Construct Validity of Selected Measures of Physical Activity Beliefs and Motives in Fifth and Sixth Grade Boys and Girls

Rod K. Dishman,[1] PhD, Ruth P. Saunders,[2] PhD, Kerry L. McIver,[2] PhD, Marsha Dowda,[2] Dr PH, and Russell R. Pate,[2] PhD

[1]*University of Georgia and* [2]*University of South Carolina*

All correspondence concerning this article should be addressed to Rod K. Dishman, PhD, Department of Kinesiology, The University of Georgia, Ramsey Student Center, 330 River Road, Athens, GA 30602-6554, USA. E-mail: rdishman@uga.edu

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Objective Scales used to measure selected social-cognitive beliefs and motives for physical activity were tested among boys and girls. **Methods** Covariance modeling was applied to responses obtained from large multi-ethnic samples of students in the fifth and sixth grades. **Results** Theoretically and statistically sound models were developed, supporting the factorial validity of the scales in all groups. Multi-group longitudinal invariance was confirmed between boys and girls, overweight and normal weight students, and non-Hispanic black and white children. The construct validity of the scales was supported by hypothesized convergent and discriminant relationships within a measurement model that included correlations with physical activity (MET • min/day) measured by an accelerometer. **Conclusions** Scores from the scales provide valid assessments of selected beliefs and motives that are putative mediators of change in physical activity among boys and girls, as they begin the understudied transition from the fifth grade into middle school, when physical activity naturally declines.

Key words accelerometer; construct validity; invariance; measurement equivalence; multi-ethnic; overweight.

Regular physical activity is associated with positive health outcomes among pre- and early-adolescent youths (Strong et al., 2005; U.S. Department of Health and Human Services, 2008). However, participation by many youths is below the recommended level of 60 min daily of moderate-to-vigorous physical activity (MVPA), and it decreases markedly between ages 9 and 15 years (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008). In the 2003–2004 National Health and Nutrition Examination Survey, 42% of children aged 6–11 years met the recommendation for daily MVPA measured by an accelerometer, but only 8% of adolescents met it (Troiano et al., 2008). Activity levels among children aged 6–15 years are lowest among girls and those of African American or Hispanic/Latino ancestry or who are overweight (Belcher et al., 2010).

The modest success of interventions designed to increase physical activity in children and youths (Metcalf, Henley, & Wilkin, 2012) has led to a renewed search for the mediators (i.e., variables in the causal pathway that transmit the intervention effect to physical activity) and moderators (i.e., variables outside the causal pathway that modify the intervention effect) of physical activity change (Baranowski, Anderson, & Carmack, 1998; Luban, Foster, & Biddle, 2008). Objective features of the family (e.g., parenting style or parental involvement with an intervention) and the built environment (e.g., ease of access to activity facilities and opportunities to be active at school or in the community) are logical choices, but they have been weakly associated with physical activity change (Berge, 2009; Berge, Wall, Loth, & Neumark-Sztainer, 2010; Ferreira et al., 2006; Kriemler et al., 2011; O'Connor, Jago, & Baranowski, 2009; Scott, Evenson, Cohen, & Cox, 2007; van Sluijs, Kriemler, & McMinn, 2011). This may be partly explained by interactions of environmental influences on physical activity with individual differences among children, which usually were not considered in studies of the family

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and school or community environments (e.g., Dowda, Dishman, Porter, Saunders, & Pate, 2009).

Youths' beliefs and motives regarding physical activity derived from social-cognitive theories such as self-efficacy and perceived behavioral control (Hagger, Chatzisarantis, & Biddle, 2001) or self-determination theory (Hagger & Chatzisarantis, 2008, 2009) have consistently shown associations with physical activity (Sallis, Prochaska, & Taylor, 2000; Van Der Horst, Paw, Twisk, Van Mechelen, 2007), although there has been little uniformity or standardization of the measures used to assess these constructs. Self-efficacy conceptualizes a belief in personal capabilities to organize and execute the courses of action required to attain a behavioral goal (Bandura, 1997), including physical activity (Bandura, 2004). Like self-efficacy, perceived behavioral control includes efficacy beliefs about internal factors (e.g., skills, abilities, and willpower) and external factors (e.g., time, opportunity, obstacles, and support from other people) that are imposed on physical activity behaviors (Ajzen, 2002). Both constructs represent personal efficacy judgments about the ease or difficulty of performing physical activity in the face of social or environmental barriers (Ajzen, 2002; Bandura, 1997). Self-determination theory is complementary to self-efficacy and perceived behavior control for understanding how people develop intrinsic motives to be physically active (Hagger & Chatzisarantis, 2009). It assumes that people strive for autonomy (i.e., behavior as a personal choice), competence (i.e., a sense of mastery or efficacy), and relatedness (i.e., supportive and satisfying social relations) (Ryan & Deci, 2007). People who are intrinsically motivated choose to be physically active because they enjoy it and find it personally meaningful and valuable. In contrast, people who are extrinsically motivated choose to be physically active more out of a sense of obligation or duty (Ryan, Williams, Patrick, & Deci, 2009).

Consistent with these social-cognitive theories, longitudinal cohort studies of adolescent girls using standardized measures suggest that the decline in physical activity during the period from late middle school through high school is mitigated directly, and also indirectly through intentions, by perceived behavioral control and self-efficacy for overcoming barriers to physical activity and by perceived social support of physical activity (Dishman et al., 2006; Dishman, Saunders, Motl, Dowda, & Pate, 2009; Motl et al., 2005), especially from family (Dowda, Dishman, Pfeiffer, & Pate, 2007; Duncan, Duncan, Strycker, & Chaumeton, 2007). Stable efficacy beliefs about physical activity barriers have also moderated the relation between naturally occurring change in perceived social support and declines in physical activity during high school among girls (Dishman, Saunders, Motl, Dowda, & Pate, 2009). Efficacy beliefs also partially mediated the positive effect of a school-based intervention to increase ninth grade girls' physical activity (Dishman et al., 2004). Other research found that perceived barriers to physical activity and enjoyment partially mediated relations between efficacy beliefs and physical activity participation among girls in the eighth and ninth grades (Dishman, Motl, Sallis, et al., 2005; Dishman, Motl, Saunders, et al., 2005). Enjoyment and perceived competence have been the physical activity correlates most studied as intrinsic motives for participation (Sallis et al., 2000; Van Der Horst et al., 2007), but how self-determined motives to be a physically active person develop within social contexts of leisure time has received little study using standardized measures and prospective cohorts in youths (Standage, Gillison, Ntoumanis, & Treasure, 2012), particularly during the transition into early adolescence (Taylor, Ntoumanis, Standage, & Spray, 2010) when self-identities are especially malleable.

