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Development and Validation of the Adolescent Psychological Need Support in

Exercise Questionnaire

Abstract

Grounded within self-determination theory (SDT; Ryan & Deci, in press; Deci & Ryan, 2000), three studies were conducted to develop and psychometrically test a measure of adolescents' perceptions of psychological need support for exercise (viz., for autonomy, competence, and relatedness): the Adolescent Psychological Need Support in Exercise Questionnaire (APNSEQ). In Study 1, 34-items were developed in collaboration with an expert panel. Through categorical confirmatory factor analysis and item response theory, responses from 433 adolescents were used to identify the best fitting and performing items in Study 2. Here, a 3-factor 9-item measure showed good fit to the data. In Study 3, responses from an independent sample of 373 adolescents provided further evidence for the 9-item solution as well as for internal consistency, criterion validity, and invariance across gender and social agent (friends, family, and PE teacher). The APNSEQ was supported as a measure of adolescents' perceptions of exercise psychological need support within the context of exercise.

Keywords: self-determination theory, measurement, autonomy, competence, relatedness

Research has consistently documented numerous physical and mental health benefits of a physically active lifestyle (cf. Janssen & LeBlanc, 2010). Yet, globally, adolescent physical activity levels are below those necessary for the maintenance of health (Hallal et al., 2012). The ill-effects of physical inactivity during adolescence include higher body mass, lower cardiovascular fitness, raised cholesterol, and poorer mental health (Craig, Mindell, & Hirani, 2011). The need, then, for a better understanding of the factors that support adolescents to engage in exercise is readily apparent. One factor particularly predictive of adolescent engagement in exercise is their motivation and the social-contextual processes that support it (Owen, Smith, Lubans, Ng, & Lonsdale, 2014). Here, guided by self-determination theory (SDT; Deci & Ryan, 2000; Ryan & Deci, in press), we present data from three studies documenting the development and validation of a new measure of social contextual supports for adolescents' motivation in the exercise context, namely the Adolescent Psychological Need Support in Exercise Questionnaire (APNSEQ).

Self-Determination Theory

SDT is an organismic theory of human motivation that addresses the inherent and social-contextual conditions influencing how individuals think, feel, and behave (Deci & Ryan, 2000; Ryan & Deci, in press). Within SDT, the extent to which social-contexts support or thwart three basic psychological needs is discriminative of whether individuals experience autonomy or heteronomy, engagement or disaffection, and wellness or illness (Deci & Ryan, 2000). The first psychological need is for autonomy. It reflects feelings of volition, responsibility, and a sense of inner endorsement over one's actions (Ryan, 1995). The second psychological need is for competence. It encompasses feelings of efficacy and the ability to overcome challenge (Deci & Ryan, 2000). The third psychological need is for relatedness. It encapsulates

feelings of belonging and being connected and cared for by significant others (Ryan, 1995). In support of SDT, data from multiple life domains (e.g., academia, family, work, and sport) show that satisfactions to these psychological needs are associated with enhanced psychological and physical functioning (cf. Ryan & Deci, in press).

Within the exercise context, data has shown that a satisfaction of the basic psychological needs positively contributes to well integrated forms of exercise motivation, increased exercise engagement, and exercise-related wellness (e.g., Sebire, Jago, Fox, Edwards, Thompson, 2013; Sebire, Standage, & Vansteenkiste, 2009; see Standage & Ryan, 2012 for a review). By contrast, a frustration of the basic psychological needs positively contributes to poorly integrated forms of exercise motivation and markers of ill-being (e.g., emotional and physical exhaustion and negative affect; Bartholomew, Ntoumanis, Ryan, & Thogersen-Ntoumani, 2011; T. Curran, Hill, Jowett, & Hall, 2014; Gunnell, Crocker, Wilson, Mack, & Zumbo, 2013). Due to the fundamental postulate within SDT that individuals are optimally motivated, function effectively, and experience well-being when their basic psychological needs are met, an understanding of social contexts that are conducive to supporting autonomy, competence, and relatedness is important, both from scientific and applied perspectives.

Basic Psychological Need Support and Measurement in the Adolescent Exercise Context

Within SDT, social contexts serve to facilitate well-integrated motivation, behavior and wellness by providing experiences that support the basic psychological needs for autonomy (e.g., supports for choice, self-initiation, and understanding), competence (e.g., supports for challenge, improvement, and the provision of appropriate positive feedback), and relatedness (e.g., supports for acceptance, of being

valued, and for caring interactions). Equally, the social context can undermine functioning and wellness by thwarting these basic psychological needs (Ryan & Deci, 2000). In the context of adolescent exercise, research has shown that perceptions of autonomy support contribute to well integrated forms of exercise motivation, behavioral engagement, and markers of well-being (e.g., Gillison, Standage, & Skevington, 2013; Standage, Gillison, Ntoumanis & Treasure, 2012). However, such investigations have typically focused on autonomy-support from significant others (e.g., parents and teachers) with only a few instruments including measures of competence- and/or relatedness-support (e.g., in the education domain the Teacher as Social Context Questionnaire [Wellborn, Connell, Skinner, & Pierson, 1988] assesses involvement and structure as markers of relatedness and competence support, respectively). This limitation is partly due to a lack of systematically developed measures incorporating items to also assess competence- and relatedness-support. Some studies have implemented holistic measures of psychological need support in physical activity and exercise environments (e.g., Markland & Tobin, 2010; Standage, Duda, & Ntoumanis, 2005), but in these cases researchers have generated items for study-specific purposes, as opposed to using a targeted and systematic scale development approach.

Although there are a lack of competence- and relatedness-support scales, a variety of measures have been used to assess autonomy support (e.g., Health Climate Questionnaire [HCCQ], Williams, Grow, Freedman, Ryan, & Deci, 1996; Learning Climate Questionnaire, [LCQ], Williams Wiener, Markakis, Reeve, & Deci, 1994; Perceived Autonomy Support Scale for Exercise Settings [PASSES], Hagger, Chatzisarantis, Hein, Pihu, Soos & Karsai, 2007). These available measures have guided SDT research in the exercise context, but suffer from two notable limitations.

First, these measures primarily identify as autonomy-support measures, but are conflated with competence- and relatedness-support items (e.g., "*they provide me with positive feedback when I do physical activity*"; PASSES, Hagger et al., 2007). Second, these measures have focused on formal 'provider-recipient' social agents only (e.g., teachers, coaches). Adolescents' exercise behaviors are, though, also influenced by other, more informal, relationships (e.g., peers, family; Salvy, de la Haye, Bowker & Hermans, 2012). Hence, extant measures are not readily applicable, nor tested for use, across alternative relationships with differing structures, degree of mutuality, and informality.

In addition to work on autonomy-support, observational studies have contributed to our understanding of what behaviours underpin competence- and relatedness-support. Collectively, this work can be used to inform the design of psychological need-support measures. For example, Haerens et al. (2013) identified a number of PE teachers' behaviors which students perceived as psychologically need-supportive. Here, asking questions, paying attention to the students' opinions, and providing choice and opportunities to work independently were identified as autonomy supportive behaviors, whereas emotional support (e.g., being empathic, asking questions), physical support (e.g., physical closeness) and teacher involvement in the lesson (e.g., showing enthusiasm and energy during the lesson) were found to be perceived as supportive of relatedness (Haerens et al., 2013). For structure, both the guidance provided before (e.g., giving clear verbal instructions and a demonstration of activities) and during the lesson (e.g., helping pupils, giving advice and positive feedback) were found to be perceived as supports for competence (Haerens et al., 2013). In accord, this work provides a useful framework of competence- and relatedness-support upon which measures might be developed.

Alongside a conceptual framework, a number of additional consdierations are required to guide the development of new psychological need support measures. Foremost here is the necessity to develop new items that are age, domain, and language appropriate. This is because it cannot be assumed that the modification of existing items validated in populaitons other than adolescents is appropriate (e.g., adults; HCCQ, Williams et al., 1992). Adolescents are still in the developmental stage of their cognitive, communicative, and social skills (de Leeuw, Borgers & Smits, 2004). Accordingly, using measures that align with adolescents' cognitive, linguistic, and social competence are needed to yield more accurate and reliable data.

