis, and hence the results should be treated indicatively. However, it is particularly important to emphasize that both creative achievements and scientific practice were analysed through the prism of individual productivity. In future, it is necessary to take into account qualitative criteria of achievement - scientific work is a phenomenon that cannot be limited only to the raw quantity of accomplishments.

In the future it is important to improve the presented scale. More complex research, conducted on a larger scale, will allow the status of orientation towards practice and creative achievements to be clarified, while at the same time considering the stage of an individual's scientific career. Is the orientation toward quantity related to the beginning of a scientific career? Does it become crucial when the potential is realized? Does the orientation change over the years, and with a decrease in productivity (Simonton, 1988) are achievements driven by a more qualitative orientation? These and other questions so far remain unanswered.

REFERENCES

Aiken, L. S. & West, S. G. (1991). Multiple regression: Testing and interpreting interactions. London, England: Sage.

Amabile, T. M. (1996). *Creativity in Context.* Boulder: Westview Press, Inc.

Busse, T. S. & Mansfield, R. S. (1984). Selected personality traits and achievement in male scientists. *Journal of Psychology, 116*, 117-131.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Bandura, A., Barbaranelli, C., Caprara, G. & Pastorelli, C. (2001). Self-efficacy beliefs as shapers of children's aspirations and career trajectories. *Child Development, 72*, 187-206.

Batey, M. & Furnham, A. (2006). Creativity, intelligence, and personality: A critical review of the scattered literature. *Genetic, Social, and General Psychology Monographs, 132*, 355–429.

Carson, S. H., Peterson, J. B. & Higgins, D. M. (2005). Reliability, validity, and factor structure of the creative achievement questionnaire. *Creativity Research Journal, 17,* 37–50.

Cramond, B. (1994). The Torrance Test of Creative Thinking: From design through establishment of predictive validity. In R. F. Subotnik & K. D. Arnold (Eds.). *Beyond Terman. Contemporary longitudinal studies of giftedness and talent* (pp. 229-255). New Jersey: Ablex.

Eijck, M.W. van, Hsu, P.-L,. & Roth, W. M. (2009). Translations of scientific practice to "students' images of science". *Science Education, 93*, 611-634.

Eysenck, H. J. (1995). *Genius: The natural history of creativity*. Cambridge: Cambridge University Press.

Feist, G. J. (1993). A structural model of scientific eminence. *Psychological Science, 4,* 366–371.

Feist, G. J. (1998). A meta-analysis of the impact of personality on scientific and artistic creativity. *Personality and Social Psychological Review, 2,* 290–309.

Feist, G. J. (2006). *The Psychology of Science and the Origins of the Scientific Mind*. New Haven and London: Yale University Press.

Gelade, G. A. (2002). Creative style, personality, and artistic endeavor. *Genetic, Social & General Psychology Monographs*, *128*, 213-234.

Jauk, E., Benedek, M. & Neubauer, A. C. (2013). The road to creative achievement: A latent variable model of ability and personality predictors. *European Journal of Personality,*wileyonlinelibrary.com, doi: 10.1002/per.1941

Jaussi, K. S., Randel, A. E. & Dionne, S. D. (2007). I am, I think I can, and I do: The role of personal identity, self-efficacy and cross-application of experiences in creativity at work. *Creativity Research Journal*, *19*, 247-258.

Jonason, P. K. & Webster, G. D. (2010). The dirty dozen: A concise measure of the dark triad. *Psychological Assessment, 22,* 420–432.

Karwowski, M. (2009). *Zgłębianie kreatywności: Studia nad pomiarem poziomu i stylu twórczości*. [*Exploring creativity. Studies over measurement of the level and style of creativity*] .Warszawa: APS.

Karwowski, M. (2010). Kreatywność – feeria rozumień, uwikłań, powodów. Teoretyczno-empiryczna prolegomena. [Creativity - feeria of understandings, entanglements, reasons. Theoretical and Empirical Prolegomena]. In M. Karwowski, A. Gajda (Eds.). *Kreatywność (nie tylko) w klasie szkolnej*. Warszawa: APS.