Very few studies have examined whether the aforementioned variables can be measured and similarly help explain physical activity change, among younger girls and boys (e.g., Garcia et al., 1998; Saunders et al., 1997). Moreover, the accumulated evidence on these variables among children and youths has been weakened by two key methodological limitations. First, physical activity has been measured in most studies by questionnaire or interview (Hagger & Chatzisarantis, 2009; Kriemler et al., 2011; Van Der Horst et al., 2007; van Sluijs et al., 2011), which can inflate relations between physical activity and children's beliefs about physical activity by a common method artifact of self-report (Dishman, Dunn, Sallis, et al., 2010). There is current agreement that accelerometers provide a preferred method for the objective measurement of physical activity in children and youths (Strath, Pfeiffer, & Whitt-Glover, 2012). Second, investigators, with few exceptions, did not provide evidence to demonstrate the measurement equivalence of the psychometric scales across time and between boys and girls who differ in age, race/ethnicity, or body mass index (BMI) (Dishman, Hales, Sallis, et al., 2010; Hagger et al., 2007), factors that might confound or modify associations of beliefs and motives with physical activity. For example, perceptions of physical activity barriers or efficacy beliefs for overcoming them, as well as enjoyment of physical activity and feelings of competence at physical activities, might change with age or differ according to gender, body fatness, or to race and ethnicity because of cultural values that affect the meaning of beliefs and motives about physical activity or because of different experiences with physical activity during the transition between elementary and middle schools, which is a developmental milestone. Physical activity beliefs and motives have been understudied in boys (Garcia, Pender, Antonakos, & Ronis, 1998; Hearst, Patnode, Sirard, Farbakhsh, & Lytle, 2012; Saunders et al., 1997; Van Der Horst et al., 2007); therefore, it is not known whether available measures are equivalent between boys and girls of the same ages. Without evidence for measurement equivalence, differences in scores on self-report measures between those groups, and across time, might reflect differences in the measurement properties of the self-report instrument (e.g., different meanings of the items or their relative importance to the construct) rather than true differences in the latent variable (MacKinnon, Fairchild, & Fritz, 2007). Invariance across time also supports the construct validity of measures (Bagozzi & Yi, 1993).

Here, we report on the factorial validity, multi-group and longitudinal measurement equivalence/invariance (MEI), and construct validity of scales developed to assess selected social-cognitive beliefs and intrinsic and extrinsic motives for physical activity participation in diverse samples of fifth and sixth grade boys and girls. We tested the hypothesis that the scales would demonstrate measurement equivalence across time between boys and girls, between those were normal weight and overweight, and between non-Hispanic white and black children. There were too few Hispanic students for trustworthy comparison. We also hypothesized that the variables would be related to physical activity measured objectively by an accelerometer and would conform to discriminant and convergent relationships consistent with their theoretical conceptions. For example, we hypothesized that self-efficacy would have positive relations with competence, fitness, and enjoyment motives but an inverse relation with perceived barriers. Thus, we also expected perceived barriers to be inversely related to competence, fitness, and motives. Parental support was expected to be positively related to self-efficacy and competence motive but inversely related to perceived barriers. We also hypothesized that motives would be interrelated with the exception of appearance, which was expected to also be unrelated to self-efficacy, parental support, and perceived barriers. Students were participants in baseline and second-year assessments for the Transitions and Activity Changes in Kids study, a prospective cohort study of children's physical activity during the transition from elementary school through middle school.

Methods

Participants

The multi-ethnic sample included fifth grade boys ($n = 501$) and girls ($n = 580$) (mean age: 10.5, $SD = 0.50$) and sixth grade boys ($n = 464$) and girls ($n = 547$) (mean age: 11.5, $SD = 0.50$) recruited from elementary and middle schools located in two school districts in South Carolina. Fourteen of the 17 elementary schools and all seven middle schools in one district and all seven elementary and all six middle schools in the other district agreed to participate. Active consent and assent forms were sent home with students, and completed forms were returned to the schools. No student who volunteered was excluded because of limited English-language skills or ability to participate in testing because of a medical condition or disability. Samples in each school ranged from 11 to 178 students (mean = 51, median = 46) in elementary schools and 6–172 students (mean = 78, median = 73) in middle schools. The participants represented a mean of 60% (range = 44–95%, median = 59%) of the schools' student population during recruitment. The race/ethnicity proportions were approximately the following: 36% non-Hispanic black, 37% non-Hispanic white, 10% Hispanic/Latino, 3% Asian/Pacific Islander, 2% American Indian, and 12% multi-racial. The samples were not randomly selected, but their gender and race/ethnicity were generally representative of the school populations. (kg/m^2) (mean ± SD) was higher ($p < .001$) in girls (21.6 ± 5.0; 22.31 ± 5.4) than boys (20.6 ± 4.7; 21.2 ± 4.9) in fifth and sixth grades, respectively; 43–45% of boys and 48–49% of girls had a BMI ≥85th percentile based on sex-specific BMI-for-age growth charts published by the Centers for Disease Control and Prevention (Kuczmarski et al., 2002).

Data Collection Procedures

All measurement protocols were reviewed and approved by the institutional review board. Data collection procedures were carried out at each school according to a manual of procedures by a trained measurement team during two visits with each participant. During the first visit, participants completed the student questionnaire, had anthropometric measurements taken, and received the accelerometer. During the second visit, participants returned the accelerometer, completed a physical activity recall, and completed a dietary screener. Participants entered all self-administered questionnaire responses into a survey software database on laptop computers. Participants completed the measures as part of small groups (≤24 students), at times and locations determined by each school. Data collection documents were pre-labeled before field use with a unique identification number for each student.

