International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 7; Issue 4(H); April 2018; Page No. 11853-11864
DOI: http://dx.doi.org/10.24327/ijcar.2018.11864.2067

Research Article

INVESTIGATION OF DEVELOPMENTAL COORDINATION DISORDER IN CHILDREN WITH AUTISTIC SPECTRUM DISORDER AND THOSE OF TYPICAL DEVELOPMENT THROUGH EDUCATIONAL OBSERVATION

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A R T I C L E I N F O

Article History:

Received 5th January, 2018
Received in revised form 20th February, 2018 Accepted 8th March, 2018
Published online 28th April, 2018

Key words:

Developmental Coordination Disorder (DCD), Motor Clumsiness, Autistic Spectrum Disorder (ASD), Special Education.

A B S T R A C T

The purpose of the present study was to investigate possible differentiation in Developmental Coordination Disorder (DCD) levels of children with Autistic Spectrum Disorder (ASD) and those of Typical Development, as well as the underlying additional difficulties and the non-motor factors of this possible differentiation, through the educators' observation. The sample consisted of 40 children aged from 6 to 12 years old. Twenty of them were diagnosed with ASD and the other 20 were characterized as typically developing children. In order to register the DCD levels of children, the "Movement Assessment Battery for Children-2 Checklist" questionnaire was used. The questionnaires were completed by Physical Education teachers, after the 2 weeks observation procedure. Results showed that children of the two groups presented statistically significant differentiations in general levels of DCD ($p < .05$). 85% of children with ASD in contrast to 20% of those with Typical Development were found to experience severe motor clumsiness. Statistical analysis also indicated the significant effect of the gender on children's motor performance ($p < .05$). The conclusion of this study was that children with ASD experienced significantly more increased levels of DCD than those of Typical Development, verifying the high comorbidity level between ASD and DCD. It was also indicated that children's motor development played an influential role in their overall development, affecting several significant areas of their daily lives.

INTRODUCTION

Motor development, being an essential part of children's life, affects their adaptation to the wider society and the overall development of their personality. Being one of the major features of humans and predominant factor of a healthy and balanced life, mobility characterizes infancy, childhood and early adolescence (Zimmer, 2007). In other words, the above-mentioned age periods are characterized by intense morphological and functional motor conquest, through the progressive development of basic motor skills of children. Motor skills refer to all forms of motor activities that require not only coordination in gross and fine movements, but also control of large and small muscle groups (Gallahue & Donnelly, 2003).

According to Gallahue and Ozmun (2002), motor development occurs in the following stages of movements: elementary, fundamental and athletic.

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In addition, being a series of basic movements that include combined models of two or more body parts, motor skills are classified into three categories: stabilization, transportation and handling. Through participating in mobility activities, children have to move in many different ways, at different levels and in different directions, manipulating various objects (Zimmer, 2007). Children's motor development is a consequence of their interaction with the environment that improves their capacity of motion control. As a result, becoming more capable and skillful, children are able to present a smooth motor development (Gallahue & Donnelly, 2003).

On the other hand, in infancy and early childhood many children fail to acquire or improve basic motor skills, without the existence of known pathology and despite the fact that they should meet the requirements of typical school activities. In other words, they display not only deficits in identification and combination of their activities (cognitive, physical-motor), but also difficulties in acquisition and execution of motor skills that require speed, accuracy and coordination. As a result, they waste both time and energy (Salter *et al*., 2004; Riek & Woolley, 2005). However, children with motor coordination problems present a differentiation in their motor difficulty

level. Some of them may face difficulties in almost every activity of their daily lives, while others have specific deficits. For example, they display impairments in performing of everyday skills like writing, the reception and return of the ball, the hopscotch, etc. "Clumsy children" or children with motor clumsiness avoid any form of physical activity, thus they are excluded from school and social activities during childhood or even in adulthood (Magalhaes, Cardoso & Missiouna, 2011).

Being a unique and separate neurodevelopmental disorder, motor clumsiness often co-occurs with one or more other neurodevelopmental and neurobehavioral disorders such as Autistic Spectrum Disorder (ASD) or Attention Deficit Hyperactivity Disorder (ADHD) (Blank *et al*., 2012). ASD belongs to neurodevelopmental disorders and affects the social interaction, communication, imagination and behavior of an individual. It is also associated with the existence of limited, repetitive and stereotyped patterns of behavior, interests or activities (APA, 2013). Autistic disorder is determined as a spectrum disorder, on the grounds that it presents heterogeneity, as regards its clinical features, ranging from mild to more severe (APA, 2013). Moreover, several noted experts have observed that ASD could coexist with motor impairments (Wisdom *et al*., 2007; Kopp, Beckung & Gillberg, 2010). Specifically, approximately 80% of children with ASD exhibit motor coordination problems (Green *et al*., 2009). According to Jansiewicz and colleagues (2006), 82% of children with ASD and 13% of those with typical development are characterized by motor difficulties. Similarly, MacNeil and Mostofsky (2012) indicated that both children with ASD and ADHD display deficits in their motor development.

According to international research, there is a plethora of studies related to DCD in children with ASD and those of Typical Development. Specifically, during the last decade, a growing interest of the educational scientific community for the above-mentioned field has been observed, because DCD is an evolving area, as regards its terminology, etiology, co-existence with other Special Educational Needs and Disabilities (SEND) and the suitable intervention techniques (Vernazza-Martin *et al*., 2005; Rinehart *et al*., 2006; Dziuk *et al*., 2007; Ming, Brimacombe & Wagner, 2007; Green *et al*., 2009; Jasmin *et al*., 2009; Kopp, Beckung & Gillberg, 2010; Noterdaeme, Wriedt & Hohne, 2010; Forti *et al*., 2011; Brisson *et al*., 2012; Nayate *et al*., 2012; Gowen & Hamilton, 2013; Lloyd, MacDonald & Lord, 2013; Ament *et al*., 2015). Being one of the major health problems among school children worldwide (Green *et al*., 2005; Polatajko&Cantin, 2006, Zwicker *et al*., 2012), it deserves special attention from the researchers. However, through searching in bibliography, it is also indicated that the majority of the above relevant studies have been conducted through standardized tests of motor function. Thus, more studies in DCD through the educational observation are necessary. In other words, this research is highly interesting because it was conducted focusing on educators and their ability to observe and evaluate motor clumsiness of their students.