Present Research

The purpose of the present work was to develop a new measure of psychological need support in the context of adolescent exercise behavior that is applicable to a number of social agents (i.e., family, friends and PE teachers) and encompasses all three psychological needs (i.e., for autonomy competence and relatedness). We term this measure the Adolescent Psychological Need Support in Exercise Questionnaire (APNSEQ). Through three studies we developed, confirmed, and tested aspects of construct validity for the APNSEQ in line with the standards presented by the American Educational Research Association (AERA, 2014). In Study 1, we developed and explored the theoretical content validity of the APNSEQ items in relation to supports for autonomy, competence, or relatedness in liaison with SDT experts. In Study 2, we used categorical confirmatory factor analysis (CFA) to examine the lower and higher order measurement models for the APNSEQ measure (i.e., scale-level assessment), and item response theory (IRT) to examine the performance characteristics of each individual item. In addition to testing the internal validity of the APNSEQ measurement model, we also examined the reliability

estimates of the subscale scores and the readability of the scale items. In Study 3, we sought to: (a) confirm the APNSEQ measurement model in an independent sample; (b) test for invariance of the APNSEQ scale responses across gender and social agent; and (c) examine the criterion validity of APNSEQ scores via associations with theoretically relevant SDT constructs (viz., psychological need satisfaction, psychological need frustration, and differing forms of motivation).

Study 1

In Study 1, our aim was to: (a) develop a pool of items assessing support for autonomy, competence, and relatedness in the context of adolescent exercise from family, friends, and PE teachers; and (b) obtain feedback from experts in SDT and adolescent exercise behavior in order to further develop and assess the content validity of the item pool.

Method

Participants

Following recommended procedures (Dunn, Bouffard, & Rogers, 1999), an expert panel ($N=7$; 6 male) of academic experts was recruited based upon their theoretical expertise and/or their involvement in adolescent physical activity and exercise research in the context of SDT. The panelists included two key SDT theorists, and five academics currently working with adolescents in a research setting; five members of the panel had previously been involved in scale development and validation. At the time of conducting this work, panel members had worked in academia for 4-40 years (Median=10.00, IQR=25.00) and had between 16 and 363 SDT-related publications in international peer-reviewed journals (Median=65.00, IQR=292.00).

Procedure

Prior to commencing the research, ethical approval for Studies 1, 2 and 3 was sought and granted by the authors' institutional ethics committee. To develop the item pool, existing measures of psychological need support (e.g., HCCQ, LCQ, PASSES) were screened and items assigned to their most relevant construct using SDT conceptualizations of autonomy-, competence- and relatedness-support (Clark & Watson, 1995). Where items did not represent the theoretical breadth of the constructs, additional items were generated based on the findings of observational studies (e.g., Haerens et al., 2013) and the wider SDT literature (e.g., theoretical overviews and review papers). Items were screened for simplicity (i.e., eliminating any overly long or double-barreled items; Clark & Watson, 1995) and alignment with the theoretical definitions of psychological need support (i.e. ensuring each item was accurately categorized according to the SDT conceptualizations). At this stage, theoretically ambiguous items were retained for further analysis. In line with recommendations on assessing item content-relevance (Dunn et al., 1999; Clark & Watson, 1995), the expert panel were provided with a pool of items categorized into autonomy-, competence- and relatedness-support, and asked to rate each item on a 5-point scale ranging from 1 (*low*) to 5 (*high*) for both appropriateness (i.e., "*how appropriate is this item for assessing its target construct in the target population*") and clarity (i.e., "*how easy or difficult is this item to answer*"). In line with previous scale development papers (e.g., Arnold, Fletcher, & Daniels, 2013), panelists were also invited to make any additional written comments for specific items to justify specific ratings. Items were discarded if the majority of panelists rated them as <3 for appropriateness. Where the majority of the panel rated an item as <3 for clarity, amendments (based on the panels' supplementary qualitative feedback) were made. By providing the opportunity for both quantitative and qualitative assessment, we

obtained rich and specific information on the reasons and suggestions for improving

each item's rating (Dunn et al., 1999; Haynes, Richard, & Kubany, 1995).

Table 1

Results and Discussion

Thirty-nine items were initially extracted through the screening process and

included in the item pool for circulation to the expert panel. In line with the panelists'

feedback (see Table 1), five items were removed from the pool (four due to issues of

appropriateness and one due to duplication) and seven items were modified based on

qualitative suggestions. The resultant item pool consisted of 34 items assessing the

range of psychological need support characteristics, spanning autonomy-support (13

items), competence-support (10 items) and relatedness-support (11 items), in the

adolescent exercise context. This pool of items formed the basis for Study 2.

Study 2

In Study 2, we aimed to: (a) create a parsimonious, balanced, and theoretically

encompassing measure of psychological need support through categorical CFA, IRT

parameters and graphics; and (b) assess the factorial structure (i.e., internal validity)

of a measure tapping psychological need support.

Method

Participants

A sample of adolescents (N=433, 211 male) aged 12-15 years *(M=13.74,*

SD=.76) were recruited through two schools in the south west of England. The

inclusion criteria were; (a) to be enrolled in full time education and; (b) to have a

good comprehension of English. Ninety-one percent of the sample were white, 4%

Asian, 2% mixed race, 1% Chinese, 1% black, and 1% other.

Measures

Psychological need support. Participants were provided with the 34 items from Study 1, preceded by the stem "In my interactions with my [either; family, friends, or PE teacher] regarding exercise…". The questionnaire was completed three times, each time referring to a different social agent. Participants were instructed to interpret exercise as 'any activity that you consider to be exercise' and asked to respond using a 7-point Likert scale from 1 (*strongly disagree*) through 4 (*neither agree nor disagree*) to 7 (*strongly agree*).

Procedure

Schools were invited to take part in the study via telephone and email. The purpose and nature of the study was explained and consent sought from senior members of staff in line with British Psychological Society guidelines (2014). Following this, information letters were sent out to parents via school email systems, providing them the opportunity to opt their child out of participating in the study. Informed assent was obtained from students who had not been opted out and who wished to participate. Questionnaires were completed in silence during a normal school day with a researcher present in order to answer any questions about the questionnaire. To ensure consistency and good practice, we did not re-interpret any of the questions to the students raising queries, but did provide definitions of words if required (cf. Katzmarzyk et al., 2013). Questionnaires were completed anonymously and posted into a box once completed to maintain anonymity.

Data Analysis

Data were screened based on the recommendations of Tabachnick and Fidell (2014). Five items (items 6, 14, 20, 23 and 25) were removed prior to the CFA analysis due to high proportions of missing data (>5% missing in reference to at least 2 social agents), thus suggesting that these were ambiguous items. The low number

of remaining missing responses were replaced using within person median

substitution.

The aims of Study 2 were addressed via a 4-step approach. In step 1,

CFA were carried out using M*plus* 7.3 (Muthén & Muthén, 1998-2015). In view of

both the deviations from normality and the ordinal categorical nature of the data, we

used polychoric correlation matrices and robust weighted least squares estimation

(WLSMV; Flora & P.J. Curran, 2004; McIntosh, 2007; Rhemtulla, Brosseau-Liard, &

Savalei, 2012). The Satorra-Bentler χ^2 test statistic (Satorra & Bentler, 1994) was

used as an indicator of model fit, yet this test is sensitive to sample size and over

powered (i.e., falsely identifying ill-fitting models with large data sets; Brown, 2006;

Cheung & Rensvold, 2002). Thus, several indices of fit were also used (Brown, 2006;

Kline, 2005): (a) the scale corrected comparative fit index (CFI); (b) the Tucker Lewis

Index (TLI); (c) weighted root mean square residual (WRMR); and (d) root mean

square error of approximation (RMSEA). The thresholds used were $\geq$.90 for

acceptable fit and $\geq$.95 for excellent fit with regards to the CFI and TLI (Hu &

Bentler, 1999), <1 for the WRMR (Yu, 2002), and close to (or less than) .10 for the

RMSEA (Schermelleh-Engel, Moosbrugger, & Müller, 2003).

In step 2, the item pool was refined using a combination of methods.

Standardized regression weights were transformed into IRT slope parameters using

the guidelines provided by Wirth and Edwards (2007). The standardized regression

weights, IRT slope parameters, and item characteristic curves (see supplementary

material) were used to refine the item pool by identifying the strongest and most

discriminating items (i.e., larger regression weights and slope parameters) for

measuring autonomy- competence- and relatedness-support (Reeve & Fayers, 2005).

