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Exercise can improve physical self perceptions in adolescents with low motor competence

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Abstract

Adolescents with low motor competence have diminished perceptions of their physical self and tend to avoid physical activities. This study examined the outcomes of an exercise intervention that focused on improving aerobic fitness, strength, and self-perceptions in the physical domain in adolescents with poor motor coordination. The sample included 35 adolescents with low motor competence, comprising boys (n = 25) and girls (n = 10) ranging in age from 13 to 17 years, who attended two sessions per week in the 13 week exercise intervention study (AMP it up). Physical self-perceptions were measured before and after the intervention using the Physical Self Perception Profile and Perceived Importance Profile. Significant improvements in perceived Physical Condition, Attractive Body and Physical Strength sub domain scores were identified between pre and post-test. Adjusting for age, gender, BMI and attendance, regression analyses revealed that Attractive Body was the strongest predictor of Physical Self Worth at pre-test, joined by Physical Condition at post-test. This exercise intervention had a positive impact on adolescent physical self-perceptions, in particular males, with improvements in those sub domains specifically related to the exercise program. Changes in specific aspects of Physical Self Worth can be facilitated by exercise interventions, after a relatively short period of time, in adolescents with poor motor coordination.

Highlights

- Exercise can lead to improved physical self perceptions in males with low motor competence
- Perceived body image contributes to Physical Self Worth in adolescents with low motor competence
- Sport competence is not perceived as important by adolescents with low motor competence

Keywords (max 6)

Exercise program, Developmental Coordination Disorder (DCD), motor competence, intervention, physical self perceptions, gender.

1. **Introduction**

Young people's perceptions and self worth of their physical competence are important correlates of physical activity participation (Crocker, Eklund, & Kowalski, 2000). Children and adolescents with more positive physical self perceptions are more likely to be motivated to participate in a physically active lifestyle (Raudsepp, Liblik, & Hannus, 2002). Furthermore, an individual's perceived competence in physical domains is a key component of intrinsic motivation including choosing to participate, sustaining effort and continuing interest in task or activities (Duda, Chi, Newton, Walling, & Catley, 1995). Adolescents with low motor competence sufficient to influence performance across daily tasks, may be at particular risk of low physical self-perceptions and self-worth. The term DCD (Cairney, Hay, Faught, & Hawes, 2005; Piek, Barrett, Allen, Jones, & Louise, 2005) may be used to define this particular group, even though all criteria for the disorder (APA, 2013) are not measured. Due to the frequency of co-occurring conditions and difficulty with measuring all criteria for the disorder (APA, 2013), we have chosen to use the term low motor competence to describe the sample in this paper.

Competence in the physical domain is positively associated with physical activity and sport participation and is important for social status and peer acceptance, particularly in adolescence (Cratty, 1994; Mandich, Polatajko, & Rodger, 2003). In order to buffer the impact of poor motor competence in their lives, individuals with low motor competence are likely to discount physical activity and exercise as an area of importance in their lives and avoid participation in physical activities (Skinner & Piek, 2001).

Numerous studies have found that children and adolescents with low motor competence have poorer physical health outcomes such as lower physical fitness (Hands & Larkin, 2006), and many experience secondary difficulties and additional stressors such as less social support and friendships (Skinner & Piek, 2001; Smyth & Anderson, 2000) which may lead to anxiety, depression and emotional problems (Cairney, Rigoli, & Piek, 2013; Piek et al., 2007; Sigurdsson, Os, & Fombonne, 2002; Skinner & Piek, 2001), lower self-perceptions, self worth and poor perceived competences (Cantell, Smyth, & Ahonen, 1994;

Rose, Larkin, & Berger, 1997). These studies mostly involved primary school aged children. The experience of adolescents with low motor competence is largely under researched as in the past it was believed they would outgrow their problems (Missiuna, Gaines, Soucie, & McLean, 2006). It is now recognized from longitudinal studies that motor coordination problems continue into adolescence and beyond (Cantell et al., 1994; Losse et al., 1991) and some evidence suggests that problems in the psychosocial domain become more evident in adolescence (Skinner & Piek, 2001).

