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Adaptation of the Thinking Styles Inventory (TSI) within a Romanian student sample

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The present paper presents the psychometric properties of the Thinking Styles Inventory (TSI) in a sample of 543 Romanian undergraduate students. The TSI is a self-report questionnaire developed for the assessment of 13 types of preferences for problem solving (or thinking styles). The internal reliability analyses indicated that TSI scales have poor reliability (Cronbach's alphas between .26 and .72, with a median value of .62), and these values were slightly improved after we removed of 10 items from the original questionnaire. Confirmatory factor analyses failed to identify an appropriate solution for describing the relationships between the TSI items, indicating poor structural validity of the questionnaire. Further analyses indicated that the sex of the respondent has small effects on TSI scales. Also, results indicated that TSI scales can be used effectively to predict the academic specialization of the respondent.

Keywords: thinking styles; mental self-government theory; questionnaire adaptation

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Introduction

Most people associate learning performance or problem solving capabilities with high levels of intelectual abilities, or with a high intelligence quotient. However, more recent perspectives suggested that, together with intelectual abilities, individual's preferences for processing information and for approaching complex tasks are of equal importance (Zhang & Sternberg, 2005). In other words, psychologists have started to take into account that *being smart* is not the same thing as *behaving in a smart way*. Different constructs (such as *learning styles*, *cognitive styles*, *teaching styles*, *thinking styles*, *modes of thinking*) define personal preferences for structuring and conducting intellectual activities. All these approaches suggested that, together with one's intelligence quotient, psychologists should consider taking into account the personal preferences for planning, organizing, and implementing the process of problem solving. From this perspective, the manner in which one plans and organises own intelectual resources is equally valuable as the resources themselves.

The Theory of Mental Self-Government (Sternberg, 1988, 1994) is one of the most influential model that describes how people are different in terms of intellectual functioning. Since its apparition, more than 330 papers cited Sternberg's seminal paper (according to *Google Scholar*). Sternberg (1988) suggested that any individual prefers some abilities, and disregards the others. However, this preference is not necessarily associated with the level of development of that ability (people do not usually prefer to use their highly developed abilities). Sternberg (1988) named this preference *thinking style* and defined it as a concept at the interface between intelectual abilities and personality.

In the Theory of Mental Self-Government, Sternberg (1988, 1994) uses the organization of a state as a metaphor to describe 13 personal approaches (or thinking styles) in problem solving. Sternberg (1988, 1994) describes thinking styles that correspond to the functions of any democratic state: legislative (preference for the formulation of own solutions to problems), executive (preference for clear guidelines and procedures), judicial (preference for

problems that require an evaluation of different solutions or algorithms). Along the function of the state, Sternberg (1988) uses the form of organization as a metaphor for describing other four thinking styles: hierarchic (preference for multiple tasks that can be prioritized and approached individually), oligarchic (preference for multiple tasks that do not require prioritization and can be addressed at the same time), monarchic (preference for solving a single problem at a time) and anarchic (preference for multiple tasks that allow for flexibility and little or no structure). The remaining six thinking styles form three pairs: global (preference for large, unstructured problems) vs. local (preference for focused, detail-oriented problems); internal (preference for individual activity) vs. external (preference for group activity); liberal (preference for novel, unfamiliar tasks) vs. conservative (preference for traditional solutions). The thinking styles that form a pair have an acceptable degree of independence (correlations coefficients smaller than -.50) and should be treated different dimensions.

The Thinking Styles Inventory (Sternberg & Wagner, 1992)

Sternberg and Wagner (1992) developed the Thinking Styles Inventory (TSI) to assess the 13 thinking styles described in the Theory of Mental Self-Government. The first version of the TSI was developed in the American culture, and researchers adapted it for use in various Asian, European and African cultures (Zhang & Sternberg, 2006). The TSI manual cumulated more than 140 citations throughout the time (according to *Google Scholar*).