Measures

Each student responded to two questions about race/ethnicity. The first asked whether the student thought of himself/herself as Hispanic or Latino. The second asked about student's self-identification as American Indian or Alaskan Native, Black/African American, Native Hawaiian or other Pacific Islander, White, Asian, or other (e.g., multi-racial). Height and weight were each assessed with two trials using a Shorr height board and a Seca Model 880 weight scale. Height measurements were repeated and averaged if the difference between the two measurements was >1 cm. Weight measurements were repeated if the difference was >0.5 kg. BMI was expressed as kg/m^2 and as percentiles and standardized scores (BMz) based on Centers for Disease Control and Prevention growth charts. Students were evaluated in their bare feet or wearing socks after removing all excess clothing and any heavy accessories.

A student questionnaire was developed for the purpose of measuring the putative mediators and moderators of change in physical activity consistent with prior studies with fifth grade boys and girls and sixth grade girls (Saunders et al., 1997) and sixth and eighth grade girls (Dishman, Motl, Sallis, et al., 2005; Dishman, Hales, Sallis, et al., 2010). Items were rated by the students using a four-point ordered response format, except for perceived parental support, which used a five-point ordered format.

Self-Efficacy. Efficacy beliefs about overcoming barriers to physical activity was measured using an eight-item questionnaire developed for use with fifth grade boys and girls and respecified for use with sixth and eighth grade girls (Dishman et al., 2002; Motl et al., 2000; Saunders et al., 1997). The test–retest stability has approximated 0.84 across 2 weeks (Dishman, Motl, Sallis, et al., 2005) and 0.40 across 2 years (Dishman, Hales, Sallis, et al., 2010).

Perceived Barriers. The nine-item version of a measure developed for the Trial of Activity in Adolescent Girls study was used. It comprises three 3-item scales for assessing obstacles, evaluation, and outcomes as barriers to physical activity (Dishman, Hales, Sallis, et al., 2010). The test–retest stability of the measure has approximated 0.77 across 2 weeks (Dishman et al., 2005) and 0.43 across 2 years.

Motives for Physical Activity. A 30-item measure was used consisting of five scales for intrinsic (enjoyment, seven items; competence, seven items) and extrinsic (fitness, five items; appearance, six items; social, five items) incentives for participation in physical activities (Deci & Ryan, in press) consistent with self-determination theory (Ryan & Deci, 2007) and modified here for reading level. Evidence for the factorial validity of the scales has been reported, along with relations of the scales with various behavioral outcomes in young adults, such as attendance, persistence, or maintained participation in some sport or exercise activity (Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997).

Parental Support. Five items from the student survey of the Amherst Health and Activity Study (Sallis, Taylor, Dowda, Freedson, & Pate, 2002), previously validated for use in the Trial of Activity in Adolescent Girls study, were used to assess children's perception of support for physical activity provided by parents or guardians (Dishman, Hales, Sallis, et al., 2010). The 2-year stability was 0.53.

Physical Activity Assessed by Accelerometer. Physical activity was measured using Actigraph accelerometers (MTI model 7164, Fort Walton Beach, FL). Each child wore an accelerometer during waking hours for 7 consecutive days, except while bathing, swimming, or sleeping. Accelerometer data were collected and stored in 60-s epochs and reduced using methods previously described (Catellier et al., 2005). MVPA was expressed as MET minutes (one MET minute of MVPA represents a metabolic equivalent of energy expended for 1 min at an intensity of four times resting metabolic rate or higher). An age-specific prediction equation (Freedson, Pober, & Janz, 2005) generalized to the mean age in the Transitions and Activity Changes in Kids cohort was used to weight MVPA according to graduated intensities >4 METS (MET-weighted minutes). This was the primary measure of physical activity used for analysis. METs for MVPA were then summed for the entire day to provide MET • min/day and MET-weighted • min/day each averaged across 6 days. Data for Sunday were excluded from analysis because of poor wear rates and low reliability. In all, 80% of children provided accelerometer data for ≥8 hrs of daily wear on ≥4 days, representing 77% of the total records possible on Monday through Saturday. Missing values for children with at least 2 days of ≥8 hrs of wear each day were estimated using Proc MI in SAS (Version 9.0, SAS Institute, Inc., Rockville, MD). Reliability (ICC-2) across the 6 days (ICC-2) was 0.83 (boys, 0.80; girls, 0.80) in fifth grade and 0.84 (boys, 0.83; girls, 0.75) in sixth grade. The test–retest stability (ICC-2) between the fifth and sixth grades was 0.57 (boys, 0.44; girls, 0.53).

Data Analysis

Confirmatory factor analysis (CFA) and structural equation models were tested using maximum likelihood estimation with robust standard errors (MLR) and full information imputation in M*plus* 7.0 (Byrne, 2012; Muthén & Muthén, 1998–2012). Mardia's coefficient of multivariate kurtosis was significant, indicating violations of multivariate normality for each scale except social motive (Mardia, 1970). MLR uses a Huber-White sandwich estimator to give robust estimates adjusted for kurtosis with up to 25% missing data (Enders & Bandalos, 2001). The MLR chi-square (χ^2) test statistic is asymptotically equivalent to the Yuan and Bentler (2000) T2* test statistic. Internal consistency of each scale was estimated by factor reliability (Bollen, 1989). There was 2.7% missing data (1,679 of 62,698 questionnaire responses). Covariances could be computed for >98% of responses for self-efficacy, perceived barriers, motives, and physical activity variables and >75% of responses for perceived parental support items. Final factor models were adjusted for nesting effects of students within schools by correcting the standard errors of the parameter estimates for between-school variance using the Huber-White sandwich estimator (Muthén & Muthén, 1998–2012). Group comparisons on observed variables were made using IBM SPSS Statistics version 19.0.

Model Fit

The χ^2 statistic, comparative fit index (CFI), root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR) were used to evaluate and compare model fit (Bollen, 1989; Hu & Bentler, 1999). The χ^2 statistic assesses absolute fit of the model to the data. It is very sensitive to sample size and suggests rejection of the hypothesized model in most cases (Bollen, 1989). For this reason, it is not used alone to judge model fit (Hu & Bentler, 1999). The CFI tests the proportionate improvement in fit by comparing the specified model with a freely estimated baseline model. Values of 0.90 were judged to be acceptable, whereas values ≥ 0.95 indicated good fit. The RMSEA represents closeness of fit of population data to the model and is one of the most informative fit criteria (Vandenberg & Lance, 2000). Values of the RMSEA ≤ 0.06 and ≤ 0.08 indicate close and acceptable fit. Concurrent values ≥ 0.96 for CFI and ≤ 0.08 for SRMR provide optimal protection against type I and type II error rates, especially in sample sizes ≤ 250 (Hu & Bentler, 1999). Nested models were compared based on χ^2 difference tests adjusted by MLR scaling, $\Delta\chi^2$ (*df*), changes in the value of the CFI ($\Delta CFI \leq 0.01$) (Cheung & Rensvold, 2002), and overlap in the RMSEA point estimates and 90% CIs between two nested models (Vandenberg & Lance, 2000).

