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Testing a bi-factor model to disentangle general and specific factors of motivation in self-determination theory ☆,☆☆

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ABSTRACT

We examined the utility of the bi-factor model for disentangling general motivation and specific motivations (i.e., amotivation, external, introjected, identified, and intrinsic regulations) in relation to goal progress and physical activity (PA). Participants ($N = 186$ undergraduate students; $M_{age} = 19.26$ years) completed assessments of motivation and PA at Time 1. Four weeks later, PA and goal progress were assessed at Time 2. Results indicated that the exploratory bi-factor model specifying motivational regulations as the specific factors and general motivation as the general factor was a good fit to the data. Results of the structural equation model indicated that identified and intrinsic regulations and general motivation predicted concurrent PA at Time 1. A novel finding was that controlling for concurrent PA at Time 1, general motivation emerged as the only predictor of Time 2 goal progress and PA. Results highlight the importance of examining general motivation in addition to quality of motivation in tandem because general motivation emerged as the sole significant longitudinal predictor of PA outcomes.

1. Testing a bi-factor model to disentangle general and specific factors of motivation in self-determination theory

'To be or not to be motivated' is a question that has attracted a large amount of theoretical and empirical attention in performance and health-related research streams (Gagné et al., 2014; Ng et al., 2012). Using self-determination theory (SDT), Deci and Ryan (2000) contend that individuals pursue activities for different reasons that reflect distinct motivations varying in quality rather than solely quantity. Across contexts, support for the assertion that motivation can be separated into specific factors of motivation that differentially predict behavior has been found (Deci & Ryan). Yet, it seems possible that an individual could have a *general motivation* that is characterized by the endorsement of multiple specific factors of motivation (Ryan, 1995). In other words, although items from SDT-based motivation scales can be regrouped into specific factors of motivation, the scores on the same items may also reflect a general factor of motivation characterizing the endorsement of multiple *reasons* for engaging in behavior. Using SDT, we contend that the quality of motivation and general motivation are reconcilable properties of human motivation that can be unpacked and studied together within the confines of bi-factor analysis. Specific factors of motivation are part of a larger pool of motivational resources (i.e., general motivation) likely to facilitate task engagement. As such, specific and general factors of motivation are expected to be empirically distinguishable and uniquely associated with consequential outcomes. Using the context of physical activity (PA) as an example, we sought to demonstrate that specific and general factors of motivation can be differentiated to predict goal progress and PA 4 weeks later.

1.1. Self-determination theory

Deci and Ryan (2000) hypothesized that individuals pursue their activities for different reasons that can be portrayed using six specific factors of motivation. Questionnaires have been developed to assess the extent or the quantity of endorsement of these specific factors of motivation (Gagné et al., 2014; Mullan, Markland, & Ingledew, 1997). On theoretical grounds, these motivations or behavioral regulations are assumed to differ in quality insofar as each regulation varies based on the relative autonomy that reflects if an activity has been internalized into the self. *Amotivation* is characterized by *non-regulation* and represents a perception that the behavior will not bring about a desired outcome. Extrinsic motivation is underpinned by four specific types of regulation (external, introjected, identified, and integrated regulations).

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An individual with *external regulation* engages in behavior because of external pressure and contingency. *Introjected regulation* is characterized by an individual engaging in behavior because of internal contingencies (e.g., guilt). An individual with *identified regulation* values the behavior. With *integrated regulation* an individual fully integrates the behavior as part of their self. The third type of motivation is intrinsic motivation. When a person is intrinsically motivated they have *intrinsic regulation* and engage in behavior because there is no separable consequence other than interest and/or enjoyment (Deci & Ryan). A focus on qualitatively distinct factors of motivation provides investigators with an opportunity to understand how each distinctly predicts external variables. Thus far, however, researchers have yet to investigate whether the scores on these specific factors of motivation – and their effects on outcomes – are confounded by a more general endorsement of the six motivations for engaging in the behavior.