The integration of CFA and IRT has been beneficial to a number of previous scale

developments (e.g., Glockner-Rist & Hoijtink, 2003; Waller, Ostini, Marlow, McCaffery, & Zimet, 2013). IRT is particularly useful in the development and refinement stages of scale development as it is not dependent on the characteristics of the sample (Petscher & Schatschneider, 2012), and therefore the strength of the scale created should be consistent in the population. The theoretical content of each item was also considered (i.e., being mindful of the feedback from the original expert panel) and, if there was any theoretical redundancy due to a degree of duplication in item content, then the stronger item (i.e., with the higher slope parameter) was retained.

In step 3, CFA was used to test the final measurement tool using the same model fit criteria as used in step 1. Finally, in step 4 the tenability of the measure was tested by comparing a 1-factor model with the proposed 3-factor structure. Such an approach assesses whether the items best predict three separate latent variables (i.e., autonomy-, competence- and relatedness-support) or one overall latent variable (i.e., psychological need support). Ordinal composite reliability scores (Raykov, 1997) were also calculated using information from the CFA to assess the internal consistency of the subscales and readability of the scale was tested using the Flesch reading ease and Flesch-Kincaid grade (Flesch, 1948).

Results

Descriptive Data

Median values and frequency distribution are presented in Table 2. Across all social agents, responses were negatively skewed and thus departed from normality. Thus, to address the nature and disrtubution of these data, polychoric correlation matrices and robust weighted least squares estimation was used in the CFA's.

Table 2

Model Testing

Results of the categorical CFA's showed the 29-item, 3-factor model to provide an acceptable fit to the data. The results nonetheless indicated that there was room for improvement in fit (Table 3). Therefore, the item pool was refined using CFA and IRT. Supplementary Figures 1-3 show the IRT distributions for all items in the scale (see supplementary online materials). Regression weights, slope parameters, and standard errors derived from the IRT analysis suggested a final 9-item, 3-factor solution to the data (i.e., 3 items loading onto each psychological need support latent factor). These items are shown in Table 4. The final model was based on these analyses and the theoretical tenets within SDT that underpin autonomy-, competence-, and relatedness-support. This 9-item, 3-factor model was shown to have acceptable fit to the data for all three social agents (Table 3).[2]

Table 3

Table 4

One factor model, reliability and readability

In order to further test the proposed 3-factor solution, the data were tested with a 1-factor model. The model fit statistics for the 1-factor model showed poorer fit to the data when compared to the 3-factor solution (Table 3). Ordinal composite reliability analysis showed the data generated for the three subscales of autonomy, competence, and relatedness support display good levels of internal consistency (Table 5). The Flesch reading ease level (73.4) and the Flesch-Kincaid grade level (5.7) for the whole scale showed it to be of a suitable reading level for adolescents (Hensel, 2014).

Table 5

Brief Discussion

In Study 2, we refined a new measure of adolescents' perceptions of psychological need support in the exercise context. With the use of CFA and IRT, 9 strongly performing items were identified that have face validity to cover the breadth of each psychological need support facet outlined within SDT (3 items for autonomy-, competence- and relatedness-support). The results of the subsequent analysis showed the 9-item, 3-factor model to have acceptable fit to the data whereas the 9-item, 1-factor model showed poor fit. The 9-item scale was also shown to be reliable and at an appropriate reading level for an adolescent population.

Study 3

Using an independent sample, in Study 3 we sought to: (a) cross-validate the 3-factor model supported in Study 2; (b) assess the invariance of the APNSEQ scale scores across gender and social agent; and (c) provide initial support for the criterion validity of the APNSEQ through correlational analysis with psychological need satisfaction, psychological need frustration, and behavioral regulations for exercise.

Method

Participants

A separate sample of adolescents (N= 373; 187 males) aged 11-15 years (M= 13.91, SD= 1.22) were recruited using the protocol outlined in Study 2. Ninety-six percent of the sample were white, 2% mixed race, 1% Asian, 0.5% black, 0.5% Chinese, and 1% other.

Measures

Psychological need support. Perceptions of psychological need support (viz., for autonomy, competence, and relatedness) were measured through the 9-item APNSEQ.

Psychological need satisfaction and frustration. Participants' perceptions of

satisfaction and frustration of the basic psychological needs for autonomy, competence, and relatedness were assessed through an amended version of the Basic Psychological Need Scale (Chen et al., 2015). The original 24-item, 6-factor scale has been validated in multicultural samples of adolescents (Chen et al., 2015). In the present study, the stem used was 'When I exercise…' and minor amendments were made to some items to ensure that responses were in relation to the exercise context (e.g. replacing 'things' with 'exercise'). Items referred to need satisfaction (e.g. '…I feel I have been doing exercise that really interests me') and need frustration (e.g. '…I feel like a failure because of the mistakes that I make'). Participants responded using a 7-point Likert scale ranging from 1 (*strongly disagree*) through 4 (*neither agree nor disagree*) to 7 (*strongly agree*).

Behavioral regulation in exercise. Motivation towards exercise was assessed using the Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2; Markland & Tobin, 2004). This 19-item scale measures the behavioral regulations of intrinsic motivation, identified regulation, introjected regulation, external regulation, and amotivation. Participants responded on a 5-point Likert scale ranging from 0 (*not true for me*) through 2 (*sometimes true for me*) to 4 (*very true for me*). Responses to the scale have previously demonstrated acceptable psychometric properties in adolescent samples (e.g., Gillison, Standage, & Skevington, 2006; Standage et al., 2012).

Data Analysis

Normality was tested using the procedures outlined in Study 2. First, due to deviations from normality and ordinal categorical nature of the data, CFAs to test both the 3-factor and 1-factor solution were conducted using polychoric correlation matrices and WLSMV estimation. Second, a sequential model testing approach was employed using multi-sample categorical CFA to examine whether the APNSEQ

displayed invariance across gender and social agent. A change in CFI of $\leq .01$

between more constrained models was considered necessary to support invariance

(Cheung & Rensvold, 2002).

Third, bivariate correlation coefficients were calculated to explore the

associations between the psychological need support variables and psychological need

satisfaction, psychological need frustration and behavioral regulations for each social

agent. Cohen's (1992) thresholds were used to distinguish between small ($>.20$),

moderate ($>.40$) and large ($>.70$) correlations. For the purpose of this analysis,

average scores for each subscale were used and therefore classical correction (i.e.,

accounting for the internal reliability of each scale) was used to account for

measurement attenuation (Charles, 2005).

Results

CFA and invariance testing

Descriptive data and internal consistency values are shown in Table 6. Results

of the multi-sample CFA showed the 3-factor model to provide excellent fit to the

data for family and acceptable fit for friends and PE teacher: Family $\chi^2_{(24)}$=93.12,

$p<0.001$; CFI= .99; TLI= .99; WRMR= .62; RMSEA= .08, CI [.07 to .10]; Friends $\chi^2_{(24)}$ = 116.49, $p<0.001$; CFI= .99; TLI= .99; WRMR= .75; RMSEA= .09, CI [.08 to

.11]; and PE teacher $\chi^2_{(24)}$ = 206.85, $p<0.001$; CFI= .99; TLI= .98; WRMR= .88,

RMSEA= .14, CI [.12 to .15]. The 1-factor model provided poorer fit to the data for

all three social agents: Family $\chi^2_{(28)}$=305.33, $p=.02$; CFI= .97; TLI= .96; WRMR=

1.77; RMSEA= .16, CI [.14 to .17]; Friends $\chi^2_{(28)}$ = 558.92, $p=.02$; CFI= .94; TLI=

.92; WRMR= 2.59; RMSEA= .21, CI [.20 to .23]; and PE teacher $\chi^2_{(28)}$ = 356.19, χ^2

$p=.48$; CFI= .98; TLI= .97; WRMR= 1.97, RMSEA=.17, CI [.15 to .18].

Table 6

Results of invariance testing provided initial support for the equivalence of the 3-factor model across gender and social agent (Table 7).

Table 7

Criterion Validity

As shown in Table 8, significant and primarily moderate positive relationships were observed between the APNSEQ psychological need support scales and both psychological need satisfaction and autonomous forms of motivation. Significant, albeit weaker, negative relationships were found between the psychological need-support scales and the psychological need frustration and controlled forms of motivation variables. There were no significant associations between the perceived psychological need support variables and introjected regulation.

Table 8

Perceived autonomy-support consistently correlated most strongly with autonomy-satisfaction across social agents. Perceived relatedness-support from family and friends had the strongest association with relatedness-satisfaction, however perceived relatedness-support from PE teacher showed a similar association with autonomy-satisfaction. Perceived competence-support from a PE teacher correlated most strongly with competence-satisfaction, however perceived competence-support from family and friends showed similar associations with relatedness-satisfaction.