Consistent with the multi-dimensional and hierarchical model of self-esteem (Harter, 1999; Marsh, 1990; Shavelson, Hubner, & Stanton, 1976), Fox and Corbin (1989) developed a model to describe the physical self. This model considers that the domain of Physical Self Worth is formed through the contribution of four sub domains of physical self perceptions, including perceptions of Physical Condition, Sport Competence, Attractive Body and Physical Strength. The Physical Self-Perception Profile (PSPP) was developed to measure this domain (Fox & Corbin, 1989). Physical Self Worth is affected by physical activity participation (Fox, 1997) and is particularly important during adolescence (Ecklund & Bianco, 2000). The relative importance an individual places on each of the sub domains will impact overall Physical Self Worth and this appears to differ between males and females (Harter, 1999;Whitehead, 1995). Previous studies have consistently found that boys report higher self perceptions and physical self worth than girls (Crocker et al., 2000; Daley, 2002; Hayes, Crocker, & Kowalski, 1999). Both Crocker et al. (2000) and Daley (2002) found that boys also had significantly greater sport competence, physical strength, and attractive body sub domain scores than girls.

Studies designed to examine the effect of exercise programs on physical self-perceptions in typically-developing adolescents have found some significant, positive effects (Burgess, Grogan, & Burwitz, 2006; Lindwall & Lindgren, 2005), whereas others did not (Schneider, Dunton, & Cooper, 2008). For example, after a six month exercise intervention involving adolescent girls, Lindwall and Lindgren (2005) identified improved scores in three of the five sub domains measured by the PSPP; Sport Competence, Physical Condition, and

Physical Self Worth. Burgess et al. (2006) found that a six week aerobic dance intervention resulted in enhanced self-perceptions in 50 adolescent girls for the Attractive Body and Physical Self Worth sub domains. No studies were found that used an exercise intervention to improve physical self perceptions in adolescents with low motor competence.

The purpose of the current study was to investigate the impact of a 13 week individually tailored exercise intervention on self perceptions in the physical domain among adolescents with low motor competence. We hypothesised that participation in the exercise intervention would improve Physical Self Worth in these adolescents and improvements would also be found in the specific sub domains that linked to the focus of the intervention, primarily physical condition and strength. Further, these changes in self perceptions may differ between males and females.

2. Methods

This study assessed changes in physical self perceptions for adolescents with poor motor competence after a specially designed 13 week exercise intervention. The study was approved and conducted in accordance with the guidelines of the relevant institutional ethics committee.

2.1 Exercise Intervention

The participants were involved in AMPitup (Adolescent Movement Program) which is an ongoing fitness and strength training research program based in an Australian University exercise rehabilitation clinic, for adolescents with low motor competence, or with other conditions that involve movement difficulties, such as cerebral palsy and ASD. The program only accommodates 20-25 each semester, with participants continuing in the research program until they turn 18 years, or are deemed ready to graduate to other activities. Each session lasts 90 minutes and they are expected to attend twice per week for each 13 week University semester. Interventions offered only once per week are less likely to achieve fitness improvements (Stice, Shaw, & Marti, 2006).

As part of the program, each adolescent worked with an individual trainer (3rd year Exercise Science or Physiotherapy student) who prescribed and monitored their exercise. In

every session, participants completed five pre-set resistance exercises (leg press, chest press, bridge, curl-ups and ankle raises) and one 5-minute aerobic exercise of their choice (bike ergometer, rowing ergometer, cross trainer or recumbent bike) as well as a variety of other strength and conditioning exercises set by the trainer. Trainers, with the support of the program researchers, ensured that exercises matched individual capabilities to enable success and all participants received acknowledgement when they achieved personal fitness or strength goals (e.g. 10 minutes on the treadmill or a 2 minute bridge/plank). In this stable, predictable environment they could take control of their own bodies by exercising on equipment that constrains their limbs to move in efficient and effective patterns. For example, the pin-loaded strength training machines commonly found in fitness gymnasiums can be adjusted to accommodate individual differences in strength as well as height, and the design constrains task demands so that a specific muscle or muscle group can be exercised using a repetitive pattern.

