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# SPORT STACKING MOTOR INTERVENTION PROGRAMME FOR CHILDREN WITH DEVELOPMENTAL COORDINATION DISORDER

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***ABSTRACT***

*The purpose of this study was to explore sport stacking as an alternative intervention approach with typically developing children and in addition to improve DCD. Sport stacking consists of participants stacking and unstacking 12 specially designed plastic cups in predetermined sequences in as little time as possible. Eighteen children (6 girls and 12 boys) classified with DCD, between the ages of 6 and 7 years, participated. A pre-test/post-test quasi-experimental design with a control group was applied. The Movement Assessment Battery for Children-2 (MABC-2) was used to assess the motor proficiency levels of the children and to classify DCD. The sport stacking intervention consisted of an 8-week programme of 3 sessions per week, 30 minutes per session. During the intervention the children learned the various sport stacking sequences, as well as how to apply them to a variety of physical activities. The results indicate that prior to the intervention no significant differences occurred between the 2 groups. After the intervention, manual dexterity and balance showed a significant difference, while aiming and catching, showed no significant difference. The total test score revealed a significant difference in the overall motor proficiency levels of the experimental group. The results suggest that sport stacking can be used as an effective intervention programme for children with DCD.*

**Key words:** Sport stacking; Motor proficiency; Developmental coordination disorder; Intervention; Movement Assessment Battery for Children-2.

## INTRODUCTION

Developmental coordination disorder (DCD) is a neuro-developmental disorder, causing marked impairment in the maturation of motor coordination (Polatajko & Cantin, 2006). According to Missiuna *et al*. (2006), children with DCD experience significant difficulties in motor learning and in the execution of functional motor tasks that are pivotal for success in their everyday lives. A large number of school-aged children have been identified with motor proficiency problems. These problems have substantial negative effects on their ability to participate fully in daily activities at home, school and in normal play (Polatajko & Cantin, 2006).

Even though children will not outgrow this disorder as previously believed (Henderson & Henderson, 2002), children can be facilitated by means of Barnett's V-step assessment process for the identification of children with motor problems (Barnett, 2008). The first step focus on the use of questionnaires for the screening and identification of children with motor

problems. The second entails the use of norm-referenced tests for measuring the motor performance of the child. The third step of this motor assessment process entails the making of a formal diagnosis of DCD. This is served by measuring the qualitative and quantitative performance in motor tasks. The fourth step focus on understanding the nature of the condition. Finally, the fifth step is the planning of an intervention programme.

It follows that intervention programmes are a vital element of the assessment process in order to improve DCD. Researchers conventionally made use of bottom-up approaches by means of sensory integration and perceptual motor training in children with DCD (Bernie & Rodger, 2004; Sugden *et al*., 2008). These approaches aim to improve children's processing abilities or performance components and are still being practised as an intervention by many therapists (Missiuna *et al*., 2006; Sugden *et al*., 2008). According to Hamilton (2002), the most frequently used approaches are perceptual-motor therapy, sensory-integration therapy and kinesthetic training. All of these more often produced positive results than not.

Due to a lack of support for the bottom-up approach, new approaches emerged known as the cognitive or top-down approach (Bernie & Rodger; 2004). More researchers are in favour of this approach (Sugden *et al*., 2008). These new approaches were based on theoretical concepts of motor learning and cognition. Motor learning is based on a conscious understanding of the processes involved when a motor problem needs to be solved. Thus, the interaction between the task and environment, as well as the child needs to be taken into consideration (Perry, 1998). Cognitive approaches use direct skill teaching, but differ in the sense of the unique problem-solving framework, attempting to help children generalise from the learning of one skill to the next (Missiuna *et al*., 2006).

According to Missiuna *et al*. (2006) and Sugden *et al*. (2008), although the task-specific approach aims at increasing various participations for children, it is preferable to consider how children can perform a specific task in a variety of real-life situations, rather than in one specific setting. Consequently, one should consider how to modify the task or to adapt the environment in order for children to participate and improve their learning capabilities.