Brief Discussion

In Study 3, we tested and reaffirmed the internal validity of the APNSEQ measurement model. Subsequent analysis showed the APNSEQ to provide a well-fitting model to the data, which was reliable and invariant across gender and social agent. Criterion validity of the APNSEQ scales were supported in relation to the broader SDT framework, with correlations supporting a nomological network of

associations. Such findings provide initial support for the utility of the APNSEQ

scores to assess autonomy-, competence-, and relatedness-support.

General Discussion

Across a series of studies, we developed and psychometrically evaluated

scores from a new measure (APNSEQ) designed to assess adolescents' perceptions of

psychological need support from family, friends, and PE teachers. Collectively, the

findings provided initial support for the factorial structure, reliability, and criterion

validity of the APNSEQ.

In Study 1, an item pool that had been formulated based on the extant SDT

literature was refined based on appropriateness and clarity by a panel of experts.

Good practice recommendations were employed for both item development (Clark &

Watson, 1995) and expert panel procedures (Dunn et al., 1999). Although there was

generally consensus amongst the panel members regarding how appropriate each item

was, there were a few minor discrepancies with regards to clarity, perhaps due to

differences in their personal research experiences (i.e., theorists versus applied

researchers). In such instances, the qualitative written feedback provided by the

panelists was informative of how we could refine items to improve clarity and/or

theoretical alignment. Thus, the refinements to items yielded a conceptually coherent

item pool for the subsequent studies.

In Study 2, and via categorical CFA and IRT analyses, we developed a 9-item

measure that is efficient, highly discriminating, and represents the breadth of the

psychological need support construct outlined within SDT (i.e., at a scale level via

CFA and at the item level through IRT). Although a single factor model approached

reasonable fit, the hypothesized 9-item 3-factor model provided better fit to the data.

Two points are worthy of note. First, a degree of model misspecification was evident

for responses to the relatedness-support items when targeting the PE teacher.

Relatedness-support is likely to hold different interpretational connotations across

interpersonal relationships differing in the degree of formality (formal vs. informal)

and structure (e.g., in this case recipient-provider or hierarchal for PE teacher vs.

mutual for family and peers). Future research into such issues seems warranted.

Second, while the CFI, TLI, and WRMR values yielded strong support for the

APNSEQ measurement model, the RMSEA values for some models were marginally

higher than suggested criteria. Here, the models with higher RMSEA values were

those with the lowest df. This is not especially surprising since the RMSEA is

calculated using the ratio of the model χ^2 to its df and, thus, penalizes for complexity

(i.e., larger model df leads to better fit; Kenny, Kaniskan, & McCoach, 2014). The

other fit index that penalizes for complexity is the TLI and we note that all values

were acceptable in the present study. Likewise, model fit cannot be solely based on

the interpretation of one fit statistic alone (Hu & Bentler, 1995). Rather, judgments

should be based on an overall assessment of different fit indices and model

parameters, and this is the approach we have taken in the current set of studies.

In Study 3, responses from an independent sample of adolescents confirmed

the reliability and internal validity of the 3-factor 9-item measurement model. Again,

the 3-factor model provided better fit to the data compared to the alternative single

factor model, illustrating that basic psychological need support is multifaceted and

best interpreted and measured through three distinct, yet highly related, constructs. A

similar pattern has been found with regards to psychological need thwarting

(Bartholomew et al., 2011). Extending these associations to the social context level,

such findings align with the tenets within SDT, which hold that the three

psychological needs are considered to be "basic", interdependent and operate

synergistically (see Ryan & Deci, in press).

Researchers often seek to investigate hypothesized differences between groups (e.g., gender differences), as well as attempt to understand the effects of differing social agents on motivation and engagement. For comparisons and interpretations to be meaningful, it is assumed that measurement tools are equivalent across various samples (Milfont & Fischer, 2010). In Study 3, the factorial invariance of the APNSEQ scores were tested and supported across gender and social agent. Such findings suggest that responses to the APNSEQ allow for meaningful comparison between genders, as well as providing a means to assess and compare psychological need support from different social agents (i.e., family, friends and PE teachers).

Moderate positive correlations between the three subscales of the APNSEQ, psychological need satisfaction, and more autonomous types of motivation (i.e., intrinsic motivation and identified regulation) provided support for criterion validity and the nomonological network outlined within SDT. In prior studies using pre-existing measures, perceived autonomy-support has been shown to have small to moderate significant associations with autonomous motivation and psychological need satisfaction and negative relationships with external regulation (e.g., T. Curran, Hill, & Niemiec, 2014; Chatzisarantis, Hagger, Kamarova, & Kawabata, 2012; Standage et al., 2012). In this work, responses to the APNSEQ showed similar relationships, yet extended on the extant literature to show that perceived competence- and relatedness- support also have significant relationships with psychological need satisfaction, psychological need frustration, and motivation variables in a manner highly consistent with the theoretical tenets within SDT. Although the associations between the psychological need support variables and behavioral regulations generally conformed to a gradient based on relative autonomy (i.e., psychological

need support variables being positively correlated with more autonomous forms of motivation and negatively associated with external regulation and amotivation), no relationship was found between the psychological need support variables and introjected regulation. As introjection manifests as compulsive and rigid engagement to service internal contingencies, a lack of a relationship with psychological need supports provided by others does not depart from the tenets within SDT. Rather, it would be expected that psychologically need thwarting contexts would be positively related to introjected regulation, as such environments would attune to internal sanctions. Further research on this issue, though, is warranted.

Limitations and Future Directions

The present research is limited by the cross-sectional design. Although justified for the development and validation of a measure, future research would do well to: (a) overcome issues such as common-method variance by validating against objectively assessed exercise and sedentary behaviors; and (b) employ the APNSEQ across a diverse range of methodologies (e.g., ecological momentary analysis, longitudinal, and experimental) that better capture the dynamic and complex interplay among motivation-related constructs and health and well-being outcomes (cf. Standge & Ryan, 2012).

The APNSEQ was developed in conjunction with theoretical and academic experts, yet not with adolescents and their significant social others (e.g., family, friends, and PE teachers). Although some of the questionnaires from which the initial item pool was drawn had been developed and/or validated with adolescent populations (e.g., PASSES; Hagger et al., 2007), consulting a sample of adolescents and social agents during development stage would have provided insightful sources of information pertaining to item comprehension, relevance, and interpretation. As this

is the first presentation of the APNSEQ measure, any future iteration to the measure could refine the instrument via user engagement and feedback.

Commensurate with an increased application of Bayesian estimation methods within the sport and exercise psychology literature (e.g., Gucciardi, Zhang, Ponnusamy, Si, & Stenling, 2016; Tamminen, Gaudreau, McEwen, & Crocker, in press; Stenling, Ivarsson, Johnson, & Lindwall, 2015), future work would do well to also test the psychometric properties of the APNSEQ using the Bayes' theorem. Data from the several samples presented in this paper provide initial and useful data to inform the prior distribution of the model parameters in such work. Researchers could also compare APNSEQ responses via the WLSMV approach, as used in this work, with the Bayesian method across factors such as sample size, normality, model misspecification, culture, gender, and age (see Liang & Yang, 2014).

Although the stem of the APNSEQ explicitly prompts respondents to have their exercise-related discussions in mind, the relatedness-support items do not explicitly refer to the exercise context to reinforce this, while the autonomy and competence items are contextually targetted. Yet, the associations among the relatedness items and other SDT constructs were of a similar magnitude to the autonomy- and competence-support scales, and thus it appears that this was sufficient to direct respondents to answers that were specific to the exercise context (proximal) as opposed to life more generally (distal).

Conclusion

In sum, within this paper we present three studies that outline the systematic development of a psychometrically sound measure of adolescent perceptions of psychological need support in the exercise context. Akin with the tenets within SDT, the APNSEQ encompasses the breadth of psychological need support (viz., supports

for autonomy, competence and relatedness) and assesses need support from family, friends and PE teachers. Aspects of construct validity, reliability, and readability of the measure support the instrument as a valid and reliable tool. We hope that this measure will play a role in encouraging researchers to examine social contexts from a multi-faceted (i.e., psychological need support) and multi-social agent approach.

