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What is the "Cognitive" in Cognitive Diversity? Investigating the Convergent Validity of Cognitive Diversity Measures

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Abstract

Among researchers who examine team composition, the cognitive diversity construct has received considerable attention. There is little agreement, however, as to what the "cognitive" in cognitive diversity actually refers. Within this literature, researchers have examined variation in team members' backgrounds and experiences, their knowledge, skills, and abilities, their cognitive styles, their attitudes and perspectives, or a combination of these characteristics. These varying conceptualizations have led to different operationalizations and measures of cognitive diversity, calling into some question the validity of these measures. In this research, we examined the convergent validity of three cognitive diversity measures that have been used in the literature: Van der Vegt and Janssen's (2013) measure of cognitive group diversity, the Cognitive Styles Indicator (Cools & Van den Broeck, 2007), and team conscientiousness diversity (Hua, 2013). Five hundred fifty-two undergraduate engineering students in 148 project teams (3-6 members each) completed these measures, with none of the measures' intercorrelations meeting the minimum requirement for evidence of convergent validity. Implications for existing literature and future research will be discussed.

What is the "Cognitive" in Cognitive Diversity? Investigating the Convergent Validity of Cognitive Diversity Measures

The growing use of teams in the workplace, and an increasingly diverse workforce, have spurred team composition research. Typically, this research focuses on the relations among team diversity, team functioning, and performance. Past researchers have studied team member diversity in observable traits like age or gender, with meta-analyses combining the individual studies' findings (e.g., Bell, Villado, Lukasik, Belau, & Briggs, 2011; van Dijk, van Engen, & van Knippenberg, 2012). In contrast, recent studies have shifted to investigating diversity on attributes that are less observable, such as members' personalities, beliefs, knowledge, and problem-solving styles (e.g., Bell, 2007). Some of these deeper-level traits have become the basis of "cognitive diversity", and research on this concept has been conducted in a variety of fields and in numerous settings (Mello & Rentsch, 2015).

Despite the growing popularity of cognitive diversity research, there is no standard definition of cognitive diversity in the literature (Mello & Rentsch, 2015). Furthermore, there are inconsistencies in how it is defined, operationalized, and measured. This variability raises the question of whether researchers are measuring the same construct, or whether cognitive diversity has become a "catch-all" that requires re-conceptualization. Therefore, the present study examines the convergent validity of three cognitive diversity measures that have been used in past research.

Overview of the "Cognitive Diversity" Construct

There is a growing interest in studying cognitive diversity within teams, as it makes conceptual sense that a team with members who "think differently" could have different performance outcomes than a team whose members do not. Researchers have studied cognitive

diversity in relation to "outcome" measures like creativity (Kurtzberg, 2005; Shin, Kim, Lee, & Bian, 2012) and decision-making results (Olson, Bao, & Paravitam, 2007), and with moderators such as conflict management (Mello & Delise, 2015), trust (Olson et al., 2007), and psychological safety (Martins, Schilpzand, Kirkman, Ivanaj, & Ivanaj, 2013). Cognitive diversity research has also been conducted in various countries and cultures (e.g., Sauer, Felsing, & Rüttinger, 2006; Wei & Wu, 2013) and has expanded into disciplines other than psychology, such as healthcare and nursing (e.g., Piven et al., 2006). Overall, team cognitive diversity appears to be a topic of growing global and interdisciplinary interest.

But what exactly is cognitive diversity? What does a cognitively diverse team look like? The next section discusses what constitutes team diversity and explores the varying ways that that researchers have defined, operationalized, and measured cognitive diversity.

What is Cognitive Diversity?

Obviously, for a team to be "diverse" on a particular characteristic, the individual team members need to vary on that characteristic. For example, a group that is "diverse" with respect to gender will be composed of both men and women, and an age-diverse team could have members in their twenties and members in their fifties. But what is the individual characteristic or trait associated with a group's cognitive diversity? In other words, what is the "cognitive" in cognitive diversity?

From the definitions present in the literature, the "cognitive" in cognitive diversity could refer to a wide range of characteristics. Some researchers view cognitive diversity as arising from differences in team members' "personal and professional backgrounds" (Colón-Emeric et al., 2006, p. 174) or from "different training, sociocultural and educational backgrounds, belief systems, and work experiences" (Piven et al., 2006, p. 296). These characteristics have generally

been measured through demographic variables (e.g., Hambrick & Mason, 1984) or by observing a team's communication and interactions (Piven et al., 2006).