Sugden and Chambers (1998) proposed that most interventions are successful with a good number of children diagnosed with DCD. This statement was supported by findings from the same authors (Sugden & Chambers, 2003), observing that interventions done by parents and teachers can also be successful. The researchers found that a 7-week intervention (task-orientated approach), conducted by parents and teachers helped the majority of children to obtain scores above the 15$^{th}$ percentile. Miyahara *et al*. (2008) made use of university students in a clinical setting to apply a task-orientated approach and found that 40% of the participants improved beyond the cut-off scores. Intervention by means of a combination of the bottom-up and top-down approaches through intense physical activity conducted by Watemberg *et al*. (2007), concluded that 50% of the participants with DCD scored above the cut-off scores (>15$^{th}$ percentile) after a 4-week intervention.

It is clear that controversies exist between these different approaches and there is still not enough evidence to substantiate that one specific intervention approach is superior to another (Miller *et al*., 2001; Miyahara *et al*., 2008). It is thus proposed that these two approaches

(bottom-up and top-down) should be merged in order to care for children with DCD (Peters & Wright, 1999; Davidson & Williams, 2000).

Sport stacking was launched in a South African setting in January 2009. Sport stacking is already recognised as a sport by more than 18 nations, including Australia and Germany in addition to South Africa (Krog, 2008). According to the World Sport Stacking Association (2009), sport stacking is defined as a sport where 12 specialised cups are used to build formations. A participant is called a stacker. Stackers must stack cups in predetermined sequences, competing against the clock or another player (Gibbons *et al*., 2007). Sport stacking can, therefore, be used as an innovative and exciting way of improving motor proficiency, such as hand-eye coordination, ambidexterity, speed and concentration while having fun (Udermann *et al*., 2004; Krog, 2008).

## RESEARCH PROBLEM

The aim of this study was to explore the effectiveness of sport stacking as an alternative intervention approach for typically developing children and in addition to improve DCD in children.

According to Aparo (2009:ii): *"*Sport stacking seems to improve, in a fun and challenging way, several rudimentary fine motor skills, such as hand-eye coordination, which is assessed in this study, and others such as bimanual coordination, ambidexterity, reaction time, concentration and quickness".

This study explores the efficacy of a cup stacking intervention for children classified with DCD in order to improve their motor proficiency levels.

## MATERIAL AND METHODS

### Study design

A pre-test/post-test quasi-experimental design with a control group was applied as an empirical study, which made use of quantitative data. The study involved a pre-test in order to identify the children with motor difficulties, in other words DCD. The children were tested at their school by Kinderkineticists in-training who were familiar with the testing procedures of the relevant instrument. Each Kinderkineticist in-training was responsible for one subtest in order to have consistency across the study.

The children classified with DCD were divided into 2 groups. The experimental group took part in an 8-week intervention programme (sport stacking) comprising 30-minute group sessions 3 times a week. The reason for the 8-week intervention instead of the prescribed 12-week intervention is due to the fact that a school term consists of only 10 consecutive weeks. The Kinderkineticists were trained by professionals from a Speed Stacking company in order to execute the intervention programme accordingly. The speed stacking intervention was combined with various fundamental movements, such as locomotor-, manipulation-, as well as stability skills. A post-test, using the same procedure as the pre-test, took place after the intervention process in order to observe any improvement.

### Participants

The participants were selected from a primary school in Bloemfontein, Free State province, South Africa, and therefore, constitute a convenient sample. Eighteen children between the ages of 6 and 7 years took part in this study. The group consisted of girls (n=6) and boys (n=12) classified with DCD.

### Ethical considerations

The Department of Education, as well as the principal of the school granted permission for the research to be conducted on the school premises during the Life Orientation class periods. Approval had been obtained from the Ethics Committee of the Faculty of Health Sciences (ECUFS57/2012) of the University of the Free State. The parents of the participants completed an informed consent form for each child participating in this study. All children in the identified classes were considered for inclusion in the study. Exclusion criteria included a child in the age group outside the expected range of 6 to 7 years, where parental permission was not obtained or the informed consent form had not been completed fully or where parents had indicated that they would be relocating during the study.