1.2. Operationalizing motivation

Various scoring procedures involving difference scores, composite scores, and relative scores have been used to operationalize motivation (see Wilson, Sabiston, Mack, & Blanchard, 2012 for a more comprehensive review). However, Chemolli and Gagné (2014) cogently outlined the pitfalls associated with using scoring procedures that combine motivations into one relative autonomy index or procedures whereby difference scores are employed because these procedures mask multidimensionality and potentially important individual differences. Furthermore, Chemolli and Gagné provided evidence to demonstrate that motivation, as conceptualized within SDT, may be best operationalized as a multidimensional construct rather than as unidimensional. Therefore, it seems preferable to score each motivation individually and account for multidimensionality rather than to create a unidimensional relative score.

Additionally, researchers have almost exclusively focused on the specific factors of motivation without taking into consideration whether scores on these factors also reflect *general motivation or an overall impetus to engage in a specific behavior*. The lack of research attention devoted to differentiating a general factor of motivation from the specific factors in SDT could be attributable to methodological limitations. Traditional factor analytical approaches are designed to optimally separate items on the basis of their conceptual distinctiveness without paying too much attention to their conceptual similarities. That is, a limitation associated with these statistical procedures is the often incorrect assumption (Reise, Bonifay, & Haviland, 2013) that the items are unidimensional insofar as they were developed to assess one construct using theory. Ample empirical evidence exists to support the tenability of a theoretically-driven model with six distinct yet correlated motivational factors (Deci & Ryan, 2000). However, more research is needed to fully explain the underlying conceptual meaning attached to the shared variance of these six specific motivational factors. A bi-factor model provides a promising platform to examine the multidimensionality of item responses and to provide an alternative to the traditional yet criticized reliance on omnibus relative autonomy indexes.

1.3. The bi-factor model

In a bi-factor model (e.g., Chen, West, & Sousa, 2006; Myers, Martin, Ntoumanis, Celimli, & Bartholomew, 2014) it is assumed that the covariances among item responses can be explained by one *general factor* that accounts for the common variance among *specific* clusters of items that share similar content (Reise, 2012). The general factor is thought to represent a conceptually broad factor that the instrument was developed to assess (e.g., general motivation) whereas the specific factors capture the more narrowly defined subscales (e.g., each of the six regulations).

The bi-factor model is particularly useful for multidimensional constructs (see Chen et al., 2006; Reise, 2012; for reviews). In the past, researchers studying motivation and hypothesizing multidimensionality have examined models wherein the items are best represented by six first order regulations which are in turn, characterized by two second order factors representing autonomous and controlled motivation (e.g., Gagné et al., 2014). Although higher order models are similar, and in fact are nested within bi-factor models, the bi-factor model has several advantages (Chen et al., 2006). Arguably the most appealing advantage of bi-factor models is that both the specific and general factors can simultaneously be examined as antecedents or consequences of external variables, and therefore the multidimensionality of item responses can be more clearly elucidated (Reise et al., 2013).

Specific clusters of items may indeed differentiate six qualitatively distinct motivations. Furthermore, each item may also tap a common content that reflects a general motivation to engage in a specific behavior. Deci and Ryan have focused their attention on the different qualities of motivation. However, Ryan (1995) reiterated the importance of the quantity of one's motivation. Someone with a score of 7 on introjection might be as 'motivated' as someone with a score of 7 on identified motivation. Yet, on phenomenological grounds, these two motivations are likely to be experienced differently by the two individuals. One is engaged in the behavior with a sense of pressure whereas the other is engaged with a sense of volition and autonomy. Despite their different quality or phenomenological properties, the scores on the specific factors of motivation could equally reflect a more general predisposition to endorse and be motivated for a particular activity.