In regard to the internal reliability (Cronbach's alpha) of the TSI scales, previous research studies reported values between .50 and .75, which indicated poor-to-acceptable levels of internal consistency (Zhang & Sternberg, 2006). Repeatedly, in the case of local, monarchic and anarchic thinking styles, previous results indicated internal consistency indices smaller than .50 (Cassidy, 2012).

Investigations of the factorial structure of TSI in various cultures (Zhang, 1999; Cano-Garcia & Hewitt-Hughes, 2000; Bernardo, Zhang & Callueng, 2002; Macsinga, Maricuțoiu & Paloș, 2002; Fjell & Walhovd, 2004) identified three or four latent factors that explained the majority of item variance. In the light of these results, Zhang and Sternberg (2005) suggested an alternative classification of the 13 thinking styles. This new classification defined three main types of thinking styles: thinking styles that generate creative solutions and require higher levels of cognitive complexity (the legislative, judicial, hierarchical, global and liberal thinking styles), thinking styles that avoid creativity and favour adherence to norms and previously tested solutions (the executive, local, monarchic and conservative styles). The third category contains thinking styles influenced by task characteristics and can denote high or low levels of cognitive complexity depending on situational factors (the anarchic, oligarchic, internal and external styles). Although Zhang and Sternberg (2005) based their new classification on qualitative analyses of results reported in the specialized literature, we are not aware of any attempts to assess whether it is superior to the initial classification of the thinking styles, using a statistical approach.

Thinking styles and demographic variables

Fer (2012) reviewed the relationships between thinking styles and demographic variables, and observed that some research studies have concluded that men obtain higher scores on styles that require high levels of cognitive complexity, while other researchers reported that men have styles that require low levels of cognitive complexity. Because these researches used student samples from different countries (US, China, Taiwan, Hong Kong), Fer (2012) concluded that cultural characteristics of gender roles could have generated different results in previous research studies.

The academic specialization is another demographic variable associated with preference for different ways of solving problems. For example, Zhang (2001) demonstrated that the judicial and hierarchic thinking styles predicts academic performance in social and humanistic disciplines, while by the executive or conservatory thinking styles predicted grades from biology or chemistry. Such results indicated that different approaches in problem solving are successful for some disciplines, but had insignificant relationships with the grades from other disciplines. Comparisons between students from social sciences and humanities and students from natural sciences and technology also revealed systematic differences regarding the preferences for thinking styles (Zhang 2004). Researchers reported similar findings, when they compared the thinking styles of teachers that activated in different academic specializations. Sternberg and Grigorenko (1995) found that science teachers are more local (more oriented towards details) and less liberal than humanities teachers.

The present research

The first objective of the present research study is to analyze the psychometric properties of the Thinking Styles Inventory (Sternberg & Wagner, 1992) on a convenience sample of Romanian students. Because previous research studies reported small values for internal reliability of the TSI scales (Zhang & Sternberg, 2005) and cultural variations of TSI's structural validity, we were interested in investigating these issues on a Romanian sample.

The second objective of the present paper is to investigate the relations between demographic variables (gender and academic disciplines) and the TSI scales.

Method

Participants

Participants were 543 students (67.6% female, mean age = 21.18 years) from three Romanian universities located in the western part of the country. We invited students from various specialisations to complete the TSI, during their *Educational Psychology* laboratories. Students were from Social Sciences Departments (39.5%, from Psychology, Sociology, Educational Sciences, Communication and PR) and various Engineering specialities (26.5%, from specialities such as Computer Sciences, Electronics and Telecommunications, Automatics or Mechanical Engineering). The remaining students were from specialities such as Natural Sciences (8% - Biology, Geography, Chemical Sciences), Physical Education and Sports (7%), Economical Sciences (6.6%), Humanities (5.2% - Hystory, Linguistics), Medicine (4.1%) and Arts (3.1%).

