Applying Multidimensional Item Response Theory Analysis to a Measure of Meta-Perspective Performance

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Abstract: The authors introduce a scale to measure meta-perspectives, my view of your view of me, about one's performance in an organizational setting. Applied to the performance appraisal process, this perspective allows the authors to investigate how employees think their supervisors view their performance. Meta-perspectives thereby enrich our understanding of the relationship effects inherent in the performance appraisal process. Due to the desirable properties of item response theory (non-sample specific item parameter estimates), a multidimensional item response theory (MIRT) model was applied to the data. This allowed for the simultaneous estimation of dimensionality and item threshold values. Data collected from 1,255 full-time workers in two different organizations reveal that the items did not lie along a unidimensional continuum, but that three dimensions underlie the proposed scale: employee perceptions of the supervisor's view of employee work ethic, work product, and self-regulation. The authors offer suggestions for refinement of the scale and future research.

Keywords: Item response theory, scale development

1. Introduction

If called upon by another to describe oneself, few individuals would have difficulty responding. Most individuals have a strong sense of self, frequently referred to as one's self-identity. Self-identity is the view of oneself created and maintained over time through inter- and intra-personal experiences that define what the self is like (Schlenker, 1986). Self-identity is formed by showing oneself to be a particular type of person both publicly, through self-presentation and self-disclosure, and privately, through introspection and contemplation of oneself (Schlenker 1984, 1985).

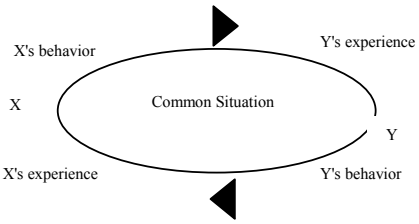

Figure 1. The inter-experience of a dyad.

An individual's identity directly impacts how others react to him or her (Schlenker and Weigold, 1989). This impact has been referred to as the inter-experience of a dyad (Kenny and Albright, 1987; Laing, Phillipson, and Lee, 1966), which is illustrated in Figure 1. As can be seen in Figure 1, in situations common to two persons, X and Y, person X's behaviour, which is based on his or her self-identity, is experienced by person Y. This experience compels person Y to enact a behaviour that is experienced by person X. As the model illustrates, the behaviours of each participant are directly influenced by the experience of the other.

One's self-identity is how one sees oneself (i.e., my view of myself). The identity that results from acting on the experience of another's actions, as illustrated by the dyad, is a "meta-perspective" (Kenny and Albright, 1987; Patterson, Churchill, Farag, and Borden, 1992) – or how I think you see me (i.e., my view of your view of me). Given that an individual defines his or her own self-identity, one's view of oneself is generally not open to refutation. However, the same cannot always be said for one's meta-perspective, as an individual can never be truly sure he or she knows why others act as they do. Instead, an individual understands another's actions based on his or her own perceptions. Frequently, the understanding that an individual has of another's behaviour is incorrect, as the individual simply projects his or her own reasons for acting a certain way onto the other. Unaware of the perceptual error, the individual continues to react to the other's behaviours based on false assumptions of why the behaviours were enacted. These false assumptions can lead to mismatched perceptions that can lead to a spiral of mismatched perceptions, resulting in a less than effective communication experience. An example may make this more concrete.

Pat reports to Chris. Pat sees himself as possessing strong leadership potential and aspires to be promoted to management. Thus, at

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every opportunity Pat engages in leader like behaviour such as setting deadlines for colleague's projects and reorganizing the office to make it more efficient. Pat fully admits that enacting these behaviours some times gets in the way of finishing his assigned duties, but believes his actions are appropriate given the continuous feedback he receives from Chris about his actions. Chris recognizes Pat's "need to lead," but attributes it to being lazy rather than a strong leader. Chris sees Pat's behaviour as a blatant attempt to get out of doing his assigned work. Chris, regularly reminds Pat that his extra-role behaviours - even when they are on target - take away from his in-role behaviour upon which he will be appraised. Appraisal time is upon them. Pat is confident that Chris will provide him a strong evaluation and place his name in the promotion pool so that he can apply his management skills full time. Unfortunately, Chris rated Pat low because he continually misses deadlines by engaging in distracting "management-like behaviours" rather than finishing his assigned work. Pat thought Chris viewed him as a strong leader when in reality Chris saw Pat as a slacker. While both thought they were clearly communicating their positions to the other, a meta level miscommunication occurred.