2.2 Participants

The data reported in this paper were gathered from 35 adolescents (25 boys and 10 girls) with low motor competence, ranging in age from 13 to 17 years (mean age = 14.02 years) before and after their first 13 week block in the program. Participants were referred to the program through allied health professionals, school teachers, or friends. To be included in the intervention, participants needed a score below one SD (<85; mild-severe disability) of the mean Neuromuscular Developmental Index using the McCarron Assessment of Neuromuscular Development (McCarron, 1997), and/or a history of movement difficulties and the physical and mental capacity to participate. Parents completed a screening questionnaire regarding the participants' health history. As this is a research program there is no cost to families and participants, and they must consent to participate.

2.3 Measures

2.3.1 Motor competence.

Motor competence was measured with the McCarron Assessment of Neuromuscular Development (MAND), a recognised test to assess DCD (Blank, Smits-Engelman, Polatajko, & Wilson, 2012). It is one of the most commonly used tests of motor performance in Australia (Caeyenberghs, Tsoupas, Wilson, & Smits-Engelsman, 2009; Chia, Guelfi, & Licari, 2010; Hands, Larkin, Parker, Straker, & Perry, 2009; O'Beirne, Larkin, & Cable, 1994; Piek, Dawson, Smith, & Gasson, 2008; Raynor, 2001; Rose et al., 1997). The psychometric properties of the test have been reported in a large sample of Australian adolescents (Hands, Larkin, & Rose, 2013). The test involves five fine motor and five gross motor tasks and has good reliability and validity with this age group (McCarron, 1997). Test-retest reliability coefficients of the MAND tasks are reported at 0.99 overall (McCarron, 1997) and researchers have found the MAND to be a reliable indicator of motor coordination in Australian children (Hoare & Larkin, 1990). Validity of the MAND as a measure of motor competence was also established in research that directly compared it to two other commonly used motor coordination tests, Bruininks Oseretsky Test of Motor Proficiency and Movement ABC (Tan, Parker, & Larkin, 2001). Raw scores are awarded based on absolute qualitative and quantitative performance in each test item, which are scaled to the participants' age according to conversion tables (3.5 years to adult). These scores are summed to yield a total overall scaled score which is converted to a Neuromuscular Development Index (NDI) score. This score has a normal distribution, with a mean of 100 and a standard deviation of 15 (McCarron, 1997). Those with a score of 70-85 are considered to have a mild disability, 55-70 indicates a moderate disability and below 55 indicates a severe disability (McCarron, 1997).

2.3.2 Physical self perceptions.

Physical self perceptions were measured using the Physical Self Perception Profile (PSPP) and Perceived Importance Profile (PIP) (Fox, 1990). The PSPP is a 30 item questionnaire comprising five subscales of six items using the structured alternate format to measure perceptions of Sports Competence (SC), Physical Condition (PC), Attractiveness of Body (AB) and Physical Strength (PS), and Physical Self-Worth (PSW). SC measures

perceptions of sport and athletic ability and confidence to participate, PC examine perceptions of stamina and fitness and ability to exercise, AB measures perceived attractiveness of one's figure and appearance, PS includes perceived muscle development and confidence in one's strength. Finally, the PSW sub scale is a measure of general feelings of happiness and satisfaction with the physical self. Each subscale score is derived from the average of six statements distributed within the questionnaire. The participant first decides which statement is most true for him or her, for example 'Some people feel that they are not very good when it comes to playing sports' BUT 'others feel they are really good at just about every sport'. They then decide whether the statement is Really True or Sort of True. The score for each statement ranges from 1 (lowest) to 4 (highest) with some items being reverse coded to ensure greater validity of responses. A mean score of above 2 for a sub domain is associated with selecting the positive statement as "Sort of True" or "Really True".

Fox and Corbin (1989) have shown the PSPP has factorial validity explaining 63.5% to 69% of item variance, discriminant validity in distinguishing self-perceptions of a high and low active sample, and high test-retest reliability. A number of studies have investigated the reliability and validity of the PSPP in different age groups and cultures (Crocker, Eklund & Kowalski, 2000; Hagger, Asçi, & Lindwall, 2004). The PIP comprises four 2-item subscales that measure the level of importance attributed to each sub domain of the PSPP (maximum score =8). Those sub domains with a higher rated level of importance (Fox, 1990 recommends scores over 5) are considered to have a greater impact on physical self-worth. A discrepancy score representing the difference between sub domain self perception scores and perceived importance scores is derived based on the following formula: (PSPP sub domain score/3) – PIP sub domain score. The scores may often be negative, a high negative discrepancy score is related to a lower physical self-worth.