### Measuring instrument

The *Movement Assessment Battery for Children-2* (Movement ABC-2) is a standardised test and requires children to perform a series of motor tasks in a specified manner. In addition to age-related norms, the test also provides qualitative information on how children approach and perform the tasks. The Movement ABC-2 assesses the subject's motor proficiency levels and classifies children with DCD. The first assessment component of this test battery contains a total of 24 items organised into 3 sets of 8 tasks. Each set is designed for use with children of a different age band. The 8 tasks are grouped under 3 categories, namely manual dexterity (MD), balance (B) and aiming and catching (AC) (Henderson *et al*., 2007). Age-adjusted standard scores and percentiles are provided, as well as a total score based on each of the 3 components of the test. The total test score can be interpreted in terms of a 'traffic light' system. The green zone indicates performance in a normal range (>$15^{th}$ percentile), while the amber zone indicates a child as being at risk and needing to be carefully monitored ($5^{th}$ to $15^{th}$ percentile). The red zone is an indication of definite motor impairment (≤$5^{th}$ percentile).

### Analysis of data

Analysis of the data was completed by a Bio-statistician using Statistical Analysis Software Version 9.1.3. Descriptive statistics, namely frequencies and percentages, were calculated for categorical data. Medians and percentiles were calculated for numerical data. Median differences were tested by calculating p-values using the signed-rank test. The chi-square was used to test for proportional differences. A significance level of 0.05 was accepted for all aspects of the study.

## RESULTS

The sample consisted of 18 children, of which 8 formed the control group and 10 the intervention group. With regard to gender the control group consisted of 2 girls (25%) and 6

boys (75%) and the intervention group consisted of 4 girls (40%) and 6 (60%) boys. There was no significant difference, (p=0.6380) between the 2 groups at the start. Table 1 presents the numerical data to compare the 2 groups regarding the pre-test median results of the various subtests of the Movement ABC-2

*TABLE 1*. **MEDIAN RESULTS OF TWO GROUPS: COMPARISON OF PRE- AND POST-TEST**

| | | **Control group** | | **Experimental group** | | **p-Value** | |
|---|---|---|---|---|---|---|---|
| **Variables** | **n** | Pre-test | Post-test | Pre-test | Post-test | Pre-test | Post-test |
| MD | 18 | 1.5 | 1.0 | 1.5 | 5.0 | 0.7832 | 0.0191 |
| AC | 18 | 25.0 | 50.0 | 25.0 | 69.0 | 0.6732 | 0.0734 |
| B | 18 | 20.5 | 7.0 | 37.0 | 20.5 | 0.2595 | 0.0472 |
| **TTS** | 18 | 5.0 | 2.0 | 9.0 | 12.5 | 0.1784 | 0.0018 |

MD= Manual Dexterity AC= Aiming and Catching B= Balance TTS= Total Test Score

It is clear from median results for the pre-test of the control and intervention groups that there was no significant difference between the 2 groups before the intervention commenced with regard to the various subtests, namely manual dexterity (p=0.7832), aiming and catching (p=0.6732), balance (p=0.2595) and the total test score (p=0.1784).

*Manual dexterity* involves the coordinated use of the hands, guided by the visual system, within time limits (Henderson *et al*., 2007). The pre-test median for the control group was 1.5 and the post-test showed a slight decrease to 1.0. For the intervention group, the pre-test was 1.5 and increased to 5.0. A significant difference (p=0.0191) was found between the 2 groups after the intervention was completed.

*Aiming and catching* entails coordinating body movements when receiving moving objects, as well as performing throwing tasks accurately (Henderson *et al*., 2007). The pre-test median score for the control group was 25.0 and this improved to 50.0 in the post-test. With regard to the intervention group, the median score was also 25.0 and increased to 69.0. Both groups improved in this category and there was no significant difference (p<0.0734) between the pre- and post-test median scores of the 2 groups in respect of aiming and catching.