Measures

We translated the Thinking Styles Inventory (TSI – Sternberg & Wagner, 1992) into Romanian, and we used the back-translation procedure to ensure the accuracy of item formulation. In the original version, the respondents had to evaluate the degree to which they are characterized by each item, using a 7-point Likert scale (ranging from 1 – *not at all well* to 7 – *extremely well*). However, we have encountered difficulties in the translation of the 7-point Likert scale because of the delimitation of verbal anchors corresponding to each point of the scale. Therefore, in the Romanian version asked the participants to express their agreement with the items. Furthermore, we used a 6-point Likert scales (ranging from 1 – *very strongly disagree* to 6 – *very strongly agree*). We based our decision to decrease the number of points from 7 to 6 points on the recommendations formulated by Muniz, Garcia-Cueto and Lozano (2005), who found that a four to six point Likert scale is optimal for achieving the highest levels of reliability and validity.

Results

Internal reliability of the TSI-65

We evaluated the internal reliability using the Cronbach's alpha, and we presented the results in Table 1. Similar with previous conclusions formulated by Zhang and Sternberg (2005), the values of Cronbach's alpha for the present sample ranged between .26 (the local style) and .72 (the liberal style). We have found values smaller than .50 in the case of four scales: the hierarchic style (Cronbach's alpha = .46), the anarchic style (Cronbach's alpha = .46), the global style (Cronbach's alpha = .49) and the local style (Cronbach's alpha = .26).

We conducted an item analysis to investigate the possibility of increasing the internal reliability of the TSI scales. We analyzed the correlation between each item and the overall score of the scale it was assigned to, and we eliminated all items that decreased the internal consistency of each scale. Following this analysis, we eliminated the following 10 items: item 3 (the judicial scale); item 43 and item 56 (the hierarchic scale); item 19 (the oligarchic scale), item 21 and item 47 (the global scale); item 9 and item 61 (the local scale); item 10 (the internal scale) and item 11 (the external scale). In Table 1, we also presented the values of the internal reliability indices for the 55 items version of the TSI.

Structural validity of the TSI

We used confirmatory factor analysis (CFA) with maximum likelihood estimation method, to assess the structural validity of the TSI. We evaluated model fit using the following goodness-of-fit indices: the χ^2 test of discrepancy, the goodness-of-fit index (GFI), the comparative fit index (GFI - Bentler, 1990) and the root mean square error of approximation (RMSEA - Browne and Cudeck, 1993).

We specified and tested two models: a model that contained all 65 items of the TSI, and a model that contained only the 55 items that remained after the optimization of the internal reliability indices. The original version of TSI (with 65 items) had the following fit indices: χ^2 (1938) = 5852.55, p<.001; GFI = .72, CFI = .58, RMSEA = .061 (with a confidence interval from.059 to .063). Taken together, these values are too small to accept as adequate the TSI version with 65 items. The 55 items version had better fit: χ^2 (1356) = 3411.25, p<.001; GFI = .81 CFI = .71, RMSEA = .053 (with a confidence interval from.051 to .055). Although all fit indices indicated this later model is better than the initial (65 items) model, the 55 items model is still not adequate to describe the answers provided by participants.

Table 1. Internal reliability and descriptive statistics of the 13 scales

Scale	*Reliability*		*Descriptive statistics of the 55-items version*	
	65 items	*55 items*	*Mean*	*Standard deviation*
Legislative	.62		4.43	0.62
Executive	.63		4.21	0.62
Judicial	.54	.57	4.04	0.69
Hierarchic	.46	.55	3.58	0.64
Monarchic	.66		4.38	0.70
Oligarchic	.53	.56	3.72	0.74
Anarchic	.46		3.87	0.62
Global	.49	.56	3.53	0.83
Local	.26	.28	4.05	0.71
Internal	.55	.58	3.82	0.76
External	.66	.71	4.31	0.77
Liberal	.72		4.10	0.70
Conservative	.70		3.73	0.69

In the light of these results, we also tested a model that grouped TSI items according to the new classification suggested by Zhang and Sternberg (2005). This third model specified the existence of two main factors (creativity-generating thinking style and creativity-avoidant thinking style), and four thinking styles that are independent of these two factors (the anarchic, oligarchic, internal and external styles). Fit indices for this model indicate that it was even more inadequate that the previous two models we previously tested: χ^2 (1689) = 5452.60, p<.001; GFI = .70, CFI = .55, RMSEA = .064 (with a confidence interval from.056 to .066).