2.4 Data analysis

The statistical software SPSS version 20 (SPSS, 2008) was used for all statistical processes. Normality of variables was assessed and parametrically distributed, therefore

descriptive data from questionnaire responses are presented as mean and standard deviations. Paired sample t-tests were used to examine changes between pre and post intervention for PSPP, Perceived Importance, and discrepancy scores for each sub domain and PSW. Standard multiple regression analyses using the general linear model, adjusting for age, gender ,BMI and attendance, were used to assess the relationship between PSW (dependent variable) and physical sub domain scores (independent variables) at pre and post test. To adjust for multiple comparisons, and assuming a correlation of 0.9 (pre to post) the alpha 0.05 was reduced to 0.04 using the Bonferroni correction.

A low sample of females restricted the depth of statistical analysis accounting for gender. As appropriate, results are presented for the total sample, males and females. The low sample size, in particular for females, may result in a Type II error.

3. Results

Participants in the study had a mean age of 168.23 months (*SD*=13.92) and an overall mean NDI score of 66.97 (*SD*=19.46). The maximum number of sessions a participant could attend for the semester was 26. On average, participants attended 22.3 sessions (89.2%) overall with females attending 23 sessions (92%) and males 22 sessions (88%). The highest rate of attendance was 25 sessions and the lowest rate of attendance was 17 sessions (1 participant) (Table 1). The mean BMI for participants was within the normal range. There were no significant differences between males and females for age (t= -1.70 p=.154), NDI (t=1.87 p=.071), BMI (t=1.04, p=.306) and dose (t=1.51, p=.141).

The overall mean scores for self perceptions across all sub domains at pre test ranged between 1.86– 2.27 (negative statement recorded as Sort of True). At post test the range improved to 2.07 – 2.48 (closer to the positive alternative Sort of True). There were no significant gender differences in sub domain scores at either pre or post test.

All physical self perceptions of PSW and sub domain mean scores increased from pre to post intervention test (Table 2). These increases were statistically significant for sub domains PC (t=-3.84 p=.001), AB (t=-2.18 p=.040) and PS (t=-2.35 p=.020) for the total sample. Gender separated analyses revealed score increases for PSW and sub domains

from pre- to post-intervention test for both males and females. However statistically significant differences were only found for males in three sub domains; PC (t=-3.86 p=.001), SC (t=-2.74 p=.010) and PS (t= -2.75 p=.010).

At pre test the males scored higher for the AB sub domain, at post test there was a significant increase in PC to make it the highest scoring sub domain. In comparison, at pre test females scored higher for PS, however at post test their AB sub domain scores rated the highest (Table 2).

Changes in PIP scores between pre and post intervention for each sub domain were not statistically significant (Table 3). For the total sample, scores increased slightly for AB and PS, decreased for SC but did not change for PC. However, trend differences were evident between males and females. Males increased scores from pre- to post-intervention for the PS sub domain and decreased for PC, SC and AB. Whereas females increased their scores for all sub domains except SC, of note is the increase for perceived importance of AB.

On average, participants reported negative discrepancy scores at both pre and post intervention indicating that their perceived importance scores were higher than their perceived competence scores for each sub domain (Table 4). Scores reduced between pre and post intervention in particular for Total Discrepancy for the whole sample (reduction of 1.74) which was primarily due to the males (reduction of 2.68).

The linear regression analyses revealed that the PSW variance explained by the sub domains improved from pre (R^2= .676) to post intervention (R^2= .779) (Table 5). Gender, age, BMI and attendance were not significant contributors to the model at pre or post intervention. Prior to the intervention, the sub domains making the strongest unique contributions to PSW (at baseline) were AB (β = .478 p =.007) and PS (β= .322, p = .162). However, AB decreased in the unique contribution to PSW from uniquely explaining 10.6% of the variance at pre test, to 4.9% at post test, and PS also declined in its contribution to PSW (β= .306, p = .070). PC became the strongest significant contributor at post test (β= .456, p = .020), followed by AB (β= .339, p = .024).