The *balance* subtest involves static and dynamic balance where the child has to keep the body upright against gravity while standing on 1 leg and performing hopping and jumping movements (Henderson *et al*., 2007). The median value of the pre-test for the control group was 20.5 and for the post-test the median score decreased to 7.0. The intervention group scores for balance resulted in a median score of 37.0, which decreased to 20.5 at the post-test. While there was a decrease in performance for both groups between pre- and post-test scores, there was a significant difference (p<0.0472) with reference to balance between the 2 groups.

The 3 categories of the MABC-2 produced the *total test score*. At the pre-test, the median score for the control group was 5.0 and in the post-test it decreased to 2.0. The pre-test

median score for the intervention group was 9.0 and increased to 12.5 in the post-test. These results indicate a significant difference (p=0.0018) between the 2 groups in respect of the total test score.

The results indicate that the control group performed poorer in the post-test with regard to manual dexterity, balance and the total test score compared to the intervention group. It is interesting to note that both groups scored poorer in the post-test with reference to the balance subtest. After the intervention period there was a significant difference between the 2 groups with regard to manual dexterity (p=0.0191), balance (p=0.0472) and the total test score (p=0.0018).

The distribution of the children, according to the traffic light system (degree of motor difficulty) before and after the intervention programme is shown in Figures 1 and 2. Note that only the children classified as borderline or severe motor proficiency impairment took part in the intervention.

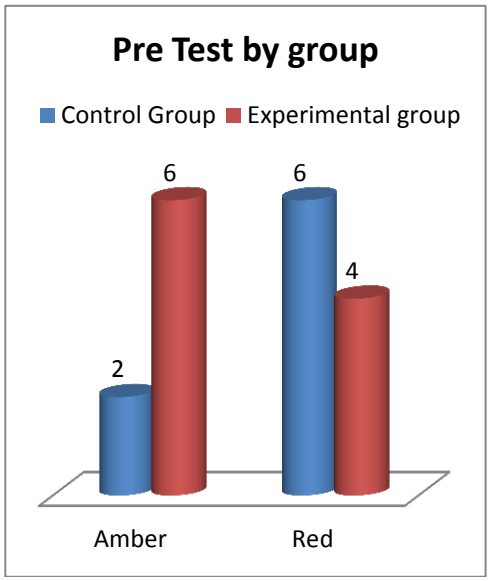


*FIGURE 1*. **Pre-test placements using the traffic light system by group**

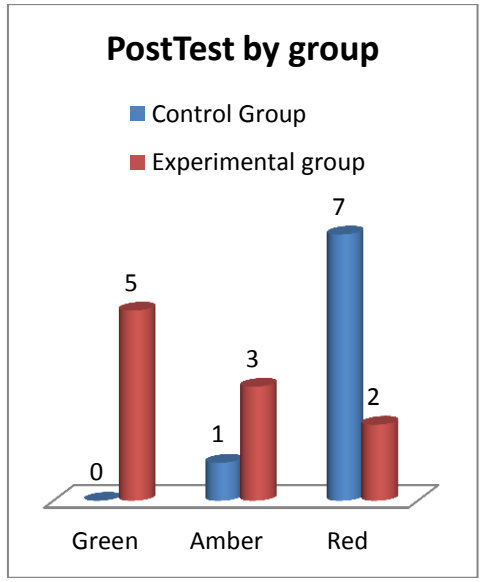


*FIGURE 2*. **Post-test placement using the traffic light system by group**

As stated previously, the total test score is derived from the 3 subtests and can be interpreted in terms of a 'traffic light' system. The green zone indicates performance in a normal range, the amber zone indicates a child as being at risk and the red zone is an indication of definite motor impairment. After the pre- and post-tests the total test scores of the 18 children were interpreted and placed according to the traffic light system.

Figure 1 indicates the placement with regard to the traffic light system prior to the intervention. The results clearly indicate that all the participants had some form of motor

proficiency problems prior to the intervention. With reference to the control group, 2 children fell in the amber zone and 6 children in the red zone. With regard to the intervention group, 6 children fell in the amber zone while 4 children were in the red zone.