1.4. Purpose

The first purpose of this short-term longitudinal study was to examine if motivation can be operationalized as a bi-factor model representing specific factors that characterize different *qualities* of motivation (i.e., amotivated, external, introjected, identified, and intrinsic regulations) and a general factor that characterizes general motivation. The second purpose was to determine if the general factor of motivation above and beyond the specific factors of motivation predicts concurrent PA (Time 1) and also goal progress and PA 1 month later (Time 2). PA was selected as the context of interest because through their Global Strategy to Promote Health, the World Health Organization (World Health Organization, 2004) has identified research on PA as one of four primary objectives given that it is a preventive factor for diseases (e.g., cardiovascular, diabetes, obesity). Furthermore, it has been argued that PA is a good context to test tenets of SDT given that PA often requires effort and perseverance (Standage & Emm, 2014; Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Finally, it is possible for someone to be less physically active than the PA guidelines while nonetheless attaining their personal PA goal. It is also common for someone who is more physically active to not make progress in the pursuit of their personal goals (see Dugas, Gaudreau, & Carraro, 2012). As such, we measured the amount of PA and the progress made in the pursuit of a PA goal to offer a complementary perspective in investigating PA outcomes.

2. Method

2.1. Procedures and participants

English speaking participants were recruited from an introductory psychology participant pool at the University of Ottawa in

Ontario, Canada and received two points for participating in the study.[1] Participants were also recruited from first and second year undergraduate courses and received $5 for their participation. Participants were not required to be physically active at the time of the study, but were asked to only participate if willing to set a PA goal. At Time 1 (in January), participants set a PA goal and completed questionnaires. Approximately 1 month later (Time 2), participants were reminded of their goal and completed questionnaires. Participants ($n = 241$) self-set goals were coded for relevance to PA by two independent coders (see Dugas et al., 2012). Individuals ($n = 47$) who set irrelevant PA goals (e.g., "getting good marks"), individuals who did not complete Time 1 measures ($n = 6$), and outliers were removed ($n = 2$).

The final sample was 186 students (70.4% female) ranging in age from 17 to 33 ($M_{age} = 19.26$ years $SD = 1.82$). The majority identified as Caucasian (65.1%), followed by Asian (15.1%), other (12.9%), African-American (4.3%), and Aboriginal/Native or Hispanic (1.1%). Students were first-years (58.1%), juniors (30.1%), sophomores (6.5%), and seniors (4.3%). Participants, on average, were classified as 'active' (Godin, 2011) at Time 1 ($M = 52.80$, $SD = 27.89$; 84.9% 'active') and Time 2 ($M = 51.32$, $SD = 26.16$; 84.7% 'active').

2.2. Measures

2.2.1. Motivation (Time 1)

Motivation for PA was assessed using the Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2; Markland & Tobin, 2004; Mullan et al., 1997). The BREQ-2 is a SDT instrument designed to assess amotivation (4 items), external (4 items), introjected (3 items), identified (4 items), and intrinsic (4 items) regulations. Participants were asked to rate each item on a scale of 1 (*not at all agree*) to 5 (*totally agree*). The BREQ-2 has been used extensively and researchers have demonstrated evidence of score reliability and validity (Markland & Tobin, 2004).

2.2.2. Goal progress (Time 2)

Goal progress was measured with a five-item questionnaire (Dugas et al., 2012) that was designed to measure goal progress in a wide array of life activities. Participants were asked the extent to which they had: (a) progressed on your goal, (b) moved forward in the pursuit of your goal, (c) come closer to reaching your goal, (d) made progress toward the realization of your goal, and (e) advanced towards your goal. Each item was anchored on a Likert scale of 1 (*not at all*) to 9 (*totally*). Past studies have reported evidence of factor structure and score reliability (e.g., Crocker, Gaudreau, Mosewich, & Kljajic, 2014; Dugas et al., 2012).

2.2.3. PA (Time 1&2)

Self-report PA was assessed using the 3-item Leisure Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985). Participants were asked to indicate the number of times they engaged in light, mild, and strenuous activity for over 15 min during a typical 7-day period. Researchers using the LTEQ have provided evidence of score reliability and validity (Jacobs, Ainsworth, Hartman, & Leon, 1993). An overall PA score was created using the formula (9 × strenuous) + (5 × moderate; Godin, 2011).