Factor Models. The factor validity of each scale was examined first by fitting the hypothesized model to the data using CFA. The measures of self-efficacy for overcoming barriers to physical activity and perceived parental support were hypothesized to represent single latent factors. Perceived barriers was hypothesized to include three correlated factors subordinate to a single second-order factor (Dishman, Hales, Sallis, et al., 2010), and the motives were hypothesized to represent five correlated single factor structures (Ryan et al., 1997).

If the hypothesized model was not supported, modification indices, standardized residuals, squared multiple correlations, and covariances between items were examined in a random hold out sample ($n = 500$) to determine whether misfit was a function of a problem item or the hypothesized factor structure (Anderson & Gerbing, 1988). The respecified model was then tested in the full sample. After establishing a good fitting model, the MEI of the model for each scale was examined between boys and girls, between overweight and normal weight students, and between non-Hispanic black and non-Hispanic white boys and girls by comparing a sequence of nested CFA models using standard procedures (Meredith, 1993; Vandenberg & Lance, 2000). Sample sizes were too small to provide stable parameter estimates for ethnicity or other racial groups. The baseline, configural model (M1) tested whether the pattern of indicator-to-factor relations were equivalent. Model 2 (M2) restricted paths from the factor(s) to the observed items (factor loadings). Model 3 (M3) tested equal factor variances/covariances. Model 4 (M4) constrained item intercepts (means) to be equal, and model 5 (M5) constrained item uniquenesses (errors) to be equal across groups. Equivalence of factor structure (configural invariance) and loadings (metric invariance) was considered sufficient for concluding weak factorial invariance across groups (Vandenberg & Lance, 2000). Longitudinal invariance was tested including auto-correlated errors to model measure specificity (Pitts, West, & Tein, 1996) for the cohort of students who completed measures in both the fifth and sixth grades ($n = 979$) to determine whether the measurement properties of the scales (i.e., stationarity) were equivalent across time between the student sub-groups. The stability coefficient (i.e., the correlation between factor scores) indicated whether participants had the same rank order of scores across time.

Construct Validity—Convergent and Discriminant Relationships

Three types of evidence were evaluated from intercorrelations among the variables using approaches derived from classical and contemporary methods. First, discriminant validity was supported when the square of an intercorrelation was less than the composite reliability of each variable (Fornell & Larcker, 1981). Second, nested models tested whether a model that specified the hypothesized discriminant or convergent relationships (positive and inverse) at unity worsened the fit of a baseline model of freely estimated relationships (ΔCFI > 0.01) (Anderson & Gerbing, 1988; Bagozzi & Yi, 1993). Supplementary Tables S7 and S8 indicate the specific discriminant (indicators 5 and 6) and positive (indicators 1, 3, and 4) and inverse (indicator 2) convergent relationships. Equal stability coefficients were also tested by a nested model. Third, the average correlations were tested between hypothesized convergent and discriminant relationships (Raykov, 2011).

Construct Validity—Structural Equation Measurement Model

A structural measurement model correlated with physical activity was also used to examine convergent and discriminant evidence for construct validity of the measures for boys and girls within a nomological network (Cronbach & Meehl, 1955) consistent with theories of self-efficacy (Bandura, 1997) and self-determination (Ryan & Deci, 2007; Ryan et al., 1997). Factor structures were specified and relations among the latent variables were freely estimated. Equivalence between gender or race was then tested using nested models that specified the path coefficients between physical activity and the beliefs and motives to be equal between boys and girls or between non-Hispanic black and white students ($\Delta\chi^2$, $p > .10$; ΔCFI < 0.01). Models were retested including BMIz and categorical variables of ethnicity (Hispanic/Latino vs. non-Hispanic/Latino) and race (non-Hispanic black vs. all others, non-Hispanic white vs. all others, and all others vs. non-Hispanic black and white groups) as covariates. Panel analysis also was used to examine relations in the sixth grade while adjusting for relations observed in the fifth grade (Bagozzi & Yi, 1993). Critical *z*-scores (parameter estimate/SE) were used to test significance of independent relations between variables ($p < .05$).

Results

Descriptive statistics for the variables are provided in Table I. Consistent with national estimates (Troiano et al., 2008), boys were more active in MVPA than girls, spending an average of 46 min each day in the fifth grade, compared with 28 min for girls. In all, 20% of boys and 4% of girls were active in MVPA an hour or more daily. By the sixth grade, daily MPVA dropped to 41 min for boys and 22 min for girls. In all, 17% of boys and 1% of girls were active in MVPA an hour or more daily. Multi-group longitudinal invariance tests are presented in Table II. To conserve space, the table contains the fit of the baseline model (all parameters free; M1) and the most constrained model judged to be invariant for each analysis (e.g., if factor loadings were invariant, but not the factor variance, M2 would be presented). At the least, configural (i.e., factor structure) and metric (i.e., factor loadings) invariance was supported in all multi-group analyses. Model fit for each scale and multi-group invariance tests in each grade presented separately for boys and girls, non-Hispanic black and non-Hispanic white students, and overweight and normal weight students is provided in Supplementary Materials (Supplementary Tables S3–S6).

Factor Models

Self-Efficacy

The hypothesized eight-item single factor model provided good fit to the data in the fifth grade (χ^2 (20) = 41.1, CFI = 0.981, RMSEA = 0.031 [0.017–0.045], SRMR = 0.024) and sixth grade (χ^2 (20) = 32.9, CFI = 0.987, RMSEA = 0.025 [0.007–0.040], SRMR = 0.022) samples. Factor loadings were 0.41–0.64. Model fit was good in boys and girls, non-Hispanic black and non-Hispanic white students, and in overweight and normal weight students in the fifth grade (CFI ≥ 0.964, RSMEA ≤ 0.044, SRMR ≤ 0.037) (Supplementary Table S3) and good or acceptable in the sixth grade (CFI ≥ 0.933, RSMEA ≤ 0.060, SRMR ≤ 0.037) (Supplementary Table S4). Factor reliability was 0.77–0.79. MEI was supported between sub-groups and across time (Table II and Supplementary Tables S5 and S6). Stability was 0.47, $p < .001$.