In addition, as far as Greece is concerned, there is relatively insufficient research data associated with DCD in Greek school population (Kourtessis *et al*., 2003, 2008; Tserkezoglou, Kourtessis & Kapsalas, 2003; Tsiotra *et al*., 2006, 2009; Papadopoulos *et al*., 2007; Ellinoudis *et al*., 2008; Asonitou *et al*., 2012; Kambas *et al*., 2012; Venetsanou & Kambas, 2016). It is also important that there is no relevant study to motor clumsiness of Greek students with ASD, in comparison with those of Typical Development. As a result, completing the existing bibliography with valid and reliable findings, this study is anticipated to be a useful tool for those who occupy with education of children with and without ASD. In particular, this research could contribute to identification and planning of suitable educational interventions for children with ASD, since an appropriate intervention programme should be based on children's motor development, which is a basic factor of their overall development (Rosenbaum, 2005; Bhat, Galloway &Landa, 2012; Cashon *et al*., 2013).

Aims and Purpose of the Study

The aim of the present study was to investigate the Developmental Coordination Disorder (DCD) in children with Autistic Spectrum Disorder (ASD) and those of Typical Development, through the educators' observation. Its primary o1bjective was to investigate possible differentiation between these categories of Coordination Disorder in Greek children with and without ASD, based on educational evaluation.

The present research was designed on the basis of the following research problem: Is there any differentiation between motor clumsiness of children with ASD and those of Typical Development, as regards the Greek school population? How Greek physical education teachers explain the possible differentiation between the above categories of motor clumsiness, as regards the non-motor factors and the additional known difficulties of children? In other words, this study attempted to confirm or contradict the theory of high comorbidity between ASD and DCD in Greek children, in accordance to educators' observation.

Research Tools

The present study was conducted through the Movement Assessment Battery for Children -2- Checklist (MABCC-2) (Henderson, Sudgen & Barnett, 2007). MABCC-2 is included to the MABC-2 assessment package that was specifically designed to detect and evaluate children who have motor difficulties, through the motor function test and the questionnaire (checklist). MABC-2 is one of the most popular tools used in surveys conducted for the evaluation of DCD in children (Henderson, Sudgen & Barnett, 2007; Smits-Engelsman *et al*., 2008).

In particular, being a questionnaire that addresses to parents, educators and specialists, MABCC-2 needs about 10 minutes, in order to be completed (Vuijk *et al*., 2010). It concerns a single age category of children ranging from 5 to 12 years old and focuses on how a child manages his home and school daily goals or tasks. MABCC-2 consists of two parts. The first one examines the motor skills of children and includes 30 questions that are divided in the following two sectors: a) motor performance in static/predictable conditions and b) motor performance in potential/unpredictable conditions. More specifically, the above-mentioned sectors consist of questions associated to self-care, classroom, physical education/leisure and ball skills. The second part includes 13 questions and examines the behavioral aspects of children that could affect the process of learning or performing of motor skills (Livesey, Coleman & Piek, 2007). The total questionnaire score occurs

by summing the scores of sectors "a" and "b". Then, the total score is compared with the "traffic light system" of the questionnaire that includes the following three zones of measured values: the green zone (children without motor impairments), the orange zone (children at risk of developing motor disorder) and the red zone (children with severe motor problems). Each one of the sample children is classified into a specific zone, in accordance with his score. The total score of each zone is different for each age year of children (Henderson, Sudgen & Barnett, 2007).

As regards the questions, they are clear, easy, comprehensive and understandable, in order to assess in detail both gross and fine motor skills of children. In addition, they are not extensive and the vocabulary used reflects the education level of the respondents, so that there is no confusion and misunderstanding as regards the main point of each question (Goyen & Liu, 2009). Questions are also formulated in a way that directs the participants to accurately respond. They are separated into topic areas that are based on detailed observation, without causing tiredness and discouraging the readers. It is essential that there are clear instructions from the beginning of the questionnaire, thus this procedure is not complicated and time consuming.

Consequently, being accessible and reflecting the reality, this research tool is characterized by validity and reliability (Henderson, Sudgen & Barnett, 2007; Watemberg *et al*., 2007). Similarly, according to Schoemaker and colleagues (2012), MABCC-2 is a valid and reliable tool designed to be used by teachers, parents and other professionals who occupy with children with motor coordination problems and impairments in a wide range of everyday activities.

Sample Selection

For the present study that was conducted through the standardized questionnaire, it seemed to be more beneficial the selection of random sampling. Initially, the researcher visited General and Special Education schools, as well as the Special Education and Training Center of her residence area, in order to meet Physical Education teachers and inform them about the research issue and process, providing them with the Information Sheets. The researcher ensured the consent of educators who decided to participate in the survey, through the Consent Forms that were signed from the very beginning of the research process. The researcher also met and informed schools Principals about the research process, through the Information Sheets, in order to ensure their permission for the research conduct. In addition, because of the fact that the sample consisted of underage vulnerable individuals, it was not deemed appropriate for these children themselves to decide their participation and give permission for becoming subjects of this research, in accordance with their age and intellectual level (BERA, 2011). Thus, it was necessary for the researcher to address to the organized parent councils of schools, in order to inform children's guardians about the research process (through the Information Sheets) and also ensure their permission for children's participation in the survey, through the Parental Consent Forms that they signed.

As regards children with ASD, the sample included the available children who met the criteria associated with their age (6-12), the ASD diagnosis by the "Center of Diagnosis, Differential-Diagnosis and Support" (sub-categories of ASD, such as Asperger's Syndrome, were excluded), no existence of neuromuscular or motor disorders and the same intellectual level. Specifically, children with ASD were diagnosed with mild Mental Retardation (IQ level: 50-70) by the "Center of Diagnosis, Differential-Diagnosis and Support" through the IQ test. As regards children of Typical Development, the sample group was randomly selected between children who met the criteria that were defined in a great extent by the ASD sample group, in order for the homogeneity of sample to be ensured. Children with TD were also of the same age (6-12), without any neurodevelopmental or neurobehavioral and neuromuscular or motor disorder. Moreover, typically developing children were considered of typical intellectual level.

Forty children, from two municipalities of Northern Greece, aged from 6 to 12 years old participated in the present study. Twenty of them, who had been diagnosed with ASD by the "Center of Diagnosis, Differential-Diagnosis and Support", were attending Special Education Schools (16 children) or Special Education and Training Centers (4 children). The other 20 children, who were of Typical Development, were attending General Education schools. Children with ASD were of the same intellectual level, presenting diagnosed mild Mental Retardation. Attending General Education schools, children of Typical Development were considered of typical intellectual level. Eight Physical Education teachers also participated in the research, completing the questionnaires of motor clumsiness. Three of them were of Special Education and the other 5 were of General Education. They also had at least one year experience with the sample children. Both educators and children voluntarily participated in the research process.

Research Process

After the sample identification, educators who participated in the survey were observing the sample children during the typical Physical Education course, for two weeks. During this process the researcher was also present throughout the Physical Education courses, under the permission of the school Principals, without actively participating in the lesson and doing any observations regarding to children's motor performance. In this way the researcher had the opportunity to unobtrusively observe the educators, who participated in the research, controlling the quality of Physical Education lessons and the research process. Every physical trainer of General Education observed 4 children of Typical Development. Physical trainers of Special Education observed children with ASD in the following proportions: one of them observed 7 children who were attending a specific special education school, the second one observed 9 children who were attending another special education school and the third one observed 4 children who were attending a Special Education and Training Center.