4. Discussion

The results confirmed previous findings that adolescents with movement difficulties have low physical self perceptions (Cantell, Smyth & Ahonen, 1994). At baseline, the self perceptions of the sample were generally lower than the means (2.30 – 2.85) and standard deviations (.53 - .99) in the norms reported by Fox (1990) for each sub domain (Table 2). Even so the mean score for PSW was recorded as "Sort of True" for the positive statement. After participating in a 13 week exercise intervention significant improvements in scores were observed for PC, AB and PS sub domains across the total sample. These improvements may be attributed to the primary focus of the intervention which was on developing physical strength and conditioning, in a supportive, motivating environment with trainers who understood the impact of low motor competence. These characteristics have been identified as facilitators to engagement in physical activity by adolescents with low motor competence (Barnett, Dawes, & Wilmut, 2013). It is also possible that changes in physical strength and conditioning perceptions contributed to the improved self perceptions related to body image (which was not a focus of the intervention).

Exercise programs focused on enjoyment, personal goals and achievement (such as AMPitup) rather than peer comparisons are more likely to be effective in improving physical self perceptions among adolescents with lower self perceptions and low motor competence than their well-coordinated peers (Lloyd & Fox, 1992). Fox (2000) suggests that the mechanism though which exercise impacts on self-perceptions is psychosocial and not through changes in physiological fitness. Further, he argued that the effects of exercise on self perceptions were most likely to be observed among those with low self-perceptions such as the participants in this study. Other intervention studies that have failed to find significant improvements in self perceptions as a result of exercise, have attributed this to a possible ceiling effect. The participants in those studies had relatively higher self perceptions at baseline (Lindwall & Lindgren, 2005; Ozdemir, Celik, & Asci, 2010; Raudsepp et al., 2002) and involved motor *competent* adolescents (Daley, 2002; Schneider et. al., 2008) whose

physical activity and self perception profiles were likely to be very different to the low motor competence sample in the present study.

Gender differences in responses to exercise may also affect self perception changes. For example, researchers have found that actual motor competence impacts perceived motor competence differently between males and females (Raudsepp & Liblik, 2002) perhaps due to valuing differing sources of information and activities in the formation of self perceptions (Weiss & Amorose, 2005; Weiss, Ebbeck, & Horn, 1997). Given the strong valuing of sport and physical competence among Australian males, those with low motor competence may be particularly vulnerable to lower self perceptions. Unlike other studies, the males in our study did not consistently score higher than females on all sub domains of physical self-perceptions at pre test or post test (Daley, 2002; Fox & Corbin, 1989). However, it was the males, and not the females that significantly improved their self perceptions in PC, SC and PS after participating in the exercise intervention. This may indicate that the males in our study valued the development of physical prowess more than females. In general, the sub domains considered most likely to change as a result of participating in exercise are PC, PS and PSW (Fox, 1997).

Even though Fox (1997) considered AB to be the least affected by exercise participation, the females showed the most improvement in self perceptions for AB. The improvement was not significant and may be due to the very small sample of females. However, in other studies enhanced perceptions in AB were also found amongst adolescent girls after participating in a six week aerobic dance intervention (Burgess et al., 2006) and an eight week resistance training program (Lubans, Aguiar, & Caliister, 2010). Daley andBuchanan (1999) found significant improvements in AB as well as SC, PC and PS sub domains after a five week aerobic dance intervention with female adolescents. These gender differences in changes in self perception score in particular sub domains may reflect current cultural expectations and messages driven by the media. Females are bombarded with messages about the importance of an attractive and slim body (Davis, 1997) whereas males are encouraged to develop a muscular physique and physical prowess through sporting

activities (Swain, 2000). In recent years the rise in social media, with the associated sex references, are likely to contribute to even greater gender intensification and this may well influence how motor competence impacts on their lives and self perceptions.