Karwowski, M. (2013, December 23). Creative mindsets: Measurement, correlates, consequences. *Psychology of Aesthetics, Creativity, and the Arts, 23*, *Advanced online publication Pagination.* doi: 10.1037/a0034898

Karwowski, M., Lebuda, I. & Wiśniewska, E. (in press). Measurement of creative self-efficacy and creative role-identity. *High Ability Studies.*

Karwowski, M. & Gralewski, J. (2011). Zmotywowana kreatywność. Synergia motywacyjna postawy twórczej młodzieży. [Motivated creativity. Motivational synergy of creative attitude of youth]. *Chowanna, 2,* 45-58.

Kim, K. H. (2008). Meta-analyses of the relationship of creative achievement to both IQ and divergent thinking test scores. *Journal of Creative Behavior, 42,* 106-130.

King, L. A., McKee Walker, L. & Broyles, S. J. (1996). Creativity and the five-factor model. *Journal of Research in Personality,* 30, 189-203.

Kirton, M. (1976). Adaptors and innovators: A description and measure. *Journal of Applied Psychology*, *61*, 622-629.

Kozielecki, J. (1997). *Transgresja i kultura*. [*Transgression and culture*]. Warszawa: „Żak"

Lim, H. S. & Choi, J. N. (2009). Testing an alternative relationship between individual and contextual predictors of creative performance. *Social Behavior and Personality, 37,* 117-136.

McCrae, R. R. (1987). Creativity, divergent thinking, and openness to experience. *Journal of Personality and Social Psychology, 52*, 1258-1265.

Nęcka, E. (2001). *Psychologia twórczości*. [*Psychology of creativity*]. Gdańsk: GWP.

Plucker, J. A. (1999). Is the proof really in the pudding? Reanalysis of Torrance's longitudinal data. *Creativity Research Journal, 12,* 103–114.

Root-Bernstein, R. S., Bernstein, M. & Garnier, H. (1995). Correlations between avocations, scientific style, work habits, and professional impact of scientists. *Creativity Research Journal,* 8, 115-137.

Root-Bernstein, R. & Root-Bernstein, M. (2004). Artistic scientists and scientific artists: The link between polymathy and creativity. In J. R. Sternberg, E. L. Grigorenko, & J. L. Singer (Eds.). *Creativity: From potential to realization* (pp. 127-151). Washington: American Psychological Association.

Silvia, P. J., Kaufman, J. C. & Pretz, J. E. (2009). Is creativity domain-specific? Latent class models of creative accomplishments and creative self-descriptions. *Psychology of Aesthetics, Creativity, and the Arts,* 3, 139-148.

Simonton, D. (1988). *Scientific genius: A psychology of science*. New York: Cambridge University Press.

Sternberg, R. J. & Hedlund, J. (2002). Practical intelligence, g, and work psychology. *Human Performance*, *15*(1/2), 143-160.

Szen-Ziemiańska, J. & Karwowski, M. (in preparation). Creative personal identity moderates the relationship between creative abilities and creative achievement in science.

Tokarz, A. (1998). Motywacja hubrystyczna i poznawcza jako dominanty systemu motywacji do pracy naukowej. [Hubristic and cognitive motivation as a dominant of motivational system for scientific work]. *Przegląd Psychologiczny, 41*(1/2), 121-134.

von Wittich, D. & Antonakis, J. (2011). The KAI cognitive style inventory: Was it personality all along? *Personality and Individual Differences*, *50*, 1044-1049.

Corresponding author at: Joanna Szen-Ziemiańska, University of Social Sciences and Humanities, Interdisciplinary Ph.D Program, 19/31 Chodakowska St., 03-815 Warsaw, Poland. E-mail: asia.szen@op.pl