At the very beginning of this session the participants (educators and parents) were explicitly informed that they had the right to withdraw any time throughout the process. It was important that, if a participant withdrew, the collected data would be destroyed. During this procedure that took place in unobtrusive way, there was no need for children to participate in a particular research process such as a motor function test or to execute any additional activity, apart from typical activities of Physical Education course. In addition, it is noted that the questionnaires were not administered to physical education

teachers before the ending of the observation period. After 2 weeks of educational observation, the researcher met the Physical Education teachers, in order to interview them for completing the questionnaires. During this process, there was the need for more clarifications, as regards the questions. For example, the researcher informed the participants about the existence of multiple choice questions and their ability to select multiple responses. After this stage, educators and children's parents were informed by the researcher, through a debriefing letter, that they could withdraw until a certain time before the analysis and dissemination of the data. None of the participants requested to withdraw. Then, all the data that was collected under the participants' permission, was safely stored by the researcher within a locked cabinet, in order to be protected and the priorities of anonymity and confidentiality to be ensured.

Data Analysis

Data analysis was performed by descriptive statistics. Specifically, indicators of central tendency (Mean and Standard Deviation) as well as frequencies analysis were used. Children's groups [Control Group (C.G.): children of Typical Development (TD) and Experimental Group (E.G.): children with ASD], age and gender were defined as independent variables. The level of motor clumsiness, in accordance to the "traffic light system" of the questionnaire (green, orange and red zones) and the individual parameters of the questionnaire were defined as dependent variables. The materiality level of all analyzes was defined as follows: p value < .05.

Independent Samples t-test was conducted, in order to indicate or not possible statistically significant differentiations in general motor clumsiness levels of children with ASD and those of TD. Motor evaluation was defined as dependent variable and children's group (C.G. and E.G.) was defined as independent variable. Frequencies analysis of the data was performed to verify or not possible differentiations in children's with ASD and TD scores on individual parameters of the questionnaire (self-care, classroom, ball, Physical Education/leisure skills in static/predictable and potential/unpredictable environments). In addition, Independent Samples t-test was performed to find out possible statistically significant differentiations between males and females of the two groups. Motor evaluation of children was defined as dependent variable and their gender was defined as independent variable. Frequencies analysis of the data was also used to verify or not possible differentiations in children's with ASD and TD scores on the above-mentioned individual parameters of the questionnaire by gender category.

One Way ANOVA parametric test was conducted, in order to establish possible statistically significant differentiations in general motor clumsiness levels between children of the two groups, by age category. Motor evaluation of children was defined as dependent variable and their age categories were defined as independent variable-factor. Frequencies analysis of the data was also used to verify or not possible differentiations in children's with ASD and TD scores on individuals parameters of the questionnaire (self-care, classroom, ball, Physical Education/leisure skills in static/predictable and potential/unpredictable environment) by age category.

Finally, Independent Samples t-tests were performed to indicate possible differentiations in non-motor factors and additional know difficulties that affect the movement of children with ASD and those of TD. Additional known difficulties and the non-motor factors were defined as dependent variables and children's group (C.G. and E.G.) was defined as independent variable.

RESULTS

According to descriptive characteristics of the sample, 40 children aged from 6 to 12 years old, with age Mean (M) 9.28 years (S.D. = 2.05) participated in the present research. Twenty of them with age M 9.05 years (S.D. = 2.09), who had been diagnosed with ASD, constituted the Experimental Group (E.G.) and the other 20 with age M 9.50 (S.D. = 2.04), who were of Typical Development (TD), constituted the Control Group (C.G.). The E.G. included 15 males and 5 females who presented diagnosed mild Mental Retardation (MR). On the other hand, the C.G. included 10 males and 10 females who were considered of typical intellectual level, since they were attending General Education schools. In addition, 8 Physical Education teachers aged from 32 to 43 years old, with age M 35.75 (S.D. = 4.33) participated in the survey, in order to complete the MABCC-2 questionnaires, after the 2 weeks procedure of educational observation. 3 of them were of Special Education (S.E.) and the other 5 were of General Education (G.E.). All of them were females and had at least one year experience with the sample children.

Initially, Cronbach's alpha measure of internal consistency was used, in order for the reliability of internal consistency between the questions that form a scale (sector "a" & sector "b") to be established. As regards sector "a" related to motor performance in static/predictable conditions, Cronbach's alpha was .91 and indicated a high level of internal consistency. Similarly, Cronbach's alpha for sector "b" related to motor performance in potential/unpredictable conditions was .96 and also indicated a high level of internal consistency.

Independent Samples t-test was used by the researcher, in order to indicate possible differentiations in general levels of motor clumsiness (red zone, 1: Yes / 2: No) between children with ASD and those of TD. T-test was statistically significant, $t(38) = 5.30$, $p < .05$. E.G. children presented more increased levels of red zone (M=1.15, S.D. = .37) than C.G. children (M= -1.80, S.D. = .41) (1: Yes, 2: No).

According to data analysis, children with ASD presented more increased rates of motor clumsiness than those of TD. 85% of E.G. children (n=17) were classified into red zone (severe motor difficulties) and the other 15% (n=3) was found to be at risk of motor clumsiness (orange zone). No one of them was of the green zone (without motor difficulties). On the contrary, 20% of C.G. children (n=4) were indicated with definite DCD, 20% of them (n=4) were at risk and 60% (n=12) was found not to present any motor difficulty.

According to frequencies data analysis that is described below E.G. and C.G. children presented differentiated score levels on self-care, classroom, ball and physical Education/leisure skills in static/predictable and potential/unpredictable conditions. As regards children's with ASD and TD scores on self-care skills in static/predictable environment, 26% of E.G. children were marked with "0" (very good), 42% with "1" (good), 27% with "2" (almost) and 5% with "3" (not at all). However, 60% of

C.G. children achieved "very good" marking, 11% "good", 4% "almost" and no one of them was marked with "3" (not at all).
As regards children's with ASD and TD scores on classroom skills in static/predictable environment, 42% of E.G. children were marked with "0" (very good), 31% with "1" (good), 17% with "2" (almost) and 10% with "3" (not at all). On the other hand, 88% of C.G. children achieved "very good", 8% "good", 3% "almost" and only 1% was marked with "3" (not at all).
According to data results, children's with ASD and TD scores on Physical Education/leisure skills in static/predictable environment are the following: 59% of E.G. children were marked with "0" (very good), 21% with "1" (good), 18% with "2" (almost) and only 2% with "3" (not at all). However, 78% of C.G. children achieved "very good", 18% "good", 4% "almost" and no one of them was marked with "3" (not at all).
As regards children's with ASD and TD scores on self-care and classroom skills in potential/unpredictable environment, data analysis indicated that 25% of E.G. children were marked with "0" (very good), 20% with "1" (good), 54% with "2" (almost) and 1% with "3" (not at all). On the contrary, 84% of C.G. children achieved "very good" marking, 12% "good", 2% "almost" and 2% was marked with "3" (not at all).