Even though it is recommended that only PIP subscale scores of 5 and above are considered important (Fox, 1990), in this study scores for all subdomains were reported. The SC sub domain was not considered important by the participants at either pre or post test and PS was below the cut point of 5 at pre test. The discrepancy scores were all negative at both pre and post test, which means that the participants rated the importance of each sub domain higher than their own perceived competencies. There appears to be a trend at post test of less discrepancy between importance and self perceptions, particularly in the males, however given the small sample size it is not possible to speculate any further. Fox (1997) hypothesises that higher negative discrepancy scores relate to lower physical and global self esteem. When examining perceived importance and derived discrepancy scores, Harter, (1990) discussed the concept of discounting as a self enhancement strategy in which individuals attach a low importance weight to those domains where low competence is perceived. Discounting prevents deficits in individual competence impacting on self esteem. However, those that are unable to discount domains in which they exhibit low competence may record higher negative discrepancy scores. As discussed earlier, the attachment of importance in particular sub domains may be influenced by a combination of personal and cultural values. In our sample, lower perceived scores in SC were also reflected in lower importance scores (below the cut point of 5), which is not surprising given their inability to participate in most sports.

When the predictors of PSW were explored, it was interesting that AB was the strongest independent contributor to PSW (explaining 10.6% of the variance) at baseline for both males and females. The overall model accounted for 67.6% of the shared variance of PSW at pre test. After the intervention, the perceptions of PC in our participants also became a significant independent predictor of PSW and the overall variance explained by the model increased to 77.9%. The independent contribution of AB to explained variance,

although still significant, was halved between pre and post intervention (4.9%). Physical condition involves perceptions of conditioning, stamina, fitness, ability to maintain exercise, and confidence in exercise setting. These aspects are all directly related to the focus of the intervention. In this study, the gymnasium-based strength and conditioning program involved at least 60 minutes of resistance training and aerobic exercise. AB was still important, but after the 13 week program the participants' perceived competence about their physical condition was making the greatest contribution to their PSW.

An important finding was that the SC sub domain did not contribute to physical self-worth in this group of adolescents. As mentioned previously it also had the lowest perceived importance scores of all sub domains for both males and females which again may link to the concept of discounting. Individuals who are low in perceived competence in some areas could try to protect their self worth by downplaying the importance of that competence (Whitehead, 1995). In other studies involving typically developing adolescents, perceptions of sport competence were important predictors of physical activity and fitness (Raudsepp et al., 2002). The adolescents in this study are likely to discount sport involvement as an area of importance in their lives because of their poor coordination and low motor skills.

To summarise, changes in self perceptions, perceived importance and discrepancy scores reported in this study imply that perceptions among low competence adolescents are influenced by mode of exercise, gender (Burgess et al., 2006) and perceptions at baseline (Ozdemir et al., 2010). Low motor competence appears to be a key influence on baseline physical self perceptions and response to exercise interventions. Overall, participation in an individually tailored exercise program with an emphasis on personal goals, can improve the physical self perceptions of adolescents with low motor competence.

The study's main limitation related to the sample size. The study was under powered to detect small between and within group differences. Further, the small sample and the gender imbalance may have affected the results with non-significant results reflective of the Type II error. A degree of caution should be undertaken when interpreting these results as it is not possible to exclude other explanations such as changes were simply due to time, or

the positive exercise environment. Future research should explore the mechanisms underlying the observed changes. Despite this, some important trends emerged and we report for the first time how an exercise intervention impacted on the physical self perceptions in adolescents with poor motor coordination and how these may differ between males and females. We chose to report the data separately for males and females as Fox (1990) recommended that the PSPP analyses should be undertaken in this way. The AMPitup Program is ongoing with the capacity to the increase sample size over time with new participant enrolments. It would be valuable to include a control group of adolescents with low motor competence for future comparisons of changes in self perceptions.

A strength of the study is the evidence that the self-perceptions of adolescents with movement difficulties can be changed if they have access to an effective exercise intervention in a supportive exercise setting. To our knowledge this has not been previously reported.

5. Conclusions

Physical self-perceptions are important drivers of level of engagement in physical activity and the many associated health benefits. Changes in some physical self perceptions in adolescents with low motor competence, particularly males, can be facilitated by an individually tailored intervention in a supportive environment that focuses on fitness and strength, and that these can occur after a relatively short period of time.

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