[1] The editor was informed that a subset ($n = 131$) of participants were used in another published study (Dugas et al., 2012). Analyses from that study were conducted only on participants who had completed the measures at both Time 1 and Time 2 because we had yet to learn sophisticated approaches to handle missing data.

2.3. Data analyses

To examine outliers, multiple imputation ($m = 5$) was used and manifest variables were created for each variable. Motivational regulations were plotted against goal progress and PA (Time 1 and Time 2). Two individuals were identified as outliers and removed (based on PA $z > 3.00$ and Mahalanobis distance criteria).

The main analyses were conducted using Robust Full Information Maximum Likelihood estimation to handle missing data and to correct for non-normality in Mplus 7.0. An exploratory bi-factor analysis (EBFA) was conducted on BREQ-2 responses to examine the suitability of the model. Consistent with recent SDT research (Myers et al., 2014), target rotation was used to specify a factor pattern matrix to reflect our *a priori* knowledge of measurement and theory. Specifically, although each item was allowed to load onto each factor, we specified target items to load onto their target factors (e.g., external items were targeted to have a pattern loading of 0.5 on the external factor and a pattern loading of 0 on the remaining regulation factors). Specifying a target loading allows for the rotated factor pattern matrix to come *as close as possible* to the pre-specified value (compared to forcing it to load at zero as would be done in confirmatory frameworks; Browne, 2001). Consistent with previous research (Myers et al., 2014; Reise, 2012), all factors in the EBFA were orthogonal.

Model fit was assessed using a combination of goodness-of-fit statistics. A comparative fit index (CFI) and Tucker Lewis index (TLI) value close to or above .95 was interpreted a good fit (Hu & Bentler, 1999). Root Mean Square Error of Approximation (RMSEA) close to .06 or below was also interpreted as good fit (Hu & Bentler, 1999).

We then proceeded to examine if the specific and general factors of motivation concurrently predicted Time 1 PA and prospectively predicted Time 2 PA and goal progress. The EBFA portion of the model remained orthogonal. The five items of goal progress were specified to load onto the latent factor of Time 2 goal progress, using the first indicator approach to set the metric. Time 1 and Time 2 PA were entered as manifest variables. The model was specified such that each specific factor and the general motivation factor (Time 1) predicted PA at Time 1. PA at Time 1 was specified to predict goal progress and PA at Time 2. Direct paths were also specified from each specific and general motivation factor to goal progress and PA (Time 2). Because bootstrapping is currently unavailable in Mplus with EBFA, indirect effects were interpreted based on the normal theory tests.

3. Results

EBFA of BREQ-2 responses indicated a good fit to the data, $\chi^2_{(72)} = 97.34$, CFI = .99, TLI = .97, RMSEA = .04 (90% CI = .02, .06). In general, the pattern matrix was consistent with hypotheses with the exception of a few significant standardized cross-loadings over .30 (see Table 1). Each item loaded onto its intended specific factor of motivation ($\lambda \geq .33$, $p < .05$), while every item also loaded onto the general motivation factor ($\lambda \geq .32$, $p < .05$), with the exception of one item from the amotivation subscale ($\lambda = .17$, $p = .07$).

Results of the structural equation model indicated a good fit to the data, $\chi^2_{(200)} = 323.72$, CFI = .96, TLI = .94, RMSEA = .06 (90% CI = .05, .07). Interpretation of the path coefficients indicated that identified and intrinsic regulations positively and significantly predicted PA at Time 1 (see Fig. 1). General motivation significantly predicted PA at Time 1 as well as goal progress and PA at Time 2. Finally, PA at Time 1 positively predicted goal progress and PA at Time 2. Time 1 PA served as a mediator in the relation of the general factor of motivation ($\beta = .22$, $p < .05$), identified regulation ($\beta = .15$, $p = .053$), and intrinsic regulation ($\beta = .11$, $p < .05$) with Time 2 PA. Time 1 PA also served as a mediator in the relation of general

Table 1
BREQ-2 using EBFA with target rotation.