Data analysis also indicated that children's with ASD and TD scores on ball skills in potential/unpredictable environment are as follows: 11% of E.G. children were marked with "0" (very good), 40% with "1" (good), 35% with "2" (almost) and 14% with "3" (not at all). As regards the C.G. children, 80% of them achieved "very good", 13% "good", 5% "almost" and 2% was marked with "3" (not at all).

Furthermore, children's with ASD and TD scores on Physical Education/leisure skills in potential/unpredictable environment are the following: 35% of E.G. children were marked with "0" (very good), 23% with "1" (good), 20% with "2" (almost) and 22% with "3" (not at all). On the contrary, 90% of C.G. children achieved "very good", 8% "good", 2% "almost" and no one of them was marked with "3" (not at all).

Independent Samples t-test was conducted, in order to indicate possible differentiations in general levels of motor clumsiness (red zone, 1: Yes / 2: No) between males and females of ASD and TD groups. As regards children with ASD, t-test was statistically significant, $t(18) = 1.88$, $p < .05$. E.G. males presented more increased levels of red zone (M=1.07, S.D. = .26) than E.G. females (M=-1.40, S.D. =.55) (1: Yes / 2: No). As regards children with TD, t-test was also statistically significant, $t(18) = 1.10$, $p < .05$. C.G. males presented more increased levels of red zone (M=1.70, S.D. = .49) than C.G. females (M=-1.90, S.D. = .32) (1: Yes, 2: No).

According to data analysis, 93% of males with ASD and 60% of females were classified into red zone (severe motor difficulties). However, 7% of males were found to be at risk of motor clumsiness (orange zone), while 40% of females was at risk. No one of them (males and females with ASD) was of the green zone (without motor difficulties). Similarly, males of C.G. presented more increased rates of motor clumsiness than females. 30% of males with TD and 10% of females were indicated with definite DCD, while 20% of both of them were at risk. 50% of males and 70% of females were classified into green zone, without any motor difficulty.

According to frequencies data analysis males and females of E.G. and C.G. children presented differentiated score levels on self-care, classroom, ball and physical Education/leisure skills in static/predictable and potential/unpredictable conditions. Specifically, as regards children's with ASD and TD scores on self-care skills in static/predictable environment, by gender category, 25% of E.G. males and 28% of E.G. females were marked with "0" (very good), 39% of males and 52% of females with "1" (good), 32% of males and 12% of females with "2" (almost) and 4% of males and 8% of females with "3" (not at all). On the other hand, 72% of C.G. males and 98% of C.G. females achieved "very good" marking, 20% of males and 2% of females "good", 8% of males "almost" and no one of them was marked with "3" (not at all).

Moreover, children's with ASD and TD scores on classroom skills in static/predictable environment, by gender category are the following: 47% of E.G. males and 28% of E.G. females were marked with "0" (very good), 26% of males and 44% of females with "1" (good), 16% of males and 20% of females with "2" (almost) and 11% of males and 8% of females with "3" (not at all). On the other hand, 78% of C.G. males and 98% of C.G. females achieved "very good" marking, 14% of males and 2% of females "good", 6% of males "almost" and 2% of males was marked with "3" (not at all).

Regarding children's with ASD and TD scores on Physical Education/leisure skills in static/predictable environment by gender category, 57% of E.G. males and 64% of E.G. females were marked with "0" (very good), 21% of males and 20% of females with "1" (good), 19% of males and 16% of females with "2" (almost) and 3% of males with "3" (not at all). However, 70% of C.G. males and 86% of C.G. females achieved "very good" marking, 22% of males and 14% of females "good", 8% of males "almost" and no one of them (males and females) was marked with "3" (not at all). In addition, children's with ASD and TD scores on self-care and classroom skills in potential/unpredictable environment, by gender category are the following: 23% of E.G. males and 32% of E.G. females were marked with "0" (very good), 16% of males and 32% of females with "1" (good), 61% of males and 32% of females with "2" (almost) and 4% of females with "3" (not at all). On the other hand, 74% of C.G. males and 93% of C.G. females achieved "very good" marking, 18% of males and 7% of females "good", 4% of males "almost" and 4% of males was marked with "3" (not at all).

According to children's with ASD and TD scores on ball skills in potential/unpredictable environment by gender category, 11% of E.G. males and 12% of E.G. females were marked with "0" (very good), 44% of males and 28% of females with "1" (good), 32% of males and 44% of females with "2" (almost) and 13% of males and 16% of females with "3" (not at all). However, 72% of C.G. males and 88% of C.G. females achieved "very good" marking, 14% of males and 12% of females "good", 12% of males "almost" and 2% of males was marked with "3" (not at all).

Children's with ASD and TD scores on Physical Education/leisure skills in potential/unpredictable environment by gender category are as follows: 33% of E.G. males and 40% of E.G. females were marked with "0" (very good), 23% of males and 24% of females with "1" (good), 21% of males and 16% of females with "2" (almost) and 23% of males and 20% of females with "3" (not at all). On the other hand, 82% of C.G. males and 98% of C.G. females achieved "very good" marking, 14% of males and 2% of females "good", 4% of

males "almost" and no one of them was marked with "3" (not at all).

One Way ANOVA parametric test was used by the researcher, in order to indicate or not possible statistically significant differentiations in general levels of motor clumsiness of children with ASD and those of TD, by age category. The basic conditions that were examined, in order for the One Way ANOVA test to be applied, were the following: normality of distribution, homogeneity of variances (homoscedasticity) and independence of residuals. Individual diagnostic tests Kolmogorov Smirnov and Shapiro Wilk were performed. According to relevant findings for the variables of age and red zone, $p= .00$, $p< .05$. As a result, the two statistics were statistically significant at a rate of 5%. Despite the fact that the normality of distribution seemed to be violated for the age categories (5-6, 7-8, 9-10, 11-12), One Way ANOVA test (equality analysis of fluctuations and their uniform distribution) was used, producing less impartial findings. However, there was no violation in homoscedasticity, based on the relevant graph. According to Levene's test for the variables of age and red zone, $p< .05$, there was uniformity and homogeneity in distribution of the fluctuations of the ANOVA test As regards children with ASD, the findings of One Way ANOVA test were not statistically significant relatively to the rates of children's motor clumsiness by age category (dependent variable: red zone, 1: Yes / 2: No), $F (3, 16) = .58$, $p= .64$. Bonferroni test of multiple comparisons between age categories of E.G. children did not indicate significant differentiations in the red zone levels, $p= 1.00$. As regards children with TD, the findings were also not statistically significant relatively to the rates of children's motor clumsiness by age category (dependent variable: red zone, 1: Yes / 2: No), $F (3, 16) = .29$, $p= .83$. Bonferroni test of multiple comparisons between age categories of C.G. children did not indicate significant differentiations in the red zone levels, $p= 1.00$.