In contrast to these background characteristics, some conceptualize cognitive diversity as team members' differences in "abilities, knowledge, expertise and problem-solving strategies" (Sauer et al., 2006, p. 935). Other researchers (Martins et al., 2013) have expanded this conceptualization by adding expertness diversity, or the amount that team members differ in their level of expertise, to the definition above. This conceptualization of cognitive diversity has been operationalized inconsistently, such as through giving team members different forms and levels of training (Sauer et al., 2006) or by assessing their educational backgrounds and cumulative grade-point averages (Martins et al., 2013).

The "cognitive" in cognitive diversity could also refer to group members' variation in cognitive styles. A cognitive style is the knowledge and processes that a person uses to frame problems, organize information, and approach tasks (Kurtzberg, 2005; Mello & Delise, 2015). Inventories used to assess cognitive style have categorized individual team members in terms of being adaptive or innovative (Kirton Adaption-Innovation Inventory; Kirton, 1976), rational or intuitive (Generalized Decision Making Style Inventory; Scott & Bruce, 1995), or as preferring knowledge, planning, or creativity (Cognitive Styles Indicator; Cools & Van den Broeck, 2007). To date, there is not a standard measure of cognitive style in use in the cognitive diversity literature.

Cognitive diversity has also been defined in terms of differences in attitudes or viewpoints within a group. Proponents of this conceptualization define cognitive diversity as variability in unobservable, deep-level attributes like beliefs, perspectives, and values (e.g., Kilduff, Angelmar, & Mehra, 2000; Wei & Wu, 2013). Like cognitive style diversity, studies

using this definition measure cognitive diversity in numerous, inconsistent ways. For example, cognitive diversity has been assessed through perceptions of the extent that team members differed in their way of thinking, their beliefs about right and wrong, and how they viewed the world (Van der Vegt & Janssen, 2003). Other studies have operationalized cognitive diversity through member variations in beliefs and preferences (e.g., Olson, Parayitam, & Bao, 2007), through perceptions of group processes (Kilduff et al., 2000), or differences in strategic goals and objectives (Meissner & Wulf, 2016).

Other researchers have integrated aspects of the definitions above when forming their own conceptualizations, but have operationalized this concept using some of the previously described methods. For instance, Tegarden, Tegarden, and Sheetz (2009) viewed cognitive diversity as differences in attitudes, values and beliefs but extended their definition to include that this variability was developed through team members' backgrounds and experiences. Another combination is Shin and colleagues' (2012) definition, which conceptualizes cognitive diversity as a mixture of cognitive styles, knowledge and skills, and values and perceptions. Therefore, there is clearly considerable variation in the conceptualizations of cognitive diversity present in the literature.

From the definitions described above, the "cognitive" in cognitive diversity could refer to variation in team members' backgrounds and experiences, their knowledge, skills, and abilities, their cognitive styles, their attitudes, perspectives, and beliefs, or a combination of these characteristics. Not surprisingly, these inconsistent definitions have led to differences between studies in operationalizing this construct and aggregating individual responses to the team level. Most researchers (e.g., Kilduff et al., 2000) are interested in the team members' variance in their responses and thus conceptualize cognitive diversity as a configural group property. With this

conceptualization, the standard deviation of individual members' scores is calculated to determine a team's cognitive diversity score. However, other authors (e.g., Van der Vegt & Janssen, 2003) have conceptualized cognitive diversity as a shared group construct, meaning that perceptions of a group's cognitive diversity are individually assessed and then averaged to obtain a team score. Therefore, the lack of consistency in the literature raises some questions about the convergent validity of cognitive diversity measures and forms the basis of the present investigation.

Although a recent review conducted by Mello and Rentsch (2015) has organized the varying cognitive diversity conceptualizations by classifying them in terms of their stability, it does not answer the question of what "cognitive" is, nor does it address whether the measures of this construct are valid. The present study will not attempt to resolve the ambiguity of the "cognitive" in cognitive diversity, but aims to extend the current literature by examining the convergent validity of some cognitive diversity measures.

The Current Study

The current study investigates the convergent validity of three cognitive diversity measures: Van der Vegt and Janssen's (2003) measure of cognitive group diversity (abbreviated to CGD), the Cognitive Styles Indicator (CoSI; Cools & Van den Broeck, 2007), and conscientiousness diversity as a proxy for cognitive diversity (Hua, 2013). These measures were chosen because they are conceptually distinct, measure different facets of the "cognitive" of cognitive diversity at the team level, and have been used by diversity researchers in their studies.