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Footnote

1. The term physical activity encompasses all movement produced by skeletal
   muscles that confer energy expenditure above rest. The term *exercise* is often
   used interchangeably with *physical activity*. Within this paper, we discuss
   exercise as a sub-component of physical activity that is more '*a subcategory of*
   physical activity that is planned, structured, repetitive and purposeful in the
   sense that the improvement or maintenance of one or more components of
   physical fitness is the objective' (World Health Organisation, 2010, p.52.). In
   considering exercise as a type of physical activity that is planned, structured,
   repetitive, and purposeful it appropriately delineates *exercise* from *physical*
   activities of daily living and captures exercise as a behavioural enactment that
   is sufficiently purposeful to require cognitive processes pertaining to the
   psychology of motivation (Standage & Ryan, 2012).

2. It should be noted that in the PE teacher model, the factor covariance between
   autonomy and competence exceeded 1 (i.e., 1.01). We therefore fixed this
   correlation to .98 on empirical grounds (the average value for this association
   across the CFA's presented within this paper). The resulting model fit was
   largely unchanged; $\chi^2_{(25)} = 207.785$, $p<0.001$; CFI= .99; TLI= .98; WRMR=
   .82, RMSEA= .14, CI [.12 to .16]).

Table 1.

Descriptive Statistics from the Expert Panel Feedback

Item	M Appropriateness (SD)	M Clarity (SD)
Autonomy		
I feel that I am provided with meaningful choices, options and opportunities.	4.71 (.49)	3.43 (1.62)
I feel that they understand why I choose to exercise.	3.29 (1.38)	4.00 (1.00)
I feel that they encourage me to do the exercise activities that I want to do.	4.00 (1.55)	4.67 (.52)
I feel that they listen to me about how I would like to take part in exercise activities.	4.14 (.90)	4.14 (1.21)
I feel that they encourage me to make my own exercise decisions.	4.71 (.49)	4.57 (.79)
I feel that they make sure I understand why it is important for me to exercise.	3.86 (1.46)	4.00 (1.15)
I feel that they carefully answer my exercise-related questions.	3.67 (1.21)	4.83 (.41)
I feel that they are interested in me and the exercise activities I do.	3.57 (1.27)	3.71 (1.50)
I feel that they provide me with the chance to put my own input to the exercise activities I do.	4.57 (.79)	3.86 (1.07)
I feel that they help me to make my own exercise-related decisions.	4.29 (.76)	4.57 (.53)
I feel that they provide options and choices that are important to me.	4.29 (.76)	3.71 (1.38)
I feel that they try to appreciate my point of view.	4.57 (.79)	5.00 (.00)
I feel that they provide me with meaningful reasoning for why I would engage in exercise activities.	4.57 (.79)	3.86 (1.07)
I feel that they really try to understand concerns I have about exercising.	4.14 (1.21)	4.71 (.49)
Competence		
I feel that they provide me with positive feedback when I try to improve my exercise abilities.	4.86 (.38)	4.71 (.49)
I feel that they display confidence in my exercise ability.	4.14 (1.07)	4.29 (.76)
I feel that they help me to improve my exercise abilities	4.57 (.53)	4.29 (.76)
I feel that they make me feel like I am good at exercise.	4.29 (.76)	3.57 (.79)
I feel that they support me in achieving my exercise goals.	4.43 (.98)	4.86 (.38)
They help me to feel like I am able to do challenging exercise activities.	4.57 (.53)	4.43 (.79)
They support me to feel confident in my ability to do well at exercise activities/tasks.	4.71 (.49)	3.57 (1.40)
They help me to feel capable of doing challenging exercise activities/tasks.	4.14 (.90)	4.00 (.58)
They help me to feel competent at doing exercise activities/tasks.	4.71 (.49)	4.29 (.76)

They help me to feel confident in my ability to achieve personal exercise challenges.	4.58 (.53)	3.57 (1.27)
I feel that they help me to fulfil my exercise potential.	3.71 (.95)	3.86 (1.07)
Relatedness		
I feel that they are very supportive of me.	3.86 (.90)	4.29 (.95)
I feel that they encourage me to work on exercise activities with others.	3.00 (1.41)	4.29 (1.11)
I feel that they have respect for me and my exercise engagement.	4.17 (.75)	3.50 (1.38)
I feel that they are interested in me.	4.00 (.58)	4.14 (.90)
I feel that they are friendly towards me.	4.14 (.90)	4.57 (.79)
I feel that they treat me with respect	4.14 (.90)	4.86 (.38)
I feel that they care about me	4.43 (.79)	4.86 (.38)
I feel a sense of being connected with them.	3.86 (1.46)	4.29 (.95)
I feel a sense of trust.	4.17 (.98)	4.83 (.41)
I feel accepted by them	4.57 (.79)	4.86 (.38)
I feel that I am valued by them.	4.43 (.79)	4.57 (.79)
I feel that I can openly talk to them about the exercise activities I want to do	4.29 (.76)	4.29 (.95)
I feel a sense of trust in their exercise-related advice	3.67 (.82)	3.67 (1.03)
They help me to feel important	3.57 (.98)	3.86 (1.07)

Table 2.

Median and Frequency of Responses for the 29-items

| | Family | | | | | | | | Friends | | | | | | | | PE teacher | | | | | | |
| | | | Proportion of responses | | | | | | | | Proportion of responses | | | | | | | | Proportion of responses | | | | |
Item	$\tilde{x}$	1	2	3	4	5	6	7	$\tilde{x}$	1	2	3	4	5	6	7	$\tilde{x}$	1	2	3	4	5	6	7
Autonomy																								
1	6	.7	.5	1.4	12.1	.2	18.0	25.6	6	2.2	1.5	3.7	19.4	15.2	20.6	37.3	6	4.8	1.3	3.7	21.9	12.0	17.9	38.2
4	6	.5	.7	2.1	8.8	14.2	26.1	47.6	6	2.5	.7	4.7	21.4	17.9	24.6	28.1	6	3.2	1.9	4.8	16.6	15.8	22.5	35.3
7	6	.7	1.4	2.1	13.7	18.0	27.7	36.2	6	2.7	1.5	3.7	22.1	18.2	23.4	28.4	6	4.0	1.6	4.0	20.9	16.8	24.7	27.8
10	6	.5	1.2	1.7	13.7	13.3	26.8	42.9	6	2.0	1.7	3.2	19.9	14.9	23.1	35.1	6	2.7	1.9	4.8	19.8	17.6	23.3	29.9
13	6	.5	.7	2.1	13.3	14.5	24.9	44.1	6	2.7	1.2	5.0	24.4	12.9	26.6	27.1	6	2.9	.5	3.2	17.6	11.8	25.1	38.8
16	6	2.1	1.9	5.5	18.7	17.5	25.8	28.4	5	3.7	4.5	5.5	25.9	16.7	20.4	23.4	6	3.7	.8	4.0	17.4	18.2	26.2	29.7
19	6	.9	2.1	1.7	10.7	18.0	28.2	38.4	6	2.7	2.0	4.5	21.1	17.7	25.4	26.6	5	4.5	1.9	5.6	23.5	17.4	22.7	24.3
22	6	.9	1.2	1.4	12.6	14.5	28.2	41.2	6	1.5	1.7	2.0	22.4	16.2	22.6	33.6	5	3.2	2.1	4.8	22.5	19.0	19.8	28.6
28	6	.7	.5	2.8	11.1	15.2	34.1	35.5	6	1.7	.5	3.5	25.6	17.7	23.4	27.6	6	3.5	2.4	5.3	19.8	16.8	25.1	27.0
31	6	1.9	.7	3.1	11.8	11.8	27.3	43.4	6	1.2	1.5	2.0	15.2	16.9	30.1	33.1	6	4/8	2.4	5.3	17.1	19.0	27.8	23.5
33	6	1.4	1.4	2.6	12.1	14.9	29.6	37.9	5	2.2	1.2	3.0	26.4	20.4	19.9	26.8	6	4.0	2.1	4.5	19.5	17.6	24.6	27.5
34	6	2.6	.9	2.6	14.7	18.0	29.1	32.0	5	3.7	2.5	4.7	24.6	20.4	19.7	24.4	5	4.8	3.2	5.3	24.6	15.2	21.9	24.9
Competence																								
2	6	.2	1.9	2.8	15.6	19.0	23.4	37.0	6	3.5	1.7	5.2	21.1	15.9	23.9	28.6	6	4.0	1.3	3.7	14.7	15.5	25.9	34.8
5	6	.5	.7	3.3	15.2	18.7	27.5	34.1	6	2.2	1.7	5.0	21.1	17.2	23.1	29.6	6	3.7	1.9	5.1	19.5	18.2	21.1	30.5
8	6	1.4	2.1	3.8	16.6	18.7	25.8	31.5	5	2.7	1.7	5.2	21.1	19.9	23.6	25.6	6	3.2	.8	2.9	16.6	15.5	25.1	35.8
11	6	1.9	1.4	4.3	16.8	13.3	25.8	36.5	6	3.5	1.0	5.0	18.4	13.2	23.8	35.1	6	4.5	3.5	3.7	18.7	18.2	22.7	28.6
17	6	.7	1.7	3.1	17.5	15.2	28.0	33.8	6	2.2	1.7	4.2	20.4	18.7	25.3	27.4	6	3.2	1.6	4.8	18.2	17.1	26.2	28.9
26	6	.7	1.7	2.1	14.5	16.9	29.9	35.3	6	1.2	2.0	2.2	21.3	20.4	24.9	27.9	6	3.2	2.7	6.4	19.8	15.5	27.8	24.6
29	6	.2	1.4	3.1	14.2	16.4	28.9	35.8	6	2.0	1.5	3.2	22.9	19.7	24.9	25.9	6	3.5	1.6	4.8	18.2	18.4	25.4	28.1
Relatedness																								
3	6	.5	2.1	3.3	14.0	15.4	28.6	36.0	5	3.7	1.7	4.7	20.9	19.7	22.1	27.1	6	2.9	1,1	3,5	17.6	13.9	21.4	39.6
9	7	1.2	.7	1.4	6.2	10.7	19.7	60.2	7	.7	.5	2.7	8.7	10.4	18.7	58.2	6	4.3	.8	2.9	14.7	15.8	27.5	24.0
12	7	.9	1.2	2.6	9.0	12.1	18.5	55.7	6	2.2	2.2	2.0	11.9	12.4	21.1	48.0	6	3.5	.8	5.9	16.6	14.2	24.6	34.5
15	7	1.9	.2	2.4	5.7	6.2	14.0	69.6	6	1.0	.5	2.2	12.7	13.7	21.6	48.2	6	3.5	2.9	4.3	22.5	14.7	24.1	28.1
18	7	1.9	1.9	1.2	13.7	10.7	25.6	45.0	6	1.0	1.5	3.5	15.2	14.7	25.1	39.1	5	7.2	2.1	5.9	24.9	18.2	18.4	23.3
21	7	1.4	1.7	1.9	9.2	11.1	19.9	54.7	6	1.0	1.0	3.5	12.4	10.9	24.6	46.5	6	4.3	.2	5.9	21.9	17.4	23.3	27.0
24	7	.9	.7	1.9	8.5	8.8	19.4	59.7	6	1.5	1.7	2.7	11.7	11.4	20.9	50.0	5	4.8	2.4	7.2	19.0	16.8	20.6	29.1