According to data analysis, 67% of the first E.G. age category (5-6), 75% of the second one (7-8), 83% of the third one (9-10), and 100% of the forth one (11-12) were found to be in red zone (definite DCD). 33% of the first E.G. age category (5-6), 25% of the second one (7-8), 17% of the third one (9-10), and no one of the forth one were classified into orange zone (at risk of motor clumsiness). No one of the E.G. age categories (5-6, 7-8, 9-10, 11-12) were classified into green zone. However, no one of the first C.G. age category (5-6), 25% of the second one (7-8), 16% of the third one (9-10) and 10% of the forth one (11-12) were found to be in red zone (definite DCD). No one of the first C.G. age category (5-6), no one of the second one (7-8), 42% of the third one (9-10) and 33% of the forth one (11-12) were classified into orange zone (at risk of motor clumsiness). 100% of the first C.G. age category (5-6), 75% of the second one (7-8), 42% of the third one (9-10) and 55% of the forth one (11-12) were found not to present any motor difficulty (green zone).

According to frequencies data analysis that is described belowsince E.G. and C.G. children did not present significantly differentiated score levels on self-care, classroom, ball and physical Education/leisure skills in static/predictable and potential/unpredictable conditions, by age category.

In particular, as regards children's with ASD and TD scores on self-care skills in static/predictable environment by age category, 27% of the first E.G. age category (5-6), 30% of the second one (7-8), 27% of the third one (9-10) and 23% of the forth one (11-12) were marked with "0" (very good). 33% of the first E.G. age category (5-6), 66% of the second one (7-8), 40% of the third one (9-10) and 27% of the forth one (11-12) were marked with "1" (good). 33% of the first E.G. age category (5-6), 4% of the second one (7-8), 30% of the third one (9-10) and 40% of the forth one (11-12) were marked with "2" (almost). 7% of the first E.G. age category (5-6), no one of the second one (7-8), 3% of the third one (9-10) and 10% of the forth one (11-12) were marked with "3" (not at all). On the other hand, 90% of the first C.G. age category (5-6), 85% of the second one (7-8), 75% of the third one (9-10) and 94% of the forth one (11-12) were marked with "0" (very good). 10% of the first C.G. age category (5-6), 5% of the second one (7-8), 18% of the third one (9-10) and 6% of the forth one (11-12) were marked with "1" (good). No one of the first C.G. age category (5-6), 10% of the second one (7-8), 7% of the third one (9-10) and no one of the forth one (11-12) were marked with "2" (almost). No one of the E.G. age categories (5-6, 7-8, 9-10, 11-12) were marked with "3" (not at all).

Children's with ASD and TD scores on classroom skills in static/predictable environment by age category are the following: 40% of the first E.G. age category (5-6), 40% of the second one (7-8), 47% of the third one (9-10) and 40% of the forth one (11-12) were marked with "0" (very good). 40% of the first E.G. age category (5-6), 30% of the second one (7-8), 30% of the third one (9-10) and 30% of the forth one (11-12) were marked with "1" (good). 13% of the first E.G. age category (5-6), 30% of the second one (7-8), 13% of the third one (9-10) and 10% of the forth one (11-12) were marked with "2" (almost). 7% of the first E.G. age category (5-6), no one of the second one (7-8), 10% of the third one (9-10) and 20% of the forth one (11-12) were marked with "3" (not at all). On the other hand, 90% of the first C.G. age category (5-6), 85% of the second one (7-8), 85% of the third one (9-10) and 94% of the forth one (11-12) were marked with "0" (very good). 10% of the first C.G. age category (5-6), 5% of the second one (7-8), 12% of the third one (9-10) and 4% of the forth one (11-12) were marked with "1" (good). No one of the first C.G. age category (5-6), 5% of the second one (7-8), 7% of the third one (9-10) and 2% of the forth one (11-12) were marked with "2" (almost). No one of the first E.G. age category (5-6), 5% of the second one (7-8), no one of the third one (9-10) and no one of the forth one (11-12) were marked with "3" (not at all).

As regards children's with ASD and TD scores on Physical Education/leisure skills in static/predictable environment by age category, 60% of the first E.G. age category (5-6), 68% of the second one (7-8), 63% of the third one (9-10) and 50% of the forth one (11-12) were marked with "0" (very good). 27% of the first E.G. age category (5-6), 32% of the second one (7-8), 17% of the third one (9-10) and 13% of the forth one (11-12) were marked with "1" (good). 13% of the first E.G. age category (5-6), no one of the second one (7-8), 17% of the third one (9-10) and 37% of the forth one (11-12) were marked with "2" (almost). No one of the first E.G. age category (5-6), no one of the second one (7-8), 3% of the third one (9-10) and no one of the forth one (11-12) were marked with "3" (not at all). On the other hand, 100% of the first C.G. age category (5-6), 95% of the second one (7-8), 62% of the third one (9-10) and 81% of the forth one (11-12) were marked with "0" (very

good). No one of the first C.G. age category (5-6), 5% of the second one (7-8), 26% of the third one (9-10) and 19% of the forth one (11-12) were marked with "1" (good). No one of the first C.G. age category (5-6), no one of the second one (7-8), 7% of the third one (9-10) and no one of the forth one (11-12) were marked with "2" (almost). No one of the C.G. age categories (5-6, 7-8, 9-10, 11-12) were marked with "3" (not at all).

Furthermore, according to data analysis, children's with ASD and TD scores on self-care and classroom skills in potential/unpredictable environment by age category were indicated as follows: 13% of the first E.G. age category (5-6), 38% of the second one (7-8), 30% of the third one (9-10) and 17% of the forth one (11-12) were marked with "0" (very good). 40% of the first E.G. age category (5-6), 9% of the second one (7-8), 20% of the third one (9-10) and 20% of the forth one (11-12) were marked with "1" (good). 47% of the first E.G. age category (5-6), 53% of the second one (7-8), 50% of the third one (9-10) and 60% of the forth one (11-12) were marked with "2" (almost). No one of the first, second and third E.G. age categories (5-6, 7-8, 9-10) and 3% of the forth one (11-12) were marked with "3" (not at all). On the contrary, 100% of the first C.G. age category (5-6), 95% of the second one (7-8), 75% of the third one (9-10) and 86% of the forth one (11-12) were marked with "0" (very good). No one of the first C.G. age category (5-6), 5% of the second one (7-8), 18% of the third one (9-10) and 10% of the forth one (11-12) were marked with "1" (good). No one of the first, second and third C.G. age categories (5-6, 7-8, 9-10) and 4% of the forth one (11-12) were marked with "2" (almost). No one of the first E.G. age category (5-6), no one of the second one (7-8), 7% of the third one (9-10) and no one of the forth one (11-12) were marked with "3" (not at all).