Cognitive Group Diversity (CGD). Van der Vegt and Janssen (2003) conceptualized cognitive diversity as a shared group construct, specifically as perceived differences in knowledge, values, and skills between individual team members. Consistent with their definition,

their cognitive group diversity measure asks group members to rate the extent that their team differs in their method of thinking, their skills and knowledge, the way they view the world, and their beliefs on what is right and wrong. As this measure conceptualizes cognitive diversity as shared amongst group members, within-group agreement and between-group variance will be assessed to determine whether individual scores could be averaged to obtain a team-level score (Klein & Kozlowski, 2000). This measure has been used in studies such as those conducted by Shin et al. (2012) and Wei and Wu (2013).

Cognitive Styles Indicator (CoSI). Other studies (e.g., Vanderheyden & De Baets, 2015) have used the CoSI to obtain a team's cognitive style scores. Cools and Van den Broeck (2007) conceptualized cognitive styles in a three-dimension model, measuring knowing, planning, and creating styles. A person with a knowing style prefers looking at data, is logical and rational, and is likely to retain details and facts. In contrast, an individual with a planning style likes structure and preparation, and prefers organization and control. Lastly, a person with a creating style sees problems as opportunities and likes having the freedom to experiment in uncertain environments. Consistent with previous research (e.g., Klein & Kozlowski, 2000), the standard deviation of team members' individual scores will be calculated to determine a team-level cognitive style score.

Conscientiousness Diversity. Conscientiousness is one of the Big Five measures of personality, and includes traits such as being dependable, hardworking, achievement-oriented, and responsible (Barrick & Mount, 1991). It has been suggested that conscientiousness diversity could be used as a proxy to cognitive diversity (Hua, 2013). This is somewhat puzzling as conscientiousness diversity is already studied on its own (e.g., Peeters, van Tuijl, Rutte, & Reymen, 2006). Conscientiousness diversity will be measured using the conscientiousness

subscale of the HEXACO-60 Inventory (Ashton & Lee, 2009), and the standard deviation of team members' individual scores will be calculated to create a team-level score.

If convergent validity exists between these measures, it is expected that they will be intercorrelated. Specifically:

Hypothesis 1a: The CGD measure will be correlated with the CoSI.

Hypothesis 1b: The CGD measure will be correlated with the teams' conscientiousness diversity.

Hypothesis 1c: The CoSI will be correlated with the teams' conscientiousness diversity.

Consistent with the recommendations put forth by Carlson and Herdman (2012), correlations above $r = .70$ will be considered to provide good evidence of convergent validity whereas correlations below $r = .50$ indicate that the measures are likely not interchangeable. Correlations between $r = .50$ and $r = .70$ will be considered as weak, but potentially acceptable evidence of convergent validity.

Methods

Participants

Participants were 604 undergraduate engineering students enrolled in an introductory design course at Western University. The students were a part of 148 project teams, with three to six members per team. The participants ranged in age from 16 to 36 years ($M = 18.4$, $SD = 1.71$), individually completed the questionnaires associated with this study, and received course credit for their participation. Fifty-two students were excluded from final analyses as they failed to complete two out of the three questionnaires, leaving a total of 552 participants.

Measures

Cognitive Group Diversity (CGD). Van der Vegt and Janssen's (2003) cognitive diversity measure asks team members to rate the extent to which members of their group differ in their way of thinking, their skills and knowledge, the way they view the world, and their beliefs on what is right and wrong. This four-item measure uses a 7-point Likert-type scale ranging from 1 (*to a very small extent*) to 7 (*to a very large extent*). Cronbach's alpha for this scale has previously been found to be .84 (Van der Vegt & Janssen, 2003); it was found to be .78 in the current study. Since this measure conceptualizes cognitive diversity as a shared group construct, the appropriateness of aggregating this scale to the group level will be assessed using intraclass correlations (ICC), which measure within-group agreement and between-group variance (Klein & Kozlowski, 2000).

Cognitive Style Indicator (CoSI). The CoSI (Cools & Van den Broeck, 2007) is an 18-item measure that assesses an individual's cognitive style. Specifically, it distinguishes among the following three styles: the knowing style (assessed using 4 items; e.g., "I want to have a full understanding of all problems"), the planning style (7 items; e.g., "I like detailed action plans"), and the creating style (7 items; e.g., "I like to contribute to innovative solutions"). Individuals completing the CoSI rated the extent to which they agreed with each statement on a 5-point Likert-type scale of 1 (*totally disagree*) to 5 (*totally agree*). Cronbach's alpha was found to range from .73 to .79, .81 to .85, and .78 to .82 for the knowing, planning, and creating styles, respectively (Cools & Van den Broeck, 2007). In this study, it was found to be .72 for the knowing style, .85 for the planning style, and .73 for the creating style. The CoSI scales have been demonstrated to show convergent validity with other cognitive style scales (e.g., Kirton

Adaptation-Innovation Inventory; Kirton, 1976), although further research is needed on its criterion-related validity (Cools & Van den Broeck, 2007).