Perceived Barriers

The hypothesized model of three first-order factors subordinate to a second-order factor model (χ^2 (24) = 92.9, CFI = 0.845, RMSEA = 0.052 [0.041–0.063], SRMR = 0.040) had poor fit to the data. The obstacles sub-scale had a negative error variance because of co-linearity with the social evaluation sub-scale. A respecified, model of two correlated factors (social evaluation and outcomes; $r = .64$, $p < .001$) had acceptable fit in the total fifth grade sample (χ^2 (8) = 18.9, $p = .015$, CFI = 0.947, RMSEA = 0.036 [0.015–0.057], SRMR = 0.030). However, the model had poor fit for non-Hispanic black students (χ^2 (8) = 21.8, $p = 0.0053$, CFI = 0.822, RMSEA = 0.067 [0.034–0.102], SRMR = 0.045), mainly because of a low non-significant squared multiple correlation for item 6 (‘‘I don't like to sweat''), which also had a negative covariance with item 10 (‘‘it would make me tired''). Trimming item 6 left the outcomes sub-scale under-identified with two indicator items, but the respecified model (two correlated factors, $r = .55$, $p < .001$) had good fit (χ^2 (4) = 2.3, $p = .68$, CFI = 1.00, RMSEA = 0.000 [0.000–0.035], SRMR = 0.011) in the total sample and in sub-groups (Supplementary Table S3).

Table I. *Means (SD) of Variables for Fifth and Sixth Grade Boys and Girls*

	Boys		Girls	
Scale items	Fifth ($n = 501$)	Sixth ($n = 464$)	Fifth ($n = 580$)	Sixth ($n = 547$)
Self-efficacy	3.29 (0.50)	3.27 (0.51)	3.22 (0.56)	3.17 (0.54)
Barriers				
Evaluation	1.46 (0.47)	1.42 (0.50)	1.53 (0.51)	1.49 (0.47)
Outcomes	1.87 (0.63)	1.88 (0.63)	1.94 (0.62)	1.96 (0.64)
Parental support	3.44 (0.96)	3.33 (0.90)	3.31 (0.91)	3.20 (0.99)
Motives				
Enjoyment	3.60 (0.50)	3.64 (0.55)	3.56 (0.55)	3.52 (0.66)
Competence	3.52 (0.51)	3.52 (0.60)	3.42 (0.58)	3.39 (0.68)
Appearance	3.17 (0.77)	3.19 (0.79)	3.00 (0.81)	3.00 (0.84)
Fitness	3.70 (0.47)	3.67 (0.49)	3.68 (0.49)	3.62 (0.50)
Social	3.08 (0.75)	3.17 (0.77)	3.00 (0.74)	3.08 (0.80)
Physical activity (MVPA)				
MET-weighted • min/day	251 (159)	224 (153)	153 (91)	121 (91)
MET • min/day	46 (25)	41 (23)	28 (14)	22 (12)

Factor loadings were 0.44–0.61. Factor reliability was 0.43 for social evaluation and 0.48 for outcomes. The respecified model of two correlated factors ($r = .61$, $p < .001$) also had good fit in the sixth grade sample (χ^2 (4) = 6.0, $p = .20$, CFI = 0.995, RMSEA = 0.022 [0.000–0.056], SRMR = 0.014). Factor loadings were 0.37–0.65. Factor reliability was 0.48 for social evaluation and 0.58 for outcomes.

This revised model had good fit in boys and girls and non-Hispanic black, non-Hispanic white boys and girls, and in overweight and normal weight students (CFI ≥ 0.95, RMSEA ≤ 0.046, SRMR ≤ 0.025) in both fifth (Supplementary Table S3) and sixth (Supplementary Table S4) grades. MEI was supported between sub-groups and across time (Table II and Supplementary Tables S5 and S6). Stability coefficients were equivalent across scales ($\Delta\chi^2$ (1) = 0.78, $p = .378$; ΔCFI = 0.000): 0.56 for evaluation barriers and 0.44 for outcome barriers, $p < .001$.

Motives for Physical Activity

A theorized model of five correlated factors did not have adequate fit to the data (χ^2 (395) = 1443.8, CFI = 0.861, RMSEA = 0.050 [0.047–0.052], SRMR = 0.064). Several items having similar content had large covariance values or cross-loaded on other factors: Enjoyment (‘‘I think it’s interesting’’; ‘‘I like the excitement of participating’’; ‘‘I find this activity stimulating’’), Competence (‘‘I want to keep up my current skills’’; ‘‘I like physical challenges’’; ‘‘I like to do activities that are physically challenging’’), Fitness (‘‘I want to improve my fitness’’; ‘‘I want to have more energy’’), and Social (‘‘because I want to be with my friends’’; ‘‘because my friends want me to’’). A respecified model that excluded those items had acceptable fit (χ^2 (160) = 419.7, CFI = 0.943, RMSEA = 0.039 [0.034–0.043], SRMR = 0.047), which was better than a model that specified the five factors as subordinate to a second-order factor (χ^2 (165) = 549.4, CFI = 0.916, RMSEA = 0.046 [0.042–0.051], SRMR = 0.069). The respecified model also had acceptable fit in the sixth grade sample (χ^2 (160) = 485.3, $p < .001$, CFI = 0.949, RMSEA = 0.045 [0.040–0.049], SRMR = 0.058).

Factor loadings ranged from were 0.39 to 0.84 with a mean of 0.68. Factor reliabilities in fifth and sixth grades were as follows: Enjoyment (0.74 and 0.82), Competence (0.70 and 0.79), Appearance (0.86 and 0.89), Fitness (0.68 and 0.70), and Social (0.62 and 0.72). Factor correlations in fifth and sixth grades were all significant ($p \leq .04$ and .01), averaged 0.53 and 0.50, and ranged from 0.102 and 0.095 (appearance with enjoyment) to 0.846 and 0.875 (competence with enjoyment).