	Specific factors										General factor	
	External		Introjected		Identified		Intrinsic		Amotivation		Motivation	
	λ	SE	λ	SE	λ	SE	λ	SE	λ	SE	λ	SE
Ex_1	**.56***	**.07**	.03	.06	−.19*	.06	**−.31***	.05	0.0	.06	**.39***	**.07**
Ex_2	**.64***	**.06**	−.02	.06	−.11	.06	**−.31***	.05	−.01	.07	**.43***	**.06**
Ex_3	**.60***	**.07**	.18*	.06	.01	.07	−.12	.07	.25*	.07	**.41***	**.07**
Ex_4	**.62***	**.08**	.00	.06	−.08	.05	−.19*	.04	.15*	.06	**.48***	**.05**
Inj_5	.13*	.06	**.63***	**.06**	.13	.07	−.06	.05	−.14*	.05	**.48***	**.05**
Inj_6	.03	.07	**.46***	**.07**	.09	.07	−.20*	.06	−.05	.05	**.51***	**.05**
Inj_7	.03	.06	**.53***	**.06**	.08	.05	.03	.05	−.08*	.04	**.62***	**.04**
Iden_8	−.10	.06	.04	.05	**.41***	**.08**	**.38***	.06	**−.32***	.07	**.36***	**.07**
Iden_9	−.05	.05	.06	.05	**.49***	**.06**	.26*	.05	−.22*	.04	**.52***	**.04**
Iden_10	−.11*	.06	−.03	.06	**.57***	**.09**	.16*	.07	−.26*	.05	**.52***	**.05**
Iden_11	−.11	.08	.22*	.09	**.33***	**.10**	.25*	.09	−.10	.05	**.48***	**.05**
Im_12	−.17*	.06	0.0	.06	.06	.09	**.85***	**.09**	−.17*	.04	**.43***	**.05**
Im_13	−.23*	.06	−.01	.06	**.30***	.07	**.71***	**.05**	−.13*	.06	**.32***	**.06**
Im_14	−.26*	.05	−.15*	.05	**.34***	.07	**.60***	**.07**	−.16*	.04	**.44***	**.04**
Im_15	−.27*	.06	−.06	.06	**.35***	.08	**.42***	**.06**	**−.35***	.04	**.49***	**.05**
Amot_16	.04	.07	−.17*	.07	−.19	.10	−.26*	.07	**.62***	**.06**	**.41***	**.07**
Amot_17	.05	.07	−.12*	.05	**−.39***	.05	−.24*	.06	**.68***	**.04**	**.43***	**.07**
Amot_18	.11	.06	−.05	.05	−.29*	.07	−.22*	.05	**.73***	**.06**	**.34***	**.07**
Amot_19	.20*	.06	.07	.05	−.03	.08	−.09	.07	**.91***	**.08**	**.17**	**.09**

Note. λ = standardized loadings, SE = standard error. Shaded cells = item intended to load onto the corresponding factor. Bolded and not shaded values = significant cross-loadings > .30. *p < .05.