27	7	.7	1.2	2.8	7.1	9.5	20.9	57.8	6	1.5	1.5	3.0	14.9	14.2	23.1	41.7	5	5.3	2.9	6.4	23.7	14.7	24.3	22.7
30	7	1.4	1.7	2.8	11.6	12.3	24.6	45.5	6	2.0	2.5	2.7	19.4	15.9	23.6	33.8	5	4.5	3.2	5.6	19.0	17.4	24.1	26.2
32	7	.9	2.1	1.9	10.2	12.8	21.8	50.2	6	1.5	1.0	1.7	16.2	18.2	24.9	36.6	5	5.3	3.5	6.7	21.7	16.3	21.4	25.1

Note. $\tilde{x}$ = median, N= 422

Table 3.

Model Fit Indices for all Models Tested in Study 2

	χ^2	df	CFI	TLI	WRMR	RMSEA (CI 90%)
29 Item, 3-factor model						
Family	1461.03	374	.97	.96	1.36	.08 (.08, .09)
Friends	2499.10	374	.94	.93	1.91	.12 (.11, .12)
PE teacher	2175.20	374	.97	.97	1.93	.11 (.11, .12)
9 Item, 3-factor model						
Family	85.70	24	.99	.99	.65	.08 (.06, .10)
Friends	88.55	24	.99	.99	.58	.08 (.06, .10)
PE teacher	187.99	24	.99	.99	.78	.14 (.12, .15)
9 Item, 1-factor model						
Family	424.36	27	.91	.95	1.72	.19 (.17, .20)
Friends	486.39	27	.95	.93	1.82	.21 (.19, .22)
PE teacher	375.99	27	.98	.97	1.40	.19 (.17, .20)

Note. All χ^2 values apart from the 9-item, 1-factor model with respect to friends are significant; $p<.001$. CFI= Comparative fit index, TLI= Tucker-Lewis index. WRMR= weighted root mean residual, RMSEA=root mean square error of approximation

Table 4.

Standardized Estimates and Standard Errors for the 9-item APNSEQ

Item	Family			Friends			PE teacher		
	B	S.E	a	B	S.E	a	β	S.E	a
Autonomy									
1 I feel that they understand why I choose to exercise	.70	.03	.98	.76	.02	1.17	.83	.02	1.49
4 I feel that they encourage me to do the exercise activities that I want to do	.79	.02	1.29	.85	.01	1.61	.90	.01	2.06
7 I feel that they listen to me about how I would like to take part in exercise activities	.81	.02	1.38	.82	.02	1.43	.87	.01	1.76
Competence									
5 They display confidence in my exercise ability	.76	.02	1.17	.83	.02	1.49	.88	.01	1.85
8 They help me improve my exercise abilities	.81	.02	1.38	.83	.02	1.49	.87	.01	1.76
17 They help me to feel like I am able to do challenging exercise activities	.86	.01	1.69	.88	.01	1.85	.90	.01	2.06
Relatedness									
15 I feel that they care about me	.84	.02	1.55	.88	.01	1.85	.90	.01	2.06
24 I feel accepted by them	.91	.01	2.19	.86	.02	1.69	.90	.01	2.06
27 I feel that I am valued by them	.90	.01	2.06	.88	.01	1.85	.88	.01	1.85

Note. All regression weights are significant at the p<.001 level. β= Standardized regression weight, SE= Standard error, a= slope parameter.

Table 5.

Factor Covariances and Internal Consistency Estimates for the 9-item APNSEQ

	Family			Friends			PE teacher		
	Autonomy	Competence	Relatedness	Autonomy	Competence	Relatedness	Autonomy	Competence	Relatedness
Autonomy	*.70*			*.77*			*.72*		
Competence	.94	*.72*		.99	*.70*		.98	*.76*	
Relatedness	.80	.74	*.82*	.80	.79	*.79*	.87	.91	*.80*

Note. All factor covariances are statistically significant at the p<.001 level. Composite reliability (ρ) scores are presented in italics on the diagonal of the factor correlations table.

Table 6.

Descriptive Statistics of Study 3 Variables

	Range	*M*	*SD*	95% CI	*a*
Autonomy support					
Family	1-7	5.72	1.24	[5.60, 5.85]	.82
Friends	1-7	4.83	1.39	[4.69, 4.98]	.77
PE teacher	1-7	5.65	1.26	[5.52, 5.78]	.81
Competence support					
Family	1-7	5.79	1.21	[5.66, 5.91]	.85
Friends	1-7	5.01	1.38	[4.87, 5.15]	.82
PE teacher	1-7	5.58	1.34	[5.44, 5.71]	.89
Relatedness support					
Family	1-7	6.23	1.25	[6.10, 6.36]	.92
Friends	1-7	5.92	1.25	[5.80, 6.05]	.88
PE teacher	1-7	5.19	1.56	[5.03, 5.35]	.93
Autonomy satisfaction	1-7	5.18	1.24	[5.05, 5.30]	.68
Competence satisfaction	1-7	5.43	1.27	[5.30, 5.56]	.78
Relatedness satisfaction	1-7	5.52	1.20	[5.39, 5.64]	.74
Autonomy frustration	1-7	2.97	1.50	[2.81, 3.11]	.78
Competence frustration	1-7	2.71	1.49	[2.56, 2.86]	.82
Relatedness frustration	1-7	2.70	1.48	[2.54, 2.84]	.77
Intrinsic motivation	0-4	2.82	1.01	[2.73, 2.93]	.83
Identified regulation	0-4	3.00	.97	[2.90, 3.10]	.80
Introjected regulation	0-4	1.45	1.00	[1.35, 1.55]	.72
External regulation	0-4	.94	.89	[.85, 1.03]	.76
Amotivation	0-4	.65	.93	[.56, .75]	.85

Note. α = Cronbach alpha.