The relationship between thinking styles and gender

Because previous reviews of the literature (Fer, 2012) could not find a general conclusion regarding the effects of sex on thinking styles, we investigated the existence of any such effects on the Romanian student sample. We analyzed the data using MANOVA, with sex as independent variable and the 13 thinking styles as dependent variables.

Results indicated that statistically significant sex differences can be found only in the case of the local thinking style (F(1,541)= 9.317, p=.002, η^2=.017), and in the case of the external thinking style (F(1,541)= 3.968, p=.047, η^2=.007). We identified other marginally insignificant effects in the case of legislative (F(1,541)= 3.755, p=.053, η^2=.007) and anarchic (F(1,541)= 3.489, p=.062, η^2=.006) thinking styles. Overall, we found weak relationships between sex and thinking styles, which indicated that less than 1% of the variance of all thinking styles (with the exception of the local thinking style) can be attributed to sex differences.

Predictive validity of TSI

The predictive validity is the hallmark of any psychological measure (Perugini & Banse, 2007). To assess their predictive validity, we investigated whether the TSI scales can predict the academic specialization. Starting from their academic specializations, we divided participants in two groups: social-humanistic specializations (61.32% of all participants) and realistic-technical (38.68% of all participants) specializations. The social-humanistic specialization included students from Psychology, Sociology, Educational Sciences, Communication and PR, Economical Sciences, Hystory, Linguistics, Arts, and Psysical Education and Sports. We classified the remaining participants in the realistic-technical specialization. Because the criterion was a dichotomic variable, we analyzed the data using logistic regression. In this analysis, the dependent variable was academic specialization, and we included the 13 thinking styles as predictors. In the logistic regression analysis, we used a stepwise, forward method for including only statistically significant predictors. .

Table 2. Results of the logistic regression

	B	*S.E.*	*Wald*	*df*	*Sig.*	*Exp(B)*
Constant	-.016	.834	.000	1	.984	.984
monarchic	-.597	.140	18.103	1	.000	.550
oligarchic	.264	.125	4.432	1	.035	1.302
local	.530	.137	14.867	1	.000	1.698

Note. Coding of the dependent variable: 0 – realistic/technical specializations; 1 – humanistic/social specializations.

Results presented in Table 2 indicated three significant predictors of academic specialization: the monarchic style (B = -.597; Wald = 18.103, p <.001), the oligarchic style (B = .264; Wald = 4.432, p = .035) and the local style (B = .530' Wald = 14.867, p < .001). The determination quotient of these three thinking styles ranged from .063 (Cox & Snell pseudo-R^2) to .085 (Nagelkerke pseudo-R^2). Because the critical values indicated by Cohen (1988) for interpreting multiple R^2 quotients are .02 for a small effect and .13 for a medium effect, we considered that the regression model had a small to moderate determination quotient.

Discussion

This research study aimed at investigating the psychometric properties of Thinking Styles Inventory (TSI - Sternberg & Wagner, 1992) within a Romanian student sample. Because previous research studies reported unsatisfactory levels of internal validity and difficulties in replicating the structural validity of TSI (Zhang & Sternberg, 2006), we focused mainly on these two types of psychometric properties. In addition, we investigated a) the gender effects on TSI scales; and b) the capability of TSI to discriminate between different academic specializations.

The analysis of internal reliability confirmed the conclusions formulated by Zhang and Sternberg (2006) regarding the poor internal reliability of TSI scales. For the most scales of TSI, reliability indices (Cronbach's alpha) were smaller than .70 (the cut-off value for acceptable reliability, according to Cortina, 1993). Moreover, we have found that some scales (the hierarchic style, the anarchic style and the global style) had reliability indices with values smaller than .50, which indicate unacceptable low levels of internal reliability. To correct this situation, we conducted an item analysis, and we removed 10 items that decreased the internal reliability of their scale. In its 55-item form, seven of the TSI scales improved their internal reliability, but the anarchic thinking style still remained with unacceptable values for the Cronbach's alpha.