The focus of the present study is on the meta-perspective described above. The decision to study meta-perspectives was based on our belief that many of the miscommunications that occur in the workplace can be explained by inaccurate perceptions about others' behaviours. Supervisors and subordinates modify their own behaviour based on limited and frequently inaccurate information about why the other is acting the way he or she is. As each person continues to behave based on a flawed understanding of who he or she is to the other person, rather than on the other's true beliefs, both individuals may get caught in an escalating series of miscommunications. Thus, gaining an understanding of how meta-perspectives are formed and how they contribute to ineffective dyadic relationships in the workplace may help us find a way to create more positive interactions.

This research represents a first step towards better understanding the occurrence of meta-perspectives. Our initial task was to develop a scale to measure meta-perspectives in an organizational setting. Although there are many different organizational issues in which meta-perspective can be applied, we elected to focus on performance ratings, as this is one of the most critical human resource issues organizations face. Organizations cannot be competitive without employees who can effectively perform their jobs. Accordingly, the primary purpose of the present study was to assess the dimensionality of our newly developed meta-perspective performance scale via multidimensional item response theory analysis (e.g., Ackerman, 1987) prior to assessing its construct validity and testing hypotheses.

2. A social relations explanation of meta-perspective

Scholars have theorized that one's identity influences how a person behaves and therefore how he or she is perceived by external others (Albert and Whetten, 1985; Ashforth and Mael, 1989). In essence, we all form our personal identity in an effort to answer the question, "Who am I?" (Ashforth and Mael, 1989). To reduce the possibility of cognitive dissonance, we are then apt to implement behaviours that enable us to confirm our self-defined identities.

In the context of a subordinate's role, if the answer to "Who am I?" is, "I am a conscientious employee," that identity may well lead to different behavioural patterns than if the answer is, "I am a team player." For example, the self-identified conscientious employee is likely to focus his/her behaviours on meeting deadlines and producing high quality work. On the other hand, the self-identified team player may be likely to focus on shared leadership and trust building.

The social relations model (Kenny, 1981; Kenny and La Voie, 1984) takes this identity-behaviour relationship a step further, and posits that individual behaviour is contingent upon three relationship factors: (1) an actor effect (consistency of actor's behaviour across partners), (2) a relationship effect (the unique ways an actor behaves with a given partner), and (3) a partner effect (consistency in the behaviour of the actor's partner). Thus, if I see person X consistently act in a cheerful, helpful manner towards many people (actor effect), if person X is consistently helpful in interactions with me (relationship effect), and if I consistently ask person X for favours in anticipation of his or her helpful response (partner effect), person X's tendency is not only to think of himself or herself as helpful, but is also to think that I think he or she is helpful (meta-perspective). Thus, these effects suggest that individuals alter their behaviour based on the subjective perceptions they hold about the perceptions held by their interaction partners; people alter their behaviour based on how they think others perceive them (DePaulo, Kenny, Hoover, Webb, and Oliver, 1987).

Because person perception is argued to be contingent in almost equal proportions upon the

perceiver as well as the person being perceived (Bourne, 1977; Kenny and La Voie, 1984), reaching agreement between the perceiver and the perceived individual is an important determinant of future behaviour. In other words, if a subordinate believes that he or she is perceived as a helpful team member, when in fact the supervisor views the subordinate as overly controlling and bossy, the subordinate may be apt to blithely continue the controlling, bossy behaviors, which the supervisor finds frustrating. Eventually, this mismatch between the two different interpretations of the same behaviour may result in tension between the employee and the manager. If the subordinate is effective at reading the reactions of his or her manager, he or she will realize that a less pushy, more low-key approach to team membership is desirable and will change his or her behaviours accordingly. However, if a mismatch exists but the subordinate does not recognize it, the employee will not change his or her behaviours and an ongoing performance problem may result.