Table 7.

Invariance Analyses of APNSEQ Scales across Gender and Social Agent

		χ^2	df	CFI	TLI	WRMR	RMSEA (CI 90%)
Gender							
Family	Configural	143.44	48	.99	.99	.86	.09 (.08, .12)
	Metric	127.93	54	.99	.99	.87	.08 (.06, .10)
	Scalar	149.69	96	1.00	1.00	.98	.05 (.04, .07)
Friends	Configural	180.12	48	.99	.98	.94	.12 (.10, .13)
	Metric	186.49	54	.98	.98	1.02	.11 (.09, .13)
	Scalar	263.20	96	.98	.99	1.35	.09 (.08, .10)
PE teacher	Configural	273.80	48	.99	.98	1.07	.15 (.13, .17)
	Metric	269.60	54	.99	.98	1.07	.14 (.12, .16)
	Scalar	258.11	96	.99	.99	1.22	.09 (.08, .10)
Social agent							
	Configural	403.52	72	.99	.98	1.31	.11 (.10, .12)
	Metric	404.26	84	.99	.98	1.31	.11 (.10, .12)
	Scalar	458.83	168	.99	.99	1.71	.07 (.06, .07)

Note. All χ^2 values are significant at the p<.001 level. CFI= Comparative fit index, TLI= Tucker-Lewis index. WRMR= weighted root mean residual, RMSEA=root mean square error of approximation

Table 8.

Bivariate Correlations among the APNSEQ Scales and Need Satisfaction, Need Frustration, and Exercise Behavioral Regulation corrected for measurement attenuation

	Family			Friends			PE teacher		
	Autonomy support	Competence support	Relatedness support	Autonomy support	Competence support	Relatedness support	Autonomy support	Competence support	Relatedness support
Family									
Autonomy support	-	.78**	.73**	.47**	.54**	.51**	.42**	.43**	.41**
Competence support	.78**	-	.84**	.44**	.54**	.53**	.52**	.54**	.48**
Relatedness support	.73**	.84**	-	.37**	.53**	.53**	.42**	.44**	.38**
Friends									
Autonomy support	.47**	.44**	.37**	-	.64**	.51**	.38**	.44**	.46**
Competence support	.54**	.54**	.53**	.64**	-	.77**	.38**	.42**	.37**
Relatedness support	.51**	.53**	.53**	.51**	.77**	-	.30**	.35**	.31**
PE teacher									
Autonomy support	.42**	.52**	.42**	.38**	.38**	.30**	-	.84**	.73**
Competence support	.43**	.54**	.44**	.44**	.42**	.35**	.84**	-	.88**
Relatedness support	.41**	.48**	.38**	.46**	.37**	.31**	.73**	.88**	-
Autonomy satisfaction	.63**	.63**	.58**	.53**	.47**	.35**	.57**	.62**	.57**
Competence	.54**	.60**	.55**	.48**	.53**	.36**	.53**	.58**	.53**

satisfaction									
Relatedness satisfaction	.59**	.63**	.62**	.50**	.60**	.53**	.53**	.55**	.47**
Autonomy frustration	-.36**	-.36**	-.42**	-.21**	-.43**	-.32**	-.20**	-.28**	-.15**
Competence frustration	-..44**	-.42**	-.42**	-.26**	-.43**	-.39**	-.21**	-.28**	-.14**
Relatedness frustration	-.30**	-.33**	-.39**	-.18**	-.42**	-.39**	-.16**	-.28**	-.13*
Intrinsic motivation	.53**	.54**	.46**	.33**	.38**	.26**	.45**	.44**	.41**
Identified regulation	.48**	.51**	.48**	.27**	.36**	.23**	.35**	.38**	.36**
Introjected regulation	.00	-.04	-.07	-.07	-.01	-.06	.03	-.00	.00
External regulation	-.32**	-.36**	-.37**	-.20**	-.30**	-.29**	-.22**	-.19**	-.20**
Amotivation	-.38**	-.41**	-.36**	-.23**	-.34**	-.28**	-.30**	-.26**	-.24**

Note: **correlation is significant at the 0.01 level (one-tailed), * correlation is significant at the 0.05 level (1-tailed).

Supplemental Online Materials for

Development and Validation of the Adolescent Psychological Need

Support in Exercise Questionnaire

These appendices are referred to in the main text and are to be posted online as

supplemental matierals. Based on the APA guidance, the content is integral in nature.

Figure S1: Item characteristic curves for autonomy-, competence- and relatedness-support in reference to family.

Figure S2. Item characteristic curves for autonomy-, competence- and relatedness-support in reference to friends.