Children's with ASD and TD scores on ball skills in potential/unpredictable environment by age category are the following: 7% of the first E.G. age category (5-6), 10% of the second one (7-8), 17% of the third one (9-10) and 10% of the forth one (11-12) were marked with "0" (very good). 13% of the first E.G. age category (5-6), 70% of the second one (7-8), 40% of the third one (9-10) and 30% of the forth one (11-12) were marked with "1" (good). 67% of the first E.G. age category (5-6), 20% of the second one (7-8), 30% of the third one (9-10) and 33% of the forth one (11-12) were marked with "2" (almost). 13% of the first E.G. age category (5-6), no one of the second one (7-8), 13% of the third one (9-10) and 27% of the forth one (11-12) were marked with "3" (not at all). On the other hand, 100% of the first C.G. age category (5-6), 80% of the second one (7-8), 78% of the third one (9-10) and 82% of the forth one (11-12) were marked with "0" (very good). No one of the first C.G. age category (5-6), 5% of the second one (7-8), 12% of the third one (9-10) and 16% of the forth one (11-12) were marked with "1" (good). No one of the first C.G. age category (5-6), 10% of the second one (7-8), 10% of the third one (9-10) and 2% of the forth one (11-12) were marked with "2" (almost). No one of the first E.G. age category (5-6), 5% of the second one (7-8), no one of the third one (9-10) and no one of the forth one (11-12) were marked with "3" (not at all).

Moreover, as regards children's with ASD and TD scores on Physical Education/leisure skills in potential/unpredictable environment by age category 40% of the first E.G. age category (5-6), 45% of the second one (7-8), 33% of the third one (9-10) and 47% of the forth one (11-12) were marked with "0" (very good). 13% of the first E.G. age category (5-6), 25% of the second one (7-8), 27% of the third one (9-10) and 23% of the forth one (11-12) were marked with "1" (good). 34% of the first E.G. age category (5-6), 12% of the second one (7-8), 17% of the third one (9-10) and 23% of the forth one (11-12) were marked with "2" (almost). 13% of the first E.G. age category (5-6), 18% of the second one (7-8), 23% of the third one (9-10) and 7% of the forth one (11-12) were marked with "3" (not at all). On the other hand, 100% of the first C.G. age category (5-6), 95% of the second one (7-8), 87% of the third one (9-10) and 87% of the forth one (11-12) were marked with "0" (very good). No one of the first C.G. age category (5-6), no one of the second one (7-8), 10% of the third one (9-10) and 13% of the forth one (11-12) were marked with "1" (good). No one of the first C.G. age category (5-6), 5% of the second one (7-8), 3% of the third one (9-10) and no one of the forth one (11-12) were marked with "2" (almost). No one of the E.G. age categories (5-6, 7-8, 9-10, 11-12) were marked with "3" (not at all).

Independent Samples t-tests were used by the researcher, in order to indicate possible differentiations in the additional known difficulties and the non-motor factors that affect the movement between children with ASD and those of TD. Children with ASD and TD did not present similar levels in all the additional and non motor factors that affect their motor performance.

As regards the additional known difficulties of children, t-test for social adaptation difficulty was statistically significant, $t(38) = 8.33$, $p < .05$, E.G. children presented more increased levels of social adaptation difficulty ($M=1.15$, $S.D. = .22$) than C.G. children ($M=1.95$, $S.D. = .37$) (1: Yes / 2: No). T-test for generalized learning difficulty was also statistically significant, $t(38) = 2.48$, $p < .05$, $t(38) = 5.30$, $p < .05$, E.G. children presented more increased levels of generalized learning difficulty ($M=1.50$, $S.D. = .51$) than C.G. children ($M=1.85$, $S.D. = .37$) (1: Yes / 2: No). T-test for attention difficulty was not statistically significant, $t(38) = .87$, $p = .39$, E.G. ($M=1.80$, $S.D. = .31$) and C.G. ($M=1.90$, $S.D. = .41$) children presented similar levels of attention difficulty (1: Yes / 2: No). T-test for speech difficulty was also not statistically significant, $t(38) = .00$, $p = 1.00$, E.G. ($M=1.95$, $S.D. = .22$) and C.G. ($M=1.95$, $S.D. = .22$) children presented the same levels of speech difficulty (1: Yes / 2: No). T-test for reading difficulty was not statistically significant, $t(38) = 1.93$, $p = .61$, E.G. ($M=1.65$, $S.D. = .49$) and C.G. ($M=1.90$, $S.D. = .31$) children presented similar levels of reading difficulty (1: Yes / 2: No). However, t-test for emotional control difficulty was statistically significant, $t(38) = 2.85$, $p < .05$, E.G. children presented more increased levels of emotional control difficulty ($M=1.60$, $S.D. = .50$) than C.G. children ($M=1.95$, $S.D. = .22$) (1: Yes / 2: No).

Specifically, E.G. children presented additional known difficulties related to the following areas at the following rates: social adaptation: 85%, generalized learning: 50%, attention: 20%, speech: 5%, reading: 35% and emotional control: 35%. Only 5% of children with ASD found not to experience any additional difficulty, in accordance to educators' responses. On the contrary, C.G. children presented the corresponding additional difficulties in the following rates: social adaptation: 5%, generalized learning: 15%, attention: 10%, speech: 5%, reading: 10% and emotional control: 5%. 85% of children with

TD found not to experience any additional difficulty, in accordance to educators' responses.

As regards the non-motor factors that affect the movement, t-tests for C.1, C.2, C.3, C.4, C.6, C.7, C.9, C12 and C.13 were not statistically significant. Children with ASD and TD presented similar levels of the above-mentioned non-motor factors. On the contrary, t-test for C.5 was statistically significant, E.G. children (M=1.55, S.D. = .51) presented more increased levels of C.5 factor than C.G. children (M=1.90, S.D. = .30) (1: Yes / 2: No). T-test for C.8 was statistically significant, E.G. children (M=1.40, S.D. = .50) presented more increased levels of C.8 factor than C.G. children (M=1.85, S.D. = .37) (1: Yes / 2: No). T-test for C.10 was statistically significant, E.G. children (M=1.70, S.D. = .47) presented more increased levels of C.10 factor than C.G. children (M=1.95, S.D. = .22) (1: Yes / 2: No). T-test for C.11 was also statistically significant, E.G. children (M=1.45, S.D. = .51) presented more increased levels of C.11 factor than C.G. children (M=1.95, S.D. = .22) (1: Yes / 2: No).