In fact, mismatched perceptions between subordinates and supervisors may be more common than congruent perceptions (Harris and Schaubroeck, 1988), and subordinates often expect higher performance ratings than they get in formal reviews (Pearce and Porter, 1986), indicating that their meta-perspectives are incorrect. Thus, many of the problems associated with the performance review process (e.g., defensiveness, conflict, political posturing), could be ameliorated by increasing the accuracy of subordinates' meta-perspectives. Therefore, our initial efforts in this line of research were directed towards developing an empirical measure of performance meta-perspectives in an organizational setting.

Due to the desirable psychometric properties inherent in multidimensional item response theory (MIRT) (e.g., non-sample specific item parameter estimates), we selected this analysis approach to model our data. MIRT combines features of both unidimensional item response theory (UIRT) and factor analysis (FA), to provide both dimensional and item threshold information. A secondary purpose of our study was to expand the exposure of MIRT methods in an applied setting.

3. Method

3.1 Sample

A survey was administered to two different samples located in the southeastern United States. One organization was a large division of a state government agency, and the other was an electrical cooperative. The employees of the state agency provided a total of 786 usable responses, and the employees of the electric cooperative returned 469 usable responses. Both surveys were administered as part of a larger employee opinion survey conducted at the request of each organization. Given this format, we were not provided complete freedom in construction of the surveys. One restriction placed upon us was that no demographic data be collected, because top management from each organization believed that this information could be used to determine the identity of specific respondents, thus eliminating the anonymity promised. Although specific demographic data are not available, there was considerable diversity among the respondents with respect to gender, race, and age, because 67% of the state agency and virtually every member of the electric cooperative (95%) responded to the survey. With such high responses rates, the demographic characteristics of the actual population are reflective of the sample. For the state agency, 14% of the employees were African American, 37% were female, and the average age was 42.1 years of age. The respondents from the electrical cooperative included 5% African Americans, 22% females, and had an average age of 44.6 years of age. When conducting the multidimensional item response theory analyses, we combined the two samples in order to create one dataset with 1255 responses. This was done with the intent of maximizing the stability of derived parameter estimates (Ackerman, 1994), by ensuring a sample more representative of the general population.

3.2 Procedure

State agency. The surveys were delivered to the director of the state government agency. He wrote an endorsement letter that was distributed with the survey via interoffice mail to each employee in the agency. Included with the survey was a return envelope addressed to the researchers. The cover letter directed the respondents to complete the survey on company time and then seal it in the envelope and mail it directly to the researchers. Of the 1175 surveys sent, 786 (67%) were returned within the three-week time period allocated.

Electrical cooperative. The surveys were mailed to the Human Resource Director for the cooperative sample. His assistant distributed the surveys to groups of 15-25 employees assembled in a conference room at the general offices over a three-day period. The respondents, collected by the assistant and mailed to the researchers, sealed the surveys in return envelopes. All employees present at work on any one of the three days of survey administration participated,

providing 469 usable responses out of 495 employees for a response rate of 95%.

3.3 Measures

Our first step was to create items to measure meta-perspectives in an organizational setting. To accomplish this goal, we created meta-perspective items about an important issue in organizations -- performance appraisals. Specifically, we modified generic performance appraisal items (Wright, Kacmar, McMahan, and DeLeeuw, 1995) to reflect a meta-perspective by reversing the referent focus of the item. For example, the performance appraisal item that asked a supervisor whether an employee always tried to do things better at work became "I think that my supervisor thinks that I always try to do things better at work" (1 = "strongly agree;" 5 = "strongly disagree"). The items are presented in the Appendix.