We assessed the structural validity of the TSI through confirmatory factor analysis. Results of this analysis indicated that TSI's original structure (65 items designed to assess 13 thinking styles) is not adequate to describe the relationships between the items. This result is not surprising because the original structure was not replicated by any of the previous exploratory factor analyses that researchers conducted in different cultures (Zhang, 1999; Cano-Garcia & Hewitt-Hughes, 2000; Bernardo, Zhang & Callueng, 2002; Fjell & Walhovd, 2004). We also tested the 55 items (grouped on 13 thinking styles) version of the TSI, and we obtained better fit indices, in comparison with the 65 items version. Although the improvement of fit indices was substantial, the 55 items version still can not be considered fully adequate for describing the relations between the items of the TSI.

Besides the analyses for assessment of structural validity of the TSI, we also tested an alternate classification of the thinking styles, which was suggested by Zhang and Sternberg (2005). This perspective defined three principal types of thinking styles: 1) thinking styles that favour creativity and novel approaches in solving problems; 2) thinking styles that favour adherence to norms and "classical" approaches in solving problems; and 3) thinking styles that are dependent on situational (task-related) factors. The fit indices for this alternate classification had values smaller than the original (65 items) model. The poor fit of the model proposed by Zhang and Sternberg (2005) indicates that there are still large cross-cultural differences in the manifestation of thinking styles.Further research is needed to identify a classification of thinking styles that are valid in different cultures.

The analysis of the sex effects on thinking styles revealed small differences between male and female respondents, on the 55-item version of the TSI. For most thinking styles, there were no significant differences induced by the sex of the respondent, despite the large sample. Females obtained significantly higher scores than males only in case of the local thinking style, but the effect size was small (less than 2% of the local thinking style variance can be attributed to sex differences). These results are consistent with the conclusions formulated by Fer (2012), who could not generalize any sex effects on thinking styles.

The investigation regarding the predictive potential of the 55-items version revealed that TSI scales discriminated between students that opted for social-humanistic specializations, and students that opted for technical-realistic specializations. Results of the present research suggested that students in technical-realistic specializations focus on details (high scores on the local thinking style), prefer multiple tasks that do not require prioritization (high scores on the oligarchic thinking styles), and do not prefer solving a single problem at a time (low scores on the monarchic thinking styles). The

determination quotient (pseudo-R^2) of the regression model indicated a below-medium effect, suggesting that TSI scales have acceptable predictive validity. We believe these results were influenced by the poor internal reliability of the TSI scales, and any future improvements in terms of internal reliability will generate improvements in predictive validity.

The results presented in this paper have some limitations that should be taken into account. First, the generalization of results presented in this paper is limited by the fact that we did not have access to a probabilistic student sample, and used a convenience students sample. Second, although we included students from various academic specializations, the students enrolled in Social Sciences specializations are overrepresented in the sample used in this research. Third, we instructed participants to express their general agreement with each item. Because preference for a thinking style can be specific to situations (Sternberg, 1994), it is possible for one person to use one thinking style in solving academic problems and another style in approaching with domestic problems. Therefore, these instructions could have affected the internal reliability and the structural validity of the TSI.

In conclusion, results presented in this paper suggested that the Romanian version of TSI has problems regarding internal reliability and structural validity. Because previous research identified similar problems when TSI was adapted to other cultures, these results were not surprising. Any future attempts to improve the psychometric characteristics of TSI should consider replacing the items we identified as problematic in this research. For example, future research should take into account the new items created by Sternberg, Wagner and Zhang (2003) for improving the psychometric properties of the TSI. In addition, we believe that future research should consider asking participants to reflect on how they prefer to solve problems in specific contexts (for example *at work*, *at school*, *at home*). This approach should increase the internal reliability of the TSI, because it should diminish the context-related variance of the thinking styles.

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