In particular, E.G. children exhibited the following behavioral aspects: they were found to be disorganized (15%) (C.1), hesitant/forgetful (20%) (C.2), passive (35%) (C.3), timid (20%) (C.4), anxious/worried (45%) (C.5), impulsive (30%) (C.6), with attention deficit (30%) (C.7), hyperactive (60%) (C.8). They also seemed to overestimate (10%) and underestimate (35%) their abilities (C.9, C.10). 50% of them were found to present lack of persistence (C.11), 10% was upset with the failure (C.12) and no one of them was unable to delight the success (C.13). C.G. children also exhibited the above behavioral aspects as follows: they were found to be disorganized (5%) (C.1), hesitant/forgetful (15%) (C.2), passive (10%) (C.3), timid (5%) (C.4), anxious/worried (10%) (C.5), impulsive (15%) (C.6), with attention deficit (10%) (C.7), hyperactive (15%) (C.8). They also seemed to overestimate (20%) and underestimate (5%) their abilities (C.9, C.10). 5% of them were found to present lack of persistence (C.11), no one of them was upset with the failure (C.12) and unable to delight the success (C.13).

As it has been mentioned above, children were classified into the corresponding zones (red, orange, green) in accordance to their total score on the above-analyzed parameters of the questionnaire in conjunction with their age. However, before the calculation of the score, educators' were asked to express their overall assessments regarding the motor difficulty existence in children. Teachers' answers indicated that 85% of E.G. children presented motor impairments and 15% of them did not. On the contrary, according to educators' general assessments, 20% of C.G. children exhibited motor problems and 80% of them did not.

Finally, as regards E.G. children, who were found to present motor difficulty, in accordance to educators' overall assessments, they seemed to be affected on the following areas: learning in classroom (53% a lot, 47% a little), Physical Education/leisure skills (35% a lot, 65% a little), self-esteem (12% a lot, 88% a little) and social interaction (29% a lot, 71% a little). C.G. children, who were assessed by educators to exhibit motor impairments, they also seemed to be affected on the following areas: learning in classroom (100% a little), Physical Education/leisure skills (50% a lot, 50% a little), self-esteem (75% a lot, 25% a little) and social interaction (50% a lot, 25% a little, 25% not at all).

DISCUSSION

The current research findings are in line with findings of researches conducted both in international and Greek school population. Several previous studies indicated the high comorbidity level between ASD and DCD (Wisdom *et al*., 2007; Kopp, Beckung&Gillberg, 2010; MacNeil&Motofsky, 2012). Moreover, Green and colleagues (2009), through their study, also found that 79% of children with ASD exhibited motor coordination problems. According to another study, the percentage of children with ASD, who were characterized by severe motor difficulties, was 82% (Jansiecz *et al*., 2006). Kopp, Beckung and Gillberg (2010) concluded that 80% of pre-school girls with ASD presented coordination impairments mainly in gross mobility. Similarly, high levels of developmental motor deficits in children with ASD were established by Lloyd, MacDonald and Lord (2013). In addition, 68% of children with ASD were found to experience severe gait abnormality, in accordance with another relevant research (Shetreat-Klein, Shinnar&Rapin, 2012). However, there is no previous research related to motor clumsiness levels of Greek children with ASD.

As regards the typically developing children, the present research is also certified by findings of previous studies in a great extent. According to international bibliography, 4%-9% of children with TD were found to present severe motor impairments (Dewey & Wilson, 2001), while 10%-15% of them exhibited moderate problems (Zwicker, Harris &Klassen, 2012) and 30% of them experienced mild motor difficulties (Dewey *et al*., 2002). Jansiecz and colleagues (2006), through their study, also established that 13% of typically developing children displayed definite DCD. It is obvious that the international findings of previous researches in children of TD indicated similar but lower rates of motor clumsiness, in comparison with the present research that concerns Greek children (20%).

The increased rate of motor clumsiness in typically developing children (20%) that was indicated by the current research is in line with the findings of several previous studies in Greek school population. According to Tsiotra and colleagues (2006), Greek school children were found to present definite DCD at a rate of 19%. Additionally, 24% of children with TD were established to experience significant, moderate and mild coordination difficulties, while 57% of them were of average motor proficiency and 18% of them achieved high motor performance, in accordance with another relevant study (Ellinoudis *et al*., 2008). Kambas and colleagues (2012) also indicated that 21.2% of children with TD presented poor motor performance, in contrast to 64.8% of them, who were of the average motor category. Similarly, according to another study conducted in Greek typically developing children, 25% of them were also found to exhibit severe motor impairments (Venetsanou&Kambas, 2016). However, Tserkerzoglou, Kourtessis and Kapsalas (2003) noted that children with TD experienced motor coordination problems at lower rate of 13.3%. Kourtessis and colleagues (2003) also found that typically developing children presented motor clumsiness at similar rate to the above-mentioned study (12%). There is also a study that indicated a significantly reduced rate of motor

impairments in Greek preschoolers (7%), in comparison to the other researches (Asonitou *et al*., 2012).

As regards the individual motor areas that were examined through the MABCC-2, the present findings indicated that children of the two groups presented significantly differentiated scores on most of them. More specifically, children's scores on self-care and classroom skills in static/predictable conditions were differentiated (E.G. children presented significantly lower scores on motor performance than those of C.G.). However, regarding to their Physical Education/leisure skills in static/predictable environment, the present research findings indicated that children of the two groups presented almost similar scores, since they were marked with "very good", as follows: E.G.: 59%, C.G.: 78%. On the other hand, children's scores on self-care, classroom, ball and Physical Education/leisure skills in potential/unpredictable conditions were found to be significantly differentiated without any exclusion (E.G. children presented significantly lower scores on motor performance in potential/unpredictable environment than those of C.G.).

Several studies conducted in children with ASD compared to those of TD certify the above research findings (Forti *et al*., 2011; Brisson *et al*., 2012; Gowen& Hamilton, 2013). Specifically, Jasmin and colleagues (2009) found that children with ASD presented significantly lower levels of motor and daily living skills than those of TD. In addition, according to another study, children of ASD group exhibited significantly more increased deficits in gait and postural control, as well as more reduced coordination of locomotor skills, in comparison with those of TD group (Nayate *et al*., 2012). Similarly, children with ASD were found to achieve significantly lower scores on their gross motor performance than that of children with TD (Papadopoulos *et al*., 2007). Significantly increased delays in ball, fine, gross and manipulative skills of children with ASD in comparison with those of TD were also established by other researchers (Derri, Zisi&Pachta, 2001; Venetsanou *et al*., 2009). Ament and colleagues (2015) also indicated significantly different scores on motor control, coordination, manual dexterity, the static balance and ball skills between children with and without ASD. Children with ASD achieved lower scores on the above motor areas in comparison with those of TD.