In addition, Figure 2 indicates that subsequent to the intervention, the intervention group performed better in contrast to the control group. The distribution according to the traffic light system was as follows: observing the control group none of the children improved and, therefore, no children were in the green zone (no motor difficulties). In contrast, 5 children from the intervention group improved after the intervention and landed in the no motor difficulty category. Furthermore, the results shows that only 1 child from the control group remained in the amber zone, in contrast to 3 of the intervention group. Finally, 7 children of the control group were in the red zone whereas there were 6 initially. This confirms that children will not outgrow their motor problems. With regard to the intervention group, only 2 children remained in the red zone. The findings of this study indicate that the motor proficiency levels of children with DCD improved to a great extent due to their participation in a sport stacking intervention.

## DISCUSSION OF RESULTS

With regard to *manual dexterity*, the results indicate a significant difference ($p=0.0191$) between the 2 groups after the intervention was completed. This is similar to a study conducted by Aparo (2009) who determined the influence of a sport stacking intervention on hand-eye coordination in children. According to the Saskatchewan Physical Education Association (2008), children using both sides of their bodies should improve their bilateral abilities. These statements support the finding of the current study. The children had ample opportunity to use both hands in a coordinated fashion during the speed stacking intervention; therefore, their manual dexterity (ability to use the 2 hands together) did improve significantly compared to the control group.

With reference to *aiming and catching*, it is interesting to note that both groups had a median score of 25.0, indicating a good standard of aiming and catching ability. Both groups improved with regard to aiming and catching. Although the intervention group improved more based on the median score, the results do not indicate a significant difference ($p<0.0734$) between the pre- and post-test median scores of the 2 groups. The improvement of the intervention group correlates with the findings of Udermann *et al*. (2004), who found that sport stacking intervention improves hand-eye coordination and reaction time, which are both important components when executing aiming and catching skills successfully. The findings of Aparo (2009) were of a similar nature. The improvement in both groups can be attributed to the fact that they had good skills prior to the intervention, thus it is harder to improve on these skills. Another reason for improvement in both groups might be due to the fact that these children participate in a variety of manipulative skills at school.

Even though both groups decreased in performance with reference to the *balance* subtest there was a significant difference ($p<0.0472$) between the 2 groups after the intervention. The decline in performance could be due to the fact that the majority of the children had to be tested on age band 2 during the post-test, indicating that the balancing activities were more

difficult to execute. This may also indicate the need for the intervention to include more balancing activities.

With reference to the *total test score*, a significant difference (p=0.0018) was observed between the groups after the intervention. The results, therefore, suggest that children would not outgrow their motor difficulties without appropriate interventions (Henderson & Henderson, 2002; Sugden & Chambers, 2003). It was also apparent that the participants of the current study were a heterogeneous group and it is necessary to address the individual needs of each child. Based on the current study, speed stacking led to a significant improvement with regard to overall motor proficiency. This correlates with Aparo (2009), who also found a significant increase in motor performance after using a speed stacks intervention programme with 20 children between 7 and 11 years of age.

## LIMITATIONS

Although the aim of this study was to determine if a sport stacking intervention might improve the motor proficiency levels of children with DCD, the population sample used in this study was obtained from a single institution and province and can, therefore, not be generalised to the larger population of 6 and 7 year old children. It is recommended that the effect of a Sport stacking intervention on children with DCD should be explored further by means of larger samples. In addition, the long-term effects of a sport stacking intervention should be researched. Another limitation to the study was that the children were tested on age band 1 (age 6) during the pre-test. A majority of the children turned 7 during the intervention, and therefore, had to be tested on age band 2, indicating that they had to perform more difficult activities compared to age band 1.

## CONCLUSION

The aim of this study was to determine if a sport stacking intervention resulted in an improvement of motor proficiency levels of children with DCD. When children are diagnosed with DCD, it is important to implement motor intervention programmes. Intervention programmes have proven to enhance the motor proficiency of these children (Peens *et al*., 2008). The results suggest that a sport stacking intervention improved the motor proficiency levels of children with DCD. From the point of view of a therapist, no two children are the same, especially children identified with DCD, since they are not a homogeneous group. The findings of this research contribute to the field of study by providing an alternative intervention approach, namely sport stacking, for Kinderkineticists to utilise with the purpose of improving the motor proficiency levels of children with DCD.

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