Conscientiousness. Team members' conscientiousness were measured using the conscientiousness subscale of the HEXACO-60 (Ashton & Lee, 2009). This is a 10-item subscale, wherein participants rate how much they agree with each statement on a 5-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). An example item would be "People often call me a perfectionist". Cronbach's alpha for this subscale was previously found to range from .76 to .78 (Ashton & Lee, 2009), with this study finding it to be .75. The conscientiousness subscale of the HEXACO-60 was found to correlate strongly with its counterpart on the NEO Five-Factor Inventory (Costa & McCrae, 1992), providing evidence of convergent validity (Ashton & Lee, 2009).

Procedure

Data were collected in September and November 2016. In September, students were randomly assigned to teams during their first "studio" session of their engineering design course. The students remained in the same teams until their course ended in April, and completed group projects for their course throughout this time. Participants individually completed a questionnaire, either online or using paper and pencil, containing a variety of scales including the conscientiousness subscale of the HEXACO-60. In November, the students completed another questionnaire which included the CGD and the CoSI measures. Questionnaires took approximately 30 to 45 minutes to complete.

Collecting data over two time points was necessary because the CGD measure required team members to become acquainted with each other; asking members about their teams' differences in values shortly after meeting would lead to inaccurate data. Additionally, as the

CoSI is a longer measure and several scales were already included in the September questionnaire, the CoSI was moved to the November questionnaire to avoid fatigue effects.

Results

Teams with fewer than three members responding to a diversity measure were deemed as incomplete and insufficient to measure diversity. Eleven teams were thus excluded from the final analysis, leaving 137 teams completing the CGD measure, 113 teams completing the conscientiousness measure, and 136 teams completing the CoSI.

Converting Individual Item Responses to Individual Scale Scores

The average of each individual's item responses were used to create an individual score for each of the three measures. The conscientiousness diversity items that required reverse-coding were reverse-coded. As previous research (e.g., Vanderheyden & De Baets, 2015) has measured teams' diversity on each of the CoSI's subscales (i.e., knowing, planning, and creating), individual scores were created for the total CoSI and for each of the three subscales.

Converting Individual Scale Scores to Team-Level Scores

Individuals' scores on the CoSI, its subscales, and the conscientiousness diversity measure were aggregated to the team level using the standard deviation of team members' scores. This is because we are interested in how members vary in their cognitive styles and their conscientiousness.

As the CGD measure conceptualizes cognitive diversity as a shared group construct, within-group agreement and between-group variance were assessed using ICC to determine if individual scores can be aggregated to the team-level (Klein & Kozlowski, 2000). The ICC values computed were lower than those that are recommended when assessing shared group constructs (*ICC[1]* = 0.07; *ICC[2]* = 0.21), indicating quite modest evidence that

conceptualizing this as a shared group construct is justifiable (Woehr, Loignon, Schmidt, Loughry, & Ohland, 2015). Accordingly, although individuals' scores were averaged to obtain a team-level score in this study, it may be more appropriate to conceptualize the variable as an additive (as opposed to a shared) group-level construct.

Correlations Among the Team-Level Scores

Teams' scores on the measures were intercorrelated to determine if there is evidence of convergent validity. See Table 1 for descriptive statistics and the correlation matrix. The correlation between teams' conscientiousness diversity scores and their total CoSI scores was significant (r = .20, p < .05); however, it is nowhere close to the minimum of r = .50 recommended by Carlson and Herdman (2012), indicating that these measures are likely not interchangeable. The correlation between the conscientiousness scores and the CGD was not significant (r = -.09, *ns*), and neither was the correlation between the CGD and the CoSI (r = -.09, *ns*, r = .12, *ns*). Furthermore, none of the CoSI subscales significantly correlated with the CGD (r_{know} = .08, *ns*; r_{plan} = .15, *ns*; r_{create} = .09, *ns*) or with teams' conscientiousness scores (r_{know} = .13, *ns*; r_{plan} = .07, *ns*; r_{create} = .13, *ns*). As all correlations between the different measures of cognitive diversity were well below the r = .50 recommended by Carlson and Herdman (2012), none of the hypotheses made were supported.

Discussion

Given that the three cognitive diversity measures used in this study were measuring the same construct, it is expected that they would be highly intercorrelated. However, their intercorrelations were found to be well below the r = .5 cutoff suggested by Carlson and Herdman (2012), indicating that these measures are likely not interchangeable.