The present research findings also indicated that children presented significantly differentiated levels of motor clumsiness by gender category. Males of the two groups were found to experience more increased motor difficulties than females. Specifically, males with ASD exhibited coordination problems at a rate of 93%, while 7% of them were at risk of developing motor clumsiness. On the contrary 60% of females had motor difficulties and 40% of them were at risk of developing motor clumsiness. As regards typically developing children, 30% of males in contrast to 10% of females presented motor impairments. 20% of both of them were at risk of developing motor clumsiness, while 50% of males and 70% of females were found to be without any motor difficulty. On the other hand, according to present research findings, age was not found to significantly affect children's motor score. Children of the two groups presented similar levels of motor clumsiness by age category. In particular, children with ASD exhibited the following rates by age category: 5-6: 67%, 7-8: 75%, 9-10: 83%, 11-12: 100%. Children of TD presented the following rates by age category: 5-6: 0%, 7-8: 25%, 9-10: 16%, 11-12: 10%.

Asonitou and colleagues (2012), though their study, also indicated that there were gender differentiations in children's with TD motor clumsiness levels. Specifically, boys were found to experience motor deficits at a rate of 67% in contrast to 33% of girls, who had motor coordination difficulties. Similarly, Kourtessis and colleagues (2008) found that boys exhibited more increased levels of motor difficulties than girls. However, according to another survey conducted in typically developing children that stressed contradictory findings to the present research, the participants did not present gender differences in DCD levels. Ellinoudis and colleagues (2008) did not indicate significant effect of the gender and the age on the examined motor areas (manual dexterity, ball and balance skills). On the contrary, age was found to significantly affect children's motor performance in contrast to the present findings (Venetsanou&Kambas, 2016). Age differentiations in children's with ASD motor clumsiness levels were also indicated by another studies (Kopp, Beckung&Gillberg, 2010; Lloyd, MacDonald & Lord, 2013). Specifically, motor delays of children were broadened as they got older. As a consequence of the above contradictory findings, gender and age differentiations in motor clumsiness levels could be a field for further investigation in more extended sample.

Regarding the additional known difficulties of children that could affect their motor performance, children with ASD and those of TD were found no to present similar levels in all of them. Children with ASD exhibited more increased rates of the difficulties related to social adaptation (85%), generalized learning (50%) and emotional control (35%) areas, in comparison with those of TD (5%, 15% and 5%). However, children of the two groups did not present significantly different levels of their attention, speech and reading difficulties (20%-10%, 5%-5%, 35%-10%). In addition, children with ASD and those of TD were not seemed to display similar rates of all the non-motor factors that affect their movement. 45% of children with ASD and 10% of those with TD were found to be anxious or worried, 60% of those with ASD and 15% of those with TD were hyperactive, 35% of the first group children were indicated to underestimate their abilities in contrast to 5% of the second group children. 50 % of children with ASD in contrast to 5% of those with TD were characterized by lack of persistence. As regards their other behavioral aspects that affect motor performance, children of the two groups presented similar levels. They were found to be disorganized (15%-5%), hesitant/forgetful (20%-15%), passive (35%-10%), timid (20%-5%), impulsive (30%-15%) and with attention deficit (30%-10%). They also seemed to overestimate their abilities (10%-20%) and be upset with failure (10%-0%). No one of them was found to be unable to delight the success.

From the above research findings it occurred that children with ASD presented more increased levels of the additional difficulties and the non-motor factors that affect their movement than those of TD, except from one aspect related to the overestimation of their abilities. The increased levels of these difficulties (including social adaptation, generalized learning, emotional control and others) in children with ASD could be correlated to the nature and etiology of ASD, as well as to their mild Mental Retardation that coexisted with ASD. As a result, the differentiation in motor clumsiness levels

between children of the two groups, as regards their additional and non-motor difficulties, seemed to be affected by autistic characteristics of children. Kopp, Beckung and Gillberg (2010) also established that autistic symptoms in conjunction with the IQ level contributed to increased levels of DCD in children with ASD. However, this field may need further and specific investigation by more researchers.

Through processing the current research findings, it was also established that educators' overall assessments were in line with children's total scores on their motor performance. Specifically, Physical Education teachers estimated that 85% of children with ASD presented motor clumsiness and 15% of them did not. According to their total scores, 85% of children with ASD were classified into red zone (with severe motor difficulties) and the other 15% of them into orange zone (at risk of developing motor clumsiness). As regards children with TD, educators estimated that 20% of them presented DCD and 80% of them did not. According to their total scores, 20% of children with TD were classified into red zone, 20% of them into orange zone and 60% of them into green zone (without any motor difficulty).

It was also significant that the present research indicated that motor performance of children and their motor deficits had an impact in several areas related to their overall development. In particular, as regards children with ASD, the areas that were found to be affected by their motor clumsiness were the following: learning in classroom (47% a little, 53% a lot), Physical Education/leisure skills (65% a little, 35% a lot), self-esteem (88% a little, 12% a lot) and social interaction (71% a little, 29% a lot). Children of TD were found to be affected in the corresponding areas at the following rates: learning in classroom (100% a little), Physical Education/leisure skills (50% a little, 50% a lot), self-esteem (25% a little, 75% a lot) and social interaction (25% not at all, 25% a little, 50% a lot). Several noted experts stressed the significance of children's motor development in their overall evolution associated with several fields such as educational and socio-emotional (Kroes *et al*., 2004; Rosenbaum, 2005; Missiuna *et al*., 2006; Cairney *et al*., 2010; Cashon *et al*., 2013). In other words, DCD was found to be accompanied by lack of confidence, low self-esteem, under-performance in school and loneliness of children (Zwicker *et al*., 2012).

Finally, it is essential to be clarified that this research investigated motor clumsiness of 40 children with ASD and TD only through their educators' observations, using the MABCC-2 questionnaire. Children with ASD, who participated in the research, were of the same intellectual level, presenting mild Mental Retardation. Attending General Education schools, children of Typical Development were considered of typical intellectual level. All the children did not have any diagnosed neuromuscular problem or motor disabilities. They were also from two municipalities of Northern Greece. As a result, generalization of conclusions drawn from the present research concerns the specific population that was represented by the research sample and should be in accordance with the research delimitations and limitations

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How to cite this article:

Dimitra Katsarou *et al* (2018) 'Investigation of Developmental Coordination Disorder in Children with Autistic Spectrum Disorder and Those of Typical Development Through Educational Observation', *International Journal of Current Advanced Research,* 07(4), pp. 11853-11864. DOI: http://dx.doi.org/10.24327/ijcar.2018.11864.2067

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