This revised model fit acceptably in boys and girls and non-Hispanic black, non-Hispanic white boys and girls, and in overweight and normal weight students (CFI ≥ 0.93, RMSEA ≤ 0.047, SRMR ≤ 0.055) in the fifth and sixth grades (Supplementary Tables S3 and S4). MEI was supported between sub-groups and across time (Table II and Supplementary Tables S5 and S6). Stability coefficients were equivalent across scales ($\Delta\chi^2$ (4) = 2.49, $p = .646$; ΔCFI = 0.000): 0.45 for enjoyment; 0.54 for competence; 59 for appearance; 0.50 for fitness; and 0.57 for social, $p < .001$.

Parental Support

The model fit for the five-item, single factor parental support scale was acceptable, but not good (χ^2 (5) = 29.7, CFI = 0.929, RMSEA = 0.076 [0.051–0.104],

Table II. *Cohort and Multi-Group Longitudinal Invariance Tests*

Scale/grade	Model	χ^2	*df*	χ^2 Δ *p*-value	CFI	RMSEA (90% CI)	SRMR
Cohort							
Self-efficacy	M1	136.2	95		0.983	0.021 (0.012–0.029)	0.025
	M3	141.4	102	.82	0.984	0.020 (0.011–0.027)	0.027
Perceived barriers	M1	32.4	24		0.990	0.019 (0.000–0.034)	0.020
	M4	45.7	35	.26	0.988	0.018 (0.000 –0.031)	0.032
Motives	M1	1391.6	675		0.942	0.033 (0.030–0.035)	0.049
	M2	1443.6	690	.001	0.939	0.033 (0.031–0.036)	0.053
Parental support	M1	22.5	15		0.997	0.024 (0.000–0.043)	0.018
	M3	28.0	19	.56	0.996	0.023 (0.000–0.040)	0.029
Multi-group gender							
Self-efficacy	M1	250.8	190		0.976	0.026 (0.016–0.034)	0.034
	M3	285.6	213	.06	0.971	0.026 (0.018–0.034)	0.055
Perceived barriers	M1	57.8	48		0.990	0.020 (0.000–0.038)	0.026
	M2	77.2	57	.02	0.980	0.027 (0.007–0.041)	0.034
Motives	M1	2359.0	1350		0.922	0.039 (0.036–0.042)	0.055
	M2	2453.9	1395	.001	0.918	0.039 (0.037–0.042)	0.064
Parental support	M1	36.3	30		0.998	0.022 (0.000–0.044)	0.024
	M3	50.2	43	.39	0.997	0.020 (0.000–0.039)	0.058
BMI							
Self-efficacy	M1	236.4	190		0.981	0.022 (0.011–0.031)	0.035
	M3	262.3	213	.31	0.980	0.022 (0.011–0.030)	0.050
Perceived barriers	M1	51.2	48		0.996	0.012 (0.000–0.032)	0.025
	M2	64.4	57	.24	0.991	0.016 (0.000–0.034)	0.032
Motives	M1	2180.3	1350		0.934	0.035 (0.033–0.038)	0.054
	M2	2287.6	1395	.001	0.929	0.036 (0.033–0.039)	0.063
Parental support	M1	48.0	30		0.994	0.037 (0.015–0.056)	0.028
	M3	68.5	43	.09	0.991	0.037 (0.019–0.052)	0.045
Race							
Self-efficacy	M1	239.3	190		0.972	0.027 (0.014–0.037)	0.038
	M3	269.4	213	.14	0.968	0.027 (0.016–0.037)	0.053
Perceived barriers	M1	42.7	48		1.00	0.000 (0.000–0.028)	0.027
	M2	59.5	57	.05	0.996	0.011 (0.000–0.035)	0.035
Motives	M1	2154.3	1350		0.919	0.041 (0.038–0.044)	0.058
	M2	2211.6	1395	.06	0.918	0.040 (0.037–0.044)	0.065
Parental support	M1	33.8	30		0.998	0.020 (0.000–0.048)	0.028
	M3	49.6	43	.23	0.996	0.022 (0.000–0.045)	0.059

SRMR = 0.023). The items 4 (''encouraged me'') and 5 (''did physical activity with me'') had a large covariance. Based on this covariance, squared multiple correlations, and a significant modification index, item 4 was removed. The revised four-item model fit the data well in the fifth grade (χ^2 (2) = 4.2, CFI = 0.997, RMSEA = 0.036, [0.000–0.085], SRMR = 0.010) (Table III) and had good fit in the sixth grade (χ^2(2) = 10.1, CFI = 0.992, RMSEA = 0.071, [0.032–0.117], SRMR = 0.013). Factor loadings were 0.71–0.83. Factor reliability was 0.86–0.89. MEI was supported between sub-groups and across time (Table II and Supplementary Tables S5 and S6). Stability was 0.61, $p < .001$.

Construct Validity—Convergent and Discriminant Relationships

Correlations between latent variables exhibited convergent and discriminant relationships consistent with the conceptual basis of their latent constructs. See Supplementary Tables S7 and S8. First, the squared inter-correlations among the latent variables were less than the composite reliability of each variable, supporting discriminant validity. The highest squared inter-correlations were between enjoyment and competence motives in the fifth and sixth grades (0.65 and 0.77), but the corresponding composite reliabilities were 0.74 and 0.82 for enjoyment and 0.70 and 0.79 for competence. Evaluation and outcome barriers had the lowest composite reliabilities (0.43–0.58) but had no squared inter-correlation with other variables that exceeded 0.20. Second, convergent relations among theoretically linked variables were generally consistent in each grade. Self-efficacy had positive relations with competence, fitness, and enjoyment but inverse relations with perceived barriers, which were also inversely related to enjoyment, competence, and fitness. Fitness and appearance motives were related. Parental support was positively related to self-efficacy and competence motive, and inversely related to perceived barriers. The intrinsic motives, enjoyment, and competence motives were more strongly related, as were the extrinsic appearance, social, and fitness motives. Competence was also related to enjoyment and social motives. As hypothesized, appearance motive was unrelated to self-efficacy, enjoyment, parental support, and perceived barriers, which were also unrelated to fitness and social motives. Statistical fit was similar between a baseline model of freely estimated relationships and nested models that specified the positive or inverse convergent relationships and discriminant relationships at unity in the fifth and sixth grades (ΔCFI $\leq$ 0.01) (see Supplementary Tables S7 and S8). Third, relations were stronger (mean *r*, 95% CI) for positive (.520, 0.490–0.550) and inverse (−.327, −0.373 to −0.281) convergent relationships than for discriminant relationships (−.030, −0.318 to 0.258) in the fifth grade and in the sixth grade (.546, 0.505 to 0.586) and (−.277, −0.323 to −0.232) vs. (.125, −0.141 to 0.347). Compared with the discriminant relationships (mean difference, 95% CI), the correlations were higher for positive convergent relationships: fifth (.538, 0.488 to 0.588) and sixth (.542, 0.489 to 0.595) grades. They were lower for inverse convergent relationships: the fifth (−.297, −0.570 to −0.024) and sixth (−.402, −0.615 to −0.188) grades.