Table 1: Correlations among teams' scores on cognitive diversity measures

	M	*SD*	1	2	3	4	5
1. CGD[a]	4.03	0.54					
2. Consc. Diversity[b]	0.47	0.22	-.094				
3. Total CoSI	0.45	0.20	.116	.203*			
4. Knowing Style	0.57	0.23	.076	.134	.554**		
5. Planning Style	0.58	0.25	.153	.066	.640**	.161	
6. Creating Style	0.51	0.24	.094	.126	.629**	.235**	.396**

[a] For the Cognitive Group Diversity measure, $n = 137$ teams; for the HEXACO-60, $n = 113$ teams; for the Cognitive Styles Indicator, $n = 136$ teams
[b] Consc. Diversity is team-level diversity on the conscientiousness subscale of the HEXACO-60
*$p < .05$
**$p < .01$

This finding is not surprising, given that the three measures were chosen on the basis of being conceptually different yet used in the cognitive diversity literature. The CGD asked questions about individual perceptions of their group's differences in values, the CoSI measured individuals' cognitive styles, and individuals' conscientiousness diversity was used as a proxy for cognitive diversity. The lack of convergent validity between these measures could be a symptom of a larger issue within the cognitive diversity literature, where there is no consistent definition or operationalization of this construct.

Having a consistent conceptualization of an identically-named concept is crucial to ensure research findings are able to build upon others' findings. Without an agreed-upon definition and operationalization, researchers cannot reliably draw conclusions about a construct and its relations to others because different measures used in the literature may not actually be measuring the same concept. Therefore, a uniform conceptualization is required for accurate knowledge about a concept to increase.

Clearly, the cognitive diversity literature would benefit from greater consistency in conceptualization. Past studies have found conflicting results regarding the relationship between a team's cognitive diversity and its performance (Mello & Rentsch, 2015), which could have resulted from the lack of uniformity in definitions and operationalizations. Furthermore, accuracy in measurement is needed to properly investigate cognitive diversity's relationship with other team input, process, and outcome variables. For example, cognitive diversity has been suggested to act as a mediator between demographic diversity and outcome measures (e.g., Kilduff et al., 2000) and could play a role in a team's process conflict (e.g., Martins et al., 2013; Olson et al., 2007). Cognitive diversity could also be investigated as an emergent state, and the boundary conditions for its relationship with other concepts need to be further researched (Mello & Rentsch, 2015). Therefore, accurate measures are required to ensure that appropriate input-process-outcome models that include cognitive diversity are properly constructed and tested.

Limitations and Future Directions

This study only investigated three out of the numerous measures of cognitive diversity in the literature. Therefore, it can be improved upon by adding other operationalizations of cognitive diversity. For instance, diversity in educational backgrounds (Martins et al., 2013), differences in strategic goals and objectives (Meissner & Wulf, 2016), or the Sussex Cognitive Styles Questionnaire (Mealor, Simner, Rothen, Carmichael, & Ward, 2016) could be included in future research on the convergent validity of cognitive diversity measures. However, given that these measures are conceptually different, both from each other and from measures used in this study, it is not expected that they will generate any higher intercorrelations.

Furthermore, this study only used self-report measures when assessing teams' cognitive diversity and did not include other forms of measurement such as peer ratings or observations. Using only one type of methodology is associated with common method variance, which has the potential to inflate the correlations amongst measures (Richardson, Simmering, & Sturman, 2009). If our results were inflated by common method variance, the measures' actual intercorrelations would be lower than what was found, providing even less evidence of convergent validity. Future research could include multiple measurement methods (e.g., self, peer, and supervisor ratings and observations of a team's conscientiousness diversity or cognitive style diversity) and determine their intercorrelations. High intercorrelations are indicative of convergent validity, and researchers can be more confident that these measures are assessing the same intended construct (Aguinis, Henle, & Ostroff, 2001).

Additionally, the questionnaires given to participants did not include any scales measuring careless responding. As participants completed a set of questionnaires, some may have not taken care when choosing the best response, thus reducing the accuracy of the data collected. Future research could include items that signal careless responding to ensure the data's overall accuracy.

Conclusion

After calculating the intercorrelations of three different measures of cognitive diversity we found little evidence supporting their convergent validity. Considering this finding, at least one of the measures investigated is not measuring the same construct as the rest, supporting the notion that researchers should exercise caution when comparing results amongst studies that use different measures of cognitive diversity. We recommend that cognitive diversity researchers come to a consensus regarding the conceptualization of cognitive diversity and choose appropriate measures to ensure the accuracy and generalizability of findings.

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