3.4 Analyses

We applied multidimensional item response theory analysis (MIRT; Ackerman, 1987, 1992, 1999; McDonald, 2000; Oshima and Miller, 1991; Reckase, 1997; Reckase, Ackerman, and Carlson, 1988; Way, Ansley, and Forsyth, 1989) to the eight meta-perspective items presented the Appendix. As mentioned in our measures section, these items were modified versions of an existing performance scale (Wright et al., 1995) that captures four key components of successful performance: initiative, diligence, competence, and confidence. Our intent was to develop an empirical understanding of both the construct and item-level measurement characteristics of these items. MIRT models a set of item responses utilizing features of both factor analysis and item response theory (Farmer, 2001). A PsychInfo search of the 1992-2004 abstracts of the literature for either "multidimensional item response theory" or "MIRT" appearing in journal articles published in English revealed only twenty studies. MIRT has been successfully applied in studies regarding measurement issues (e.g., Ackerman, 1996; Douglas, Roussos, and Stout, 1996; Ferrando and Lorenzo, 1998; Janssen, and De Boeck, 1999; Luecht, 1996; Luecht, and Miller, 1993; Miller and Hirsch, 1999; Segall, 2001). However, despite its usefulness and appropriateness, we are aware of only one previous study that applied MIRT to issues of relevance to the I/O literature (Farmer, 2002).

Factor analysis is a "dimension discovery" technique (Brown, 1994) that is typically utilized to reduce a set of measured variables to an interpretable set of fewer "unmeasured" or latent variables. These latent variables are generally hypothesized to underlie the measured variables and typically are of more theoretical interest than the individual items themselves (Cattell, 1966). Though confirmatory methods (including structural equation modelling) have tended to dominate the literature in recent years, exploratory factor analytic techniques still serve an invaluable role in establishing dimensionality of a new measuring instrument (as the one used in this study) or in the absence of substantive theory. Exploratory efforts are usually based on the common factor model, in which the response to any variable in a dataset is modelled as a linear weighted combination of a set of latent variables that are "common" to all of the variables. The remaining variance in each item is accounted for by a factor unique to that variable.

In item response theory (IRT), a set of items is modelled along an assumed latent trait, resulting in an index (item difficulty or threshold) of the item's position on the latent continuum. In Likert-type data, thresholds are produced for each item category (minus 1). In addition, in models that consider item discrimination, an index of the item's ability to differentiate those at particular points on the continuum is provided. Whereas in factor analysis multidimensionality is explicitly modelled, commonly used IRT models generally operate under the assumption that a set of items modelled together lie somewhere along a single unidimensional continuum. Though a fair amount of research (Hambleton, 1989) has been done to examine the effects of multidimensionality in a dataset, until recently practical efforts were directed at minimizing the effects of dimensions other than the one explicitly assumed to underlie the modelled items. This situation, along with a general requirement of large sample sizes, has hindered a widespread utilization of IRT methods in most organizational research (Tenopyr, 1994).

MIRT methods assume that more than one dimension underlies the responses to a set of items, and models each item in a continuous multidimensional space. Item thresholds are produced, as in unidimensional item response theory (UIRT) models, as are item discrimination indices. Unlike in UIRT models, which provide one discrimination index per item, MIRT analyses result in the same number of discrimination indices, as there are modelled dimensions. In fact, they serve as the MIRT analogue to factor loadings.

That being stated, the focus of this analysis is to simultaneously model the data dimensionality and the item-level measurement characteristics of the eight survey items. The analysis was performed using *Mplus 2* (Muthen and Muthen, 2001). *Mplus*

provides a number of modelling options that allow for exploratory or confirmatory latent variable and latent class analysis, and for any combination of continuous and categorical measured variable formats.

4. Results

Item inter-correlations are presented in Table 1. For the purpose of this study, the meta-perspective items were modelled as ordinal categorical variables, which was necessary from an IRT perspective. Therefore, the coefficients that are presented are polychoric.

Table 1: Meta-perspective item inter-correlations*

Item	1	2	3	4	5	6	7	8
1	---							
2	.80	---						
3	.78	.84	---					
4	.71	.73	.77	---				
5	.59	.63	.70	.68	---			
6	.61	.62	.66	.67	.76	---		
7	.54	.55	.60	.57	.62	.60	---	
8	.57	.56	.61	.58	.60	.61	.65	---

* Note: Polychoric coefficients; N = 1,255.