Construct Validity—Structural Equation Measurement Model

In fifth grade, the hypothesized structural measurement model had acceptable fit (χ^2 (621) = 1224.8, CFI = 0.929, RMSEA = 0.031 [0.029–0.034], SRMR = 0.042). Physical activity was related to self-efficacy (β = 0.190, *SE* = 0.053, $p < .001$), evaluation barriers (β = −0.178, *SE* = 0.053, $p = .001$), parental support (β = 0.125, *SE* = 0.052, $p = .016$), enjoyment (β = 0.152 *SE* = 0.042, $p < .001$), and competence (β = 0.118, *SE* = 0.062, $p = .05$). Multi-group models had acceptable fit between boys and girls (χ^2 (1243) = 2107.5, CFI = 0.903, RMSEA = 0.037 [0.035–0.040], SRMR = 0.053) and between non-Hispanic black and white students (χ^2 (1243) = 174.2, CFI = 0.918, RMSEA = 0.035 [0.031–0.038], SRMR = 0.055). Nested models indicated that the path coefficients between physical activity and the beliefs and motives were not different according to gender or race ($\Delta\chi^2$, $p > .10$; Δ CFI < 0.01). Results were not substantively changed after including BMIz in the models. Bivariate relations of the variables with physical activity and BMIz are provided in Supplementary Table S9.

The hypothesized model also had acceptable fit in the sixth grade (χ^2 (621) = 1248.4, CFI = 0.938, RMSEA = 0.034 [0.032–0.037], SRMR = 0.047). Physical activity was related to self-efficacy (β = 0.208, *SE* = 0.037, $p < .001$), evaluation barriers (β = −0.212, *SE* = 0.047, $p < .001$), outcome barriers (β = −0.126, *SE* = 0.036, $p < .001$), parental support (β = 0.166, *SE* = 0.052, $p = .001$), enjoyment (β = 0.108, *SE* = 0.035, $p = .002$), and competence (β = 0.107, *SE* = 0.037, $p = .004$). Multi-group models had acceptable fit between boys and girls (χ^2 (1243) = 2191.9, CFI = 0.911, RMSEA = 0.042 [0.039–0.045], SRMR = 0.057) and between non-Hispanic black and white students (χ^2 (1243) = 2006.8, CFI = 0.910, RMSEA = 0.044 [0.041–0.048], SRMR = 0.059). Nested models indicated that the path coefficients between physical activity and the beliefs and motives were not different according to gender or race ($\Delta\chi^2$, $p > .10$; Δ CFI < 0.01). Results were not substantively changed after including BMIz in the models. The sixth grade panel model that adjusted for fifth grade relations in the longitudinal cohort had similar fit (χ^2 (1,161) = 1744.6, CFI = 0.945, RMSEA = 0.025 [0.023–0.028], SRMR = 0.042) and is shown in Figure 1.

Discussion

The results confirm the factorial validity and the multi-group and longitudinal invariance (at least equal structure and factor loadings) of revised self-report scales used to measure motives and social-cognitive beliefs that are putative mediators of change in physical activity in large samples of racially/ethnically diverse fifth and sixth grade boys and girls. Consistent with prior findings in girls in the sixth, eighth, and ninth grades (Dishman, Dunn, Sallis, et al., 2010; Dishman, Motl et al., 2005), physical activity measured here objectively was related to self-efficacy, perceived barriers, parental support, and enjoyment motive among girls and boys in the fifth or sixth grades. Moreover, the cross-sectional and longitudinal relationships found here between competence motive and an objective measure of physical activity extends previous evidence on perceived competence from a longitudinal study of adolescents (Standage et al., 2012) and from