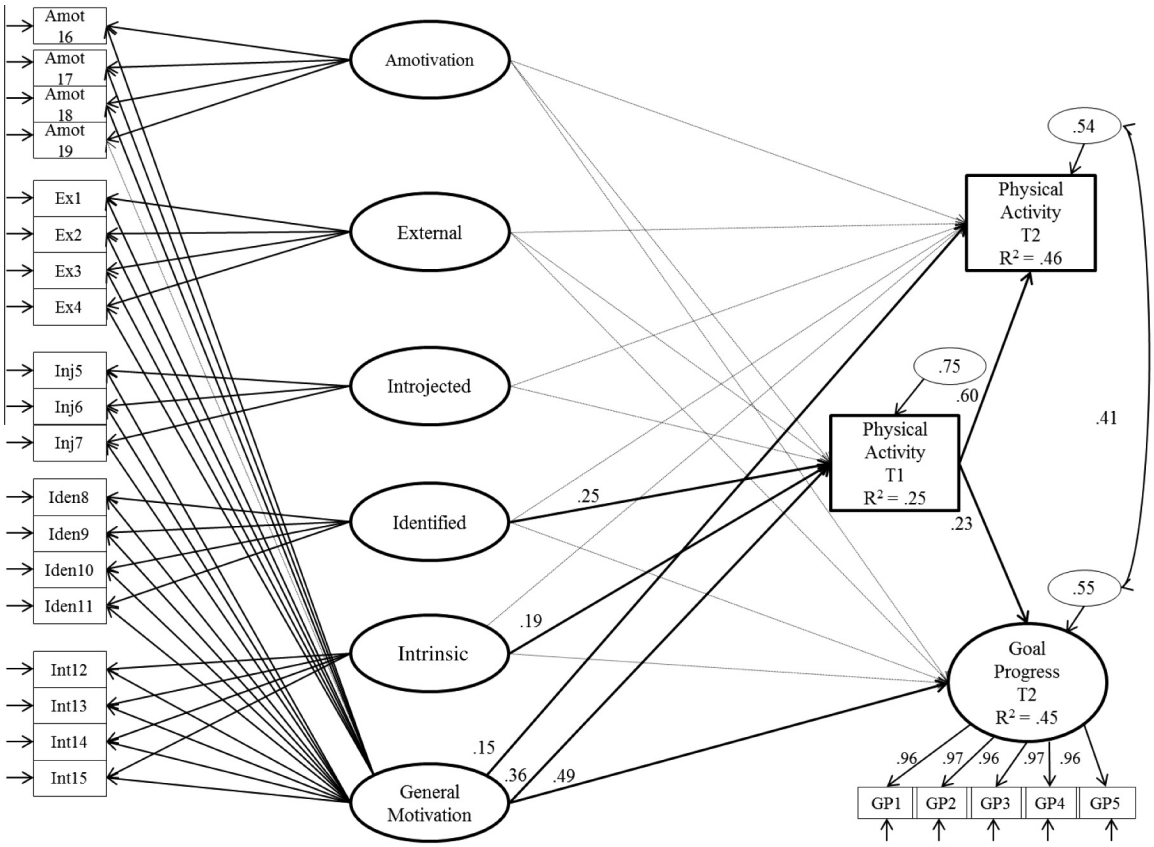

Fig. 1. Specific and general factors of motivation predicting PA and goal progress. *Note.* T1 = Time 1, T2 = Time 2. Bold lines p < .05. Gray lines p > .05. Standardized values presented. For simplicity, factor loadings and cross-loadings from factors to items are not shown for the EBFA portion of the model (available from first author upon request).

motivation (β = .08, p < .05) and intrinsic regulation (β = .04, p = .056) with Time 2 goal progress.

4. Discussion

Using SDT, we examined if a bi-factor model could be used to separate a general factor of motivation from specific factors representing different qualities of motivation. We also investigated the relation of the general and specific factors of motivation with important health-related outcomes such as goal progress and PA. Our results supported the tenability of EBFA and that BREQ-2 items can be operationalized by specific factors (i.e., regulations) and a general factor (i.e., general motivation). Extending previous research (Teixeira et al., 2012), we found that identified and

intrinsic regulations were salient predictors of PA at Time 1 even when accounting for the potentially confounding effect of a general factor of motivation. Of particular interest, our findings illustrated that only the general factor of motivation predicted the longitudinal assessment of PA and goal progress at Time 2.