Based on a scree test plot of eigenvalues (Cattell, 1966), we determined that three underlying dimensions were probably accounting for the variance in the correlation matrix. Due to the exploratory nature of this study, an exploratory model-testing paradigm was used. A number of models (ranging from 1- to 4-dimensional solutions) were tested using a chi-square difference test to arrive at a model that fit the data. In addition, RMSEA and RMSR indices were used in the evaluation of model fit. Model testing results are presented in Table 2.

Table 2: Results of model testing procedure for 1- to 4-dimension solutions

Item	1-dim	2-dim	3-dim	4-dim
χ^2	433.1	164.5	26.22	1.857
df	20	13	7	2
p-value	<.001	<.001	.001	.391
RMSEA	.128	.096	.047	.009
RMSR	.156	.058	.015	.003

Note: N = 1,255. RMSEA = Root mean square error of approximation. RMSR = Root mean square residual.

Using a combination of model fit indices, we determined that the 3- and 4-dimension solutions most closely approximated the underlying structure of the data. After further evaluation, in which the criterion of interpretability was used as the primary criterion, we decided to use a 3-dimensional solution. Further, rotational analysis (both orthogonal and oblique) suggested (mean inter-factor correlation was .693) that allowing the dimensions to correlate was appropriate.

The results of the MIRT analyses are presented in Table 3. The first three columns represent the obtained factor loadings of the items. As illustrated, the first four meta-perspective items load most highly on the first dimension. In succession, items 7 and 8 comprise a second dimension (though item 7 also demonstrates a low loading on the third dimension); and the third dimension is most closely linked to items 5 and 6. The next three columns are the loadings transformed to a logistic metric (Muthen and Muthen, 2001) to allow for an alternate interpretation of the item discrimination values. Finally, the last four columns represent the item category thresholds. From inspection, it would appear that these items appear to capture a wide range of the latent dimensions as defined by the eight variables.

Table 3: Estimated item parameters for eight meta-perspective items (3 latent dimensions)

Item	f1	f2	f3	a (f1)	a (f2)	a (f3)
1	.84	.09	-.03	1.52	.09	-.03
2	.91	-.01	.03	2.15	-.01	.03
3	.76	.03	.18	1.18	.03	.18
4	.59	.05	.27	.73	.05	.28
5	.04	-.03	.92	.04	-.03	2.38
6	.16	.11	.63	.16	.11	.81
7	.12	.42	.30	.12	.46	.32
8	.02	.94	-.02	.03	2.63	-.02

Item	b1-2	b2-3	b3-4	b4-5
1	-1.06	.38	1.38	2.01
2	-1.05	.30	1.37	1.95
3	-.89	.72	1.49	1.98
4	-.72	.78	1.62	2.04
5	-.79	.65	1.50	2.06
6	-.97	.32	1.27	2.07
7	-.72	.54	1.49	1.99
8	-.84	.32	1.05	1.82

Note: *f**= factor loading, *a(f*)* = item discrimination parameter, *b* = item difficulty/threshold parameter. N = 1,255.

5. Discussion

In summary, statistical results indicate that as many as three dimensions may underlie the responses to the eight meta-perspective items. A substantive interpretation of the dimensions found to underlie the responses to the eight meta-perspective items clearly supported a three-dimensional structure. Dimension 1 (items 1 thru 4) refers to a general self-perception of what one's supervisor thinks of one's work ethic. This

dimension is comprised of the extent to which one believes that his or her supervisor thinks one tries to "do things better at work," "do more than asked," "work hard," and possesses confidence in one's "ability to succeed, reach challenging goals, or overcome obstacles." Dimension 2 (items 5 and 6) refers to a self-perception of supervisor's thoughts on work products. Specifically, these items reflect a meta-perspective of the extent to which one completes work on time and produces high quality work. Lastly, Dimension 3 (items 7 and 8) reflects a self-perception of one's supervisor's thoughts on personal self-regulation. This dimension includes items measuring the meta-perception of work habits like "tardiness, length of breaks, etc," and the extent to which the subordinate thinks that the supervisor thinks he or she has to "check up on" the subordinate.