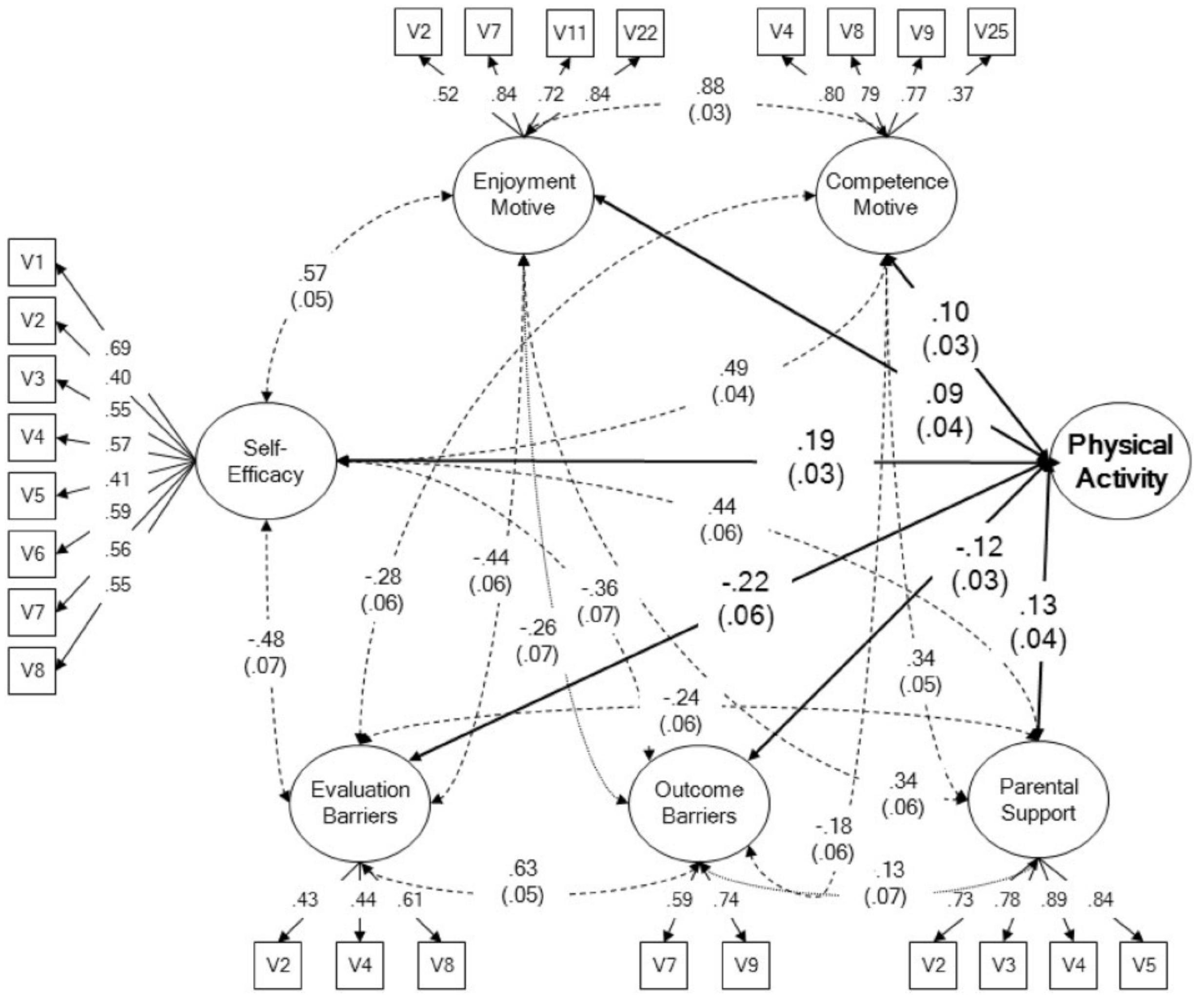

Figure 1. Standardized correlations (SE) between latent constructs and physical activity in the sixth grade cohort adjusted for relations in fifth grade. Broken lines indicate intercorrelations among the constructs.

cross-sectional studies of children that have been limited to a self-reported physical activity (Van Der Horst et al., 2007).

The general pattern of inter-correlations among the scale scores and their relationships with an objective measure of physical activity added discriminant and convergent evidence for the construct validity of the scales. However, among the motives, only enjoyment and competence were related to physical activity, implying that physical activity interventions during the transition between fifth and sixth grades should target these motives. The stability of factor scores between grades (i.e., the extent to which students' rank order of scores stayed the same across time) was moderately high but indicated a considerable amount of naturally occurring change, indicating that the measured variables are feasible targets for intervention. A successful intervention with adolescent girls increased self-reported physical activity concomitant with increased self-efficacy for overcoming barriers, enjoyment of physical activity, and increased goal setting, but the intervention effect was not mediated by goal setting, which did not specify goal content (Dishman et al., 2004). The present results showed no association between objectively measured physical activity and fitness, health, and social motives. Hence, the findings suggest that goal-setting interventions with children in elementary and early middle school might be more effective if they focus on goals related to intrinsic motives of fun and physical competence, using developmentally appropriate physical activities that are not restricted to fitness (Strong et al., 2005).

The revised scales demonstrated equivalent factor structure and at least invariant factor loadings between boys and girls, between non-Hispanic black and white students, and between overweight and normal weight students across 1 year. Hence, the scales provide a technology for assessing cross-sectional and longitudinal differences in selected social-cognitive beliefs and motives for physical activity among fifth and sixth grade boys and girls, including non-Hispanic black and white students, regardless of their BMI. The results extend earlier findings among sixth grade girls (Dishman, Hales, Sallis, et al., 2010) to support valid assessment of self-efficacy, perceived barriers, and perceived parental support in fifth and sixth grade boys. Unlike earlier findings for sixth grade girls, perceived barriers were best measured as two (social evaluation and outcomes barriers), rather than three (the time barrier scale was not confirmed), correlated factors. Because the outcomes barriers factor was underspecified by just two indicator items, further research on barriers seems necessary in other groups of this age. We provide here the initial evidence of factor validity for self-ratings of extrinsic and intrinsic motives for participating in physical activity. Follow-up studies are needed to examine whether the goal contents of these motives conform to hypothesized components of autonomous and controlled regulation of physical activity in children, as has been proposed and studied in adults (Teixeira, Carraça, Markland, Silva, &, Ryan, 2012).

Construct validation is an evolving process that involves the evaluation and respecification of external structure, tests of stationarity and growth over time, and relations with external criteria or other variables within nomological networks stipulated by theory (Messick, 1989; Nunnally, 1978). The use of CFA to test hypothesized structures is an important aspect of building evidence for the validity of scores derived from the items, whereas correlations of the scale scores with an objective measure of physical activity, independently of BMI, provides an important external criterion for the validity of the scales. New studies will be needed to determine whether the respecified models generalize to other samples and demonstrate MEI across years beyond the sixth grade, when children's motives for physical activity and their efficacy beliefs and perceptions of barriers and parental support may change. Without a valid measurement technology, the importance of children's beliefs and motives about physical activity cannot be identified and interventions designed to change physical activity by targeting these factors as mediators of change cannot be accurately evaluated.

A strength of the study is the racial diversity of the sample, including non-Hispanic black girls and boys, who have been understudied. A substantial number of Hispanic/Latino boys and girls were also sampled, but not enough to permit strong analysis of factor structure or MEI. A weakness of the study is the poor representation of other racial/ethnic populations. Another weakness is the absence of child-level measures of socio-economic status; therefore, we cannot conclude that the scales have measurement equivalence/invariance and relations with physical activity across levels of social resources, independently of race/ethnicity. Also, measures were not assessed in a random or counterbalanced manner, which might alter relations among the measures and inflate factor reliabilities. We conclude that the scores from these revised scales can provide valid assessments of motives, as well as some perceived barriers to physical activity, self-efficacy for overcoming such barriers, and parental support of physical activity. These putative moderators or mediators of change in physical activity can be used in observational studies of naturally occurring change or interventions designed to increase physical activity during early adolescence among boys and girls as they transition from the fifth grade to middle school.

Supplementary Data

Supplementary data can be found at: http://www.jpepsy.oxfordjournals.org/

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