Our results speak to the importance of general motivation beyond quality of motivation, which is a novel finding for the extant SDT literature. Not only was general motivation concurrently associated with higher levels of PA but it was also linked to the extent of progress made in the pursuit of one's PA goal and the amount of change in PA over a four-week period. Overall, these findings suggest that the quality of motivation underlying the specific factors of motivation might be more important to predict short-term outcomes whereas the general factor of motivation might be equally important to promote both short-term and longer-term positive changes in PA. This general factor of motivation might capture the quantity of motivation or the overall extent to which a person is motivated. General motivation draws on a pool of motivational resources (or the multiple reasons) that might be needed to face the many challenges associated with maintaining PA in the long haul.

Interestingly, findings indicated that items assessing amotivation positively loaded onto the general motivation factor. Therefore, in the confines of the BREQ-2, amotivation does not simply represent a lack of motivation, but rather these items (e.g., I think exercise is a waste of time) are characteristic of the perception that an action will not result in an expected outcome. Although amotivation was not significantly associated with the PA outcomes, it nonetheless added to the pool of motivational resources of an individual and should not be simply ignored on the basis that individuals with amotivation are simply not motivated to act at all.

4.1. Limitations and future directions

A general factor of motivation could also operate in a non-linear fashion insofar as it could be associated with increased positive behavioral outcomes up to a certain threshold after which we might expect diminishing rates of return. Also, EBFA does not allow for the examination of how different combinations of the specific factors of motivation (e.g., high introjected and low intrinsic regulation) could differentially predict outcomes. It appears possible that some specific factors of motivation could act as potential moderators of the relation between general motivation and outcomes. Future methodological developments are needed to facilitate the modeling of non-linear and interactive effects within the confines of EBFA

Researchers wishing to pursue EBFA of motivation could simultaneously incorporate emotional, cognitive, and behavioral outcomes. Researchers should replicate and extend our findings using more precise measures of PA (e.g., measures that account for intensity and duration), larger samples of participants in the community, and in more than one life domain (e.g., education, work) to ensure that the general factor of motivation generalizes beyond the context of PA and the BREQ-2. EBFA is complex because it freely estimates both the theoretically expected primary factor loadings and secondary cross-loadings. As such, this approach may not be applicable for researchers working with smaller samples, or applied to complex multilevel data structures. Nevertheless, EBFA does afford the advantage of invariance testing (Chen et al., 2006) to set equality constraints on parameters across time or groups of people. Researchers could also employ Bayesian bi-factor analysis to further explore the multidimensionality of motivation.

It is possible that the general factor was contaminated by method effects attributable to the self-report nature of the questionnaire. However, a general factor of personality contained negatively and positively worded items suggesting that a general factor may represent more than method effects (Pettersson, Turkheimer, Horn, & Menatti, 2012). Based on contentions by Ryan (1995) who stated that regulations "... reflect variation in the *orientation* of motivation but not necessarily its *level* or amount" (p. 408), it is also possible that the shared variance among motivation items reflects a certain quantity of motivation. Recent work by Vansteenkiste, Sierens, Soenens, Luyckx, and Lens (2009) using cluster analysis has examined the question of quality and quantity of motivation. Both variable-centered and group-based modeling (e.g., cluster analyses) are defendable and needed to fully understand motivation. We forward EBFA as one additional method of understanding motivation with the advantages of maintaining the continuous nature of the data while providing researchers with the ability to examine how each specific and general factor of motivation predicts important outcomes. More research is needed to fully understand the general factor of motivation and under which circumstances it explains unique variance in outcomes.

5. Conclusion

The results of our EBFA indicated that self-reported motivation encompasses distinct forms of regulations as well as a general factor of motivation that captures the extent to which a person is motivated by a certain activity. This research represents an initial attempt to highlight how the specific regulations proposed in SDT and a general factor of motivation can be simultaneously studied to better understand the complex nature of motivation and behavior. Notably, we found that general motivation, beyond the specific regulations or qualities of motivation, was the most salient predictor of goal progress and changes in PA over 4 weeks. These findings have important implications for how motivation can be fully elucidated and we recommend that researchers continue to explore the utility of bi-factor models.

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