Figure S3. Item characteristic curves for autonomy-, competence- and relatedness-support in reference to PE teacher.
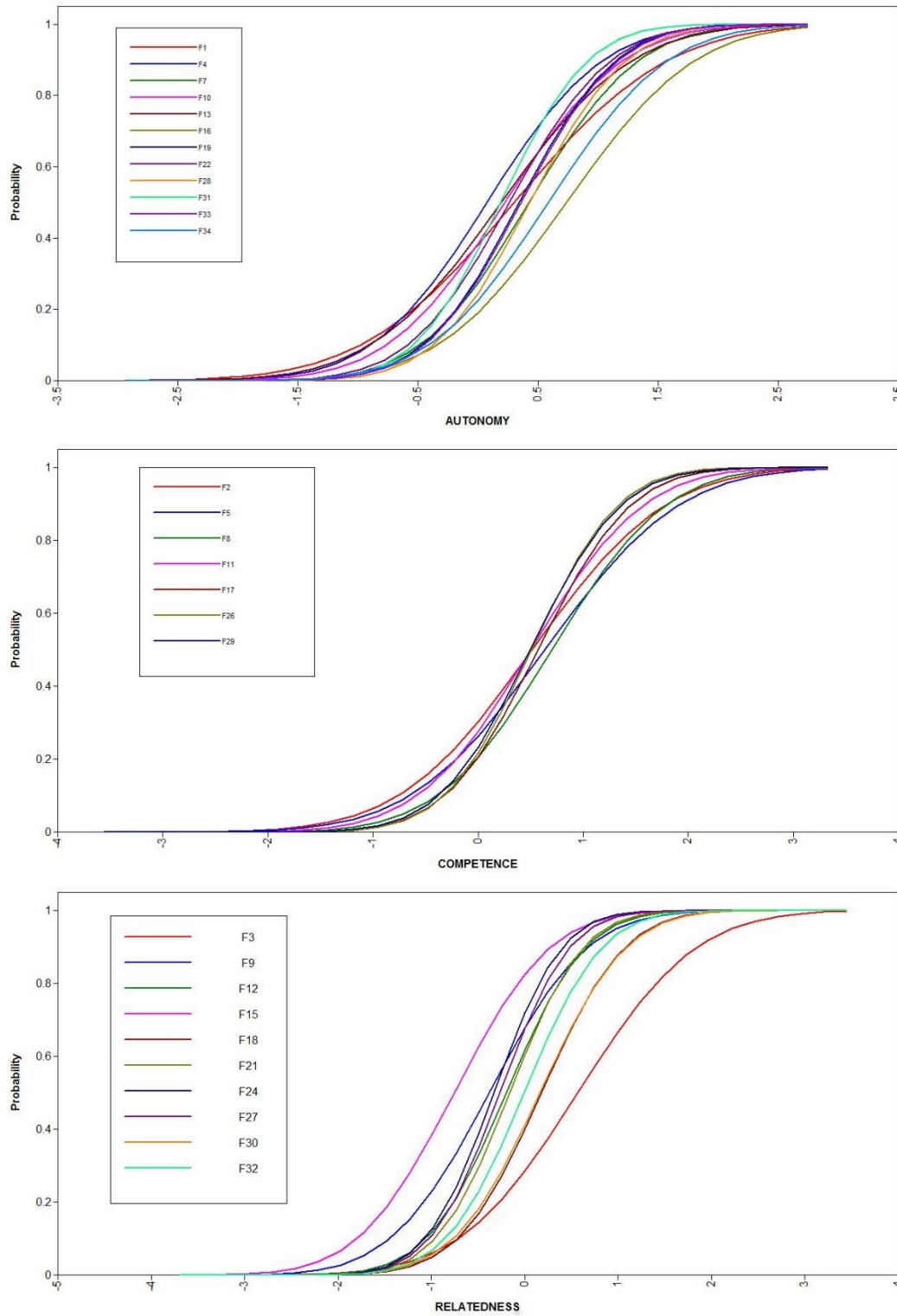
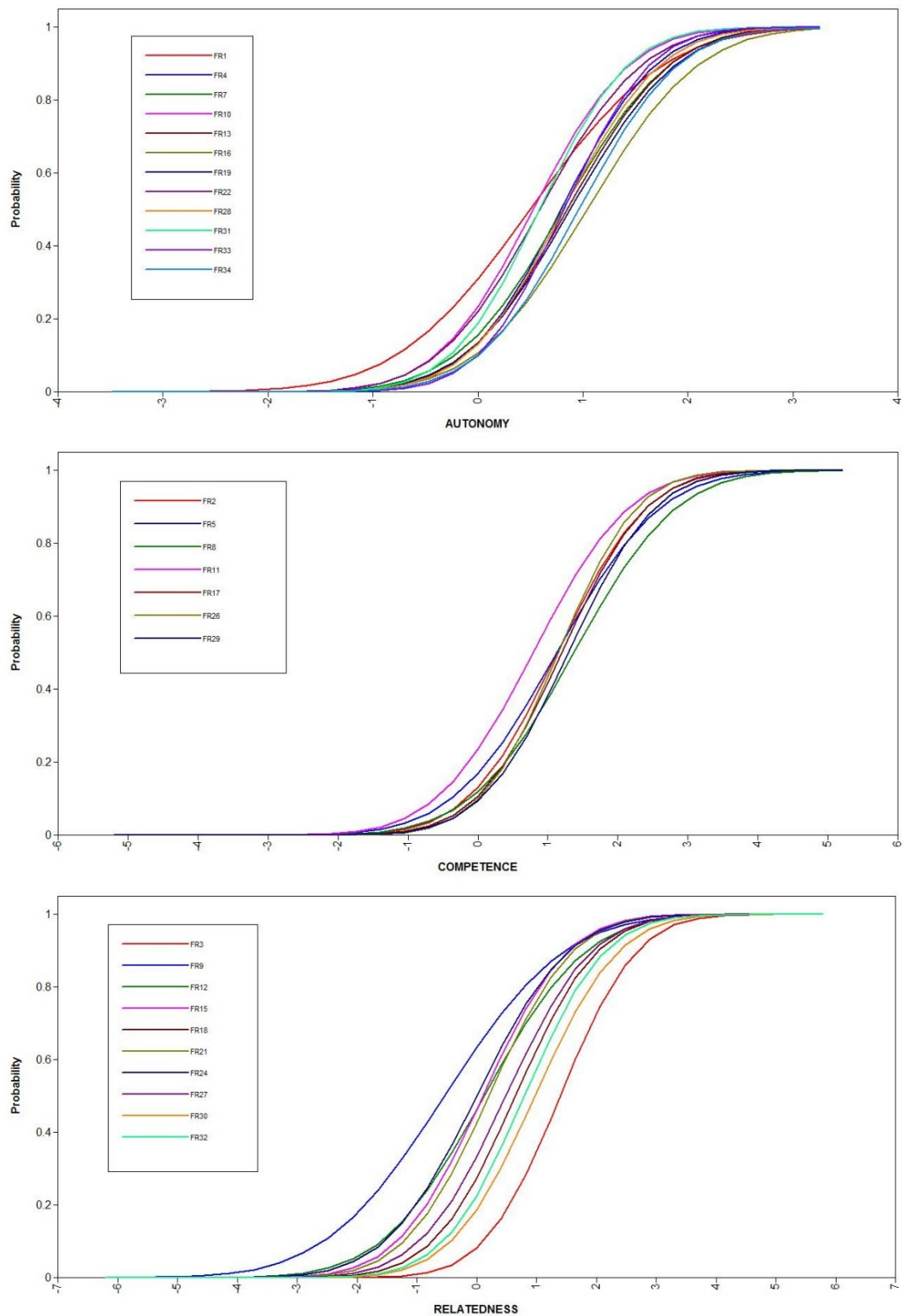*Figure S1*. Item characteristic curves for autonomy-, competence- and relatedness-support in reference to family.

Figure S2. Item characteristic curves for autonomy-, competence- and relatedness-support in reference to friends.
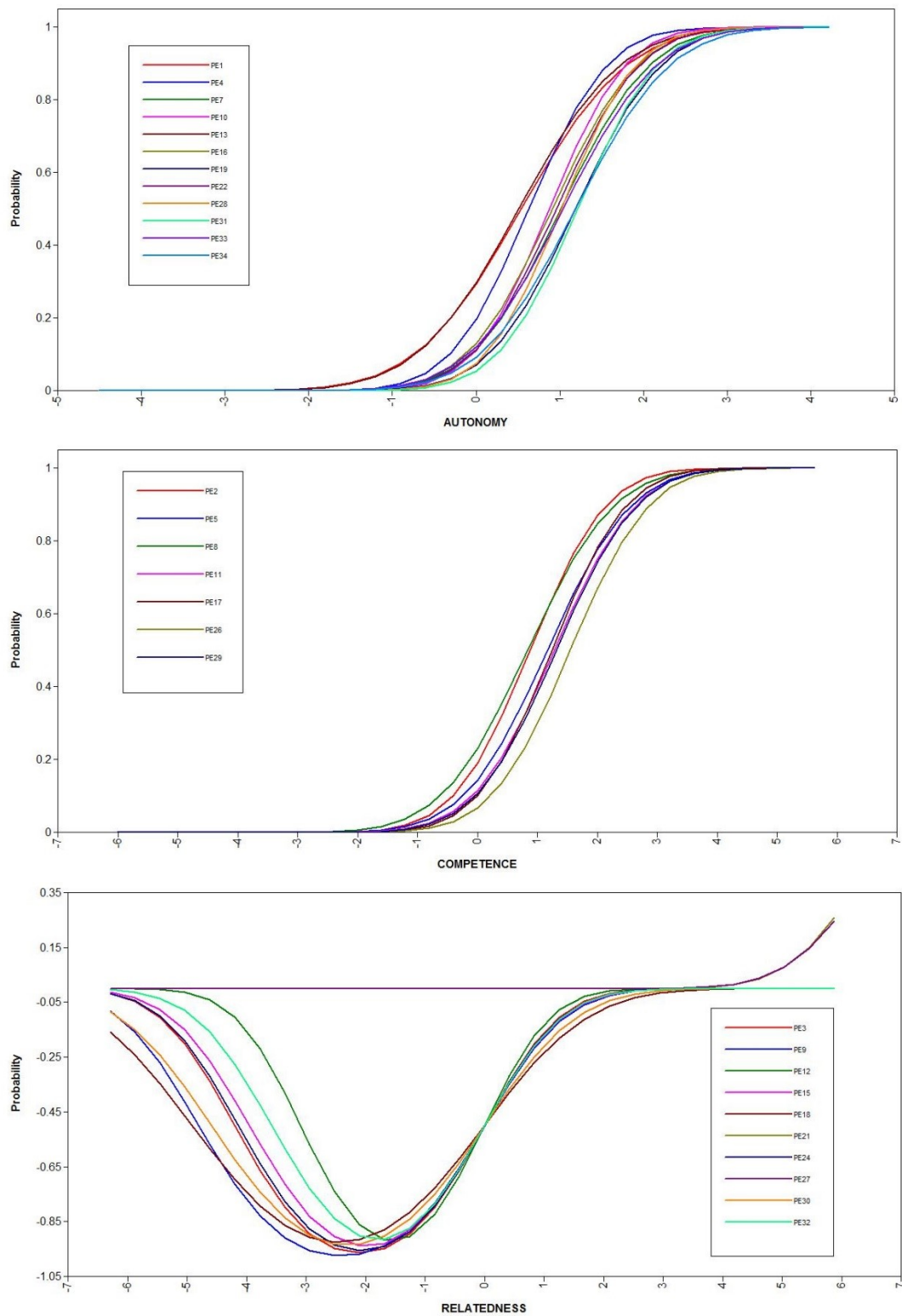
Figure S3. Item characteristic curves for autonomy-, competence- and relatedness-support in reference to PE teacher.