Based on examination of the factor loadings and item discrimination indices, it appears that the inclusion of item number 7, "I think that my supervisor thinks that my work habits (tardiness, length of breaks, etc.) are excellent," may need to be re-evaluated, as it loaded on the factor relatively weakly. We speculate that modifying the item rather than eliminating it completely might improve its loading, as its conceptual fit appears sound despite its potential double-barrelled wording. Specifically, we recommend that changing the item to "I think that my supervisor thinks that my habits regarding how I structure my work are excellent" might garner better results, as "habits" are defined conceptually rather than through multiple examples. If modification does not improve its overall fit with Dimension 3, eliminating item 7 entirely would result in a two-dimension scale, which might be a more accurate representation of the scale. In that case, future researchers seeking to validate the scale also would have the opportunity to augment Dimension 3 with additional items as deemed necessary based on their results.

Three strengths of our approach increase the contribution of the present study to the management literature. First, this study represents an important first step in empirically testing the social relations model in the context of human resource management generally, and in performance appraisal specifically. Performance management is a perennially challenging area for practicing managers, and social relations theory has the potential to help us understand some of the miscommunications inherent in the process and address them proactively. However, the measurement challenges associated with a social exchange-based, reflexive theoretical perspective have not readily lent it to empirical study in the management literature. Scale development in this area is an important first step. Secondly, we gathered data from two organizations rather than limiting our data to a single source, thereby increasing the potential generalizability of our findings. Additionally, the samples were fairly large and representative of their respective organizations. Finally, our use of multidimensional item response theory may help to increase awareness of this methodological approach in the management literature. MIRT methods allow researchers to simultaneously model the data and item-level measurement characteristics, thereby combining the strengths of factor analysis and item response theory.

6. Directions for future research

Despite the strengths of this study, however, three steps for continued research in this area appear warranted. First, although the use of two data sources may represent a good start, further replication is needed to determine how the findings reported here correspond to the results of studies conducted in other work environments. Following replication, a logical next step would be to examine the construct validity of the meta-perspective scale through convergent and discriminant validity strategies (Hinkin, 1998). Finally, once construct validity of the scale has been established, work will be needed to derive and test hypotheses regarding the antecedents and outcomes of the accuracy of meta-perspectives based on the social relations model. To date, this work has not been done due to difficulties operationalizing meta-perspective accuracy. Based on our scale development, we suggest that this hypothesis testing may best proceed by employing an analysis of self-other agreement on items in the meta-perspective scale.

Based on prior theoretical work in this area, we believe that empirically testing performance-based models that incorporate a meta-perspective may provide researchers with several important insights. As discussed, antecedents to a meta-perspective are thought to be primarily individually based, including variables such as self-identity, individual behaviour, and attributions. Therefore, empirical tests may help us to proactively recognize and address potential performance troubles before they escalate.

We also believe that variance in several work-related outcomes, including those examined under the rubrics of leader-member exchange theory, organizational justice, organizational support, and organizational politics will be accounted for by the meta-perspective construct given the complex exchange-based nature of

these research areas. Additionally, this research suggests that developing additional meta-perspective scales related to other organizational phenomena such as change management, organizational learning, and negotiation may be a useful endeavour. Given that these work-related outcomes may include group and even organizational level effects, meta-perspectives also may prove to be an important link between micro and macro levels of analysis, thereby providing future researchers with an important avenue through which meso-level research may be pursued (Porter, 1996). An additional opportunity to apply the meta-perspective in the context of performance appraisals may be in upward feedback (i.e., 360-degree) research. Identifying how managers see others as seeing their performance may even be more useful than identifying how managers see their own performance. Such insights may have significant applications for leadership research.

Appendix

Meta-Perspective Items

1. I think that my supervisor thinks that I always try to do things better at work.
2. I think that my supervisor thinks that I always try to do more than what's asked.
3. I think that my supervisor thinks that I always try to work hard.
4. I think that my supervisor thinks that I have a sense of confidence in my ability to succeed, reach challenging goals, or overcome obstacles.
5. I think that my supervisor thinks that I always get things done on time.
6. I think that my supervisor thinks that I never disappointed him or her with the quality of work that he or she receives from me.
7. I think that my supervisor thinks that my work habits (tardiness, length of breaks, etc.) are excellent.
8. I think that my supervisor thinks that he or she never has to check up on me.

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