

Development of Motor-Life-Skills: Variations in Children at Risk for Motor Difficulties from the Toddler Age to Preschool Age

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Abstract

This article explores variations in development of everyday motor-life-skills in 661 children (329 girls and 332 boys) in Norwegian kindergartens of ages 2:9 (T1) and 4:9 (T2) years:months. The particular focus is on children at risk for problems in motor development (the 10 % weakest children in the sample). The methodological approach chosen is authentic assessment (Bagnato & Macy 2010), applying the Early Years Movement Skills Checklist (EYMSC, Chambers and Sugden 2002, 2006). All correlations between motor-life-skills at ages 2:9 and 4:9 are statistically significant ($p < 0.01$), varying between $r = .26$ to $.38$ for the four section scores of EYMSC (Self-help skills, Desk skills, General classroom skills and Recreational and playground skills) and $r = .39$ for the EYMSC total score. The group composition of children assumed to be at risk for motor difficulties changes considerably between ages 2:9 and 4:9. Approximately two-thirds of the 10 % weakest at T1 do not belong to the 10 % weakest at T2. Logistic regression failed to identify children at risk at T1 being among the 10 % weakest at T2. However, for two sections of EYMSC (Self-help skills; Recreational and Playground skills), it was possible to distinguish between stable and flux groups.

Introduction

In Norway today, the vast majority of toddlers attend Early Childhood Education and Care (ECEC) institutions on a full time basis (Statistics Norway 2015). Yet, according to Bjørnstad and Pramling Samuelsson (2012), there still is a lack of research-based knowledge about their skill development, especially concerning children with developmental challenges. The overall purpose of this study is to explore the variability and stability of motor-life-skill development in kindergarten age, which in Norway means from 1 to 5 years, particularly focusing on children at risk for motor difficulties.

Terminology

Following the understanding of Adams (1987), *motor skills* are learned and goal-directed solutions of specific tasks requiring movement. *Motor-life-skills* can be understood as a subset of what in the literature is referred to as life-skills (Hanley et al. 2007) or daily living skills (Jasmin et al. 2009), denoting the skills a child should have available to cope with daily demands and challenges for action in an everyday life context. *At risk for motor difficulties* is defined as the group of children scoring below the 10th percentile in motor-life-skills (Early Years Movement Skills Checklist - EYMSC, Chambers and Sugden 2002, 2006). This study aims to look at the dynamics of motor development from toddler to preschool age. We define children who are crossing the 10th percentile from age 2:9 (T1) to age 4:9 (T2) in either one direction or the other as *flux groups*, and children who remain in the weak or not-weak groups as *stable groups*.

The Importance of motor Skills

Motor skills are a fundamental requirement for intentional behaviour and goal directed actions in children's lives (von Hofsten 2004). Achieving appropriate motor behaviour builds on the acquisition of fundamental motor skills (motor-life-skills), an often undervalued

domain of development in young children's lives, taking place in interaction with the physical, social and cultural environment. Today, a number of studies support the assumption that early intervention for children at risk for motor difficulties can contribute significantly to the stimulation and enhancement of motor skill development (Goodway et al. 2003; Iivonen et al. 2011; Venetsanou and Kambas 2010).

Furthermore, cross-sectional and predictive studies confirm a positive relationship between motor and non-motor domains in early childhood (Asonitou et al. 2012; Bart, Hajami, and Bar-Haim, 2007; Fulton et al. 2006; Grissmer et al. 2010; Oudgenoeg-Paz, Leseman, and Volman, 2014; Piek et al. 2008; Reikerås, Moser, & Tønnessen, 2017; Trevlas, Matsouka, and Zachopoulou 2003; Wang et al. 2014). Thus, knowledge about the processes of motor development during early age is required for seeking developmentally appropriated practices, concerning all children and especially children at risk for motor difficulties.

Children at Risk for motor Difficulties

International studies indicate a prevalence of motor difficulties or Developmental Coordination Disorder (DCD) in school-aged children at approximately 5-6 % (Barnhart et al. 2003; Vaivre-Douret, 2014; Vaivre-Douret et al. 2011). Mæland (1992) confirmed this proportion has also been confirmed for Norwegian schoolchildren between 8 and 10 years old.

Recent studies further revealed that socially disadvantaged children have lower motor skills compared to non-disadvantaged children (Krombholz 2012; McPhillips and Jordan-Black 2007; Stagnitti et al. 2011; To et al. 2004; Venetsanou and Kambas 2010). Thus, weak motor skills could become an additional risk factor for children who already have somewhat lower chances in realizing their educational potentials.

Early assessment and intervention might have significant effects on single movement performance as well as for achieving developmental milestones (e.g., Asonitou et al. 2012; Brown 2010; Dziewolska and Cautilli 2006; Goodway, Crowe, and Ward 2003; Iivonen, Sääkslahti, and Nissinen 2011). Facilitating developmentally appropriate educational programmes to improve toddlers' motor skills (e.g., Gagen and Getchell 2006; Goodway et al. 2003) require that kindergarten staff are able to recognize and take into account the individual child's physical and motor prerequisites (Hardy et al. 2010; Robinson et al. 2012). Early assessment might be helpful in identifying specific motor and cognitive difficulties.

Inter-individual Variations in Development of motor Skills

Individual variations in the development of motor skills in early life are well documented (see for instance Adolph et al. 2008; Gasser et al. 2010; Largo et al. 2001a, 2001b, World Health Organization 2006). The individual development of motor skills is influenced by personal (e.g., Goodway, Robinson, and Crowe 2010; McPhillips and Jordan-Black 2007); environmental factors (e.g., Hua et al. 2014; Hwang et al. 2014; Iivonen, Saakslahti, and Nissinen 2011); and cultural factors (e.g., Adolph, Karasik, and Tamis-LeMonda 2012; van Rossem et al. 2012). Currently, little is known about individual variations in the motor development of children in Norwegian kindergartens.

Research Questions

The present study attempts to answer two overarching research questions and each consists of two interconnected sub-questions:

- 1) (a) What is the relationship between motor-life-skills at ages 2:9 (T1) and 4:9 (T2)?
(b) Is it possible to predict children at risk for motor difficulties at T2 based on the results at T1?

- 2) (a) Are there changes in the composition of groups of children at risk and not at risk for motor difficulties between ages 2:9 and 4:9? In case of such changes: (b) Does the level of motor-life-skills at T1 affect these changes?

Design and Method

The present study is part of the longitudinal, interdisciplinary Stavanger Project - The Learning Child, a collaboration between the National Centre for Reading Education and Research at the University of Stavanger, Norway, and the municipality of Stavanger. The study follows children from the age of two-and-a-half years to ten years old and focuses on the development of language, mathematics, and social, emotional and motor behaviour, the relation between these domains as well as their relation to reading, writing and arithmetic at school age.

Authentic Assessment

The methodological approach is in line with fundamental purposes of the national Framework plan (Ministry-of-Education-and-Research 2006), which emphasizes the importance of observations as a pedagogical tool in ECEC. Authentic assessment provides ecologically valid data and offers useful information about the children's functioning, strengths and weaknesses (Keilty, LaRocco, and Casell 2009). Data concerning the children's skills should be gained in a gentle and non-intrusive way, in accordance with the concept of authentic assessment (Bagnato et al. 2014; Macy and Bagnato 2010). Toddlers' interactions with their natural physical and social environments becomes the core objects of observation for providing important insight into the development of young children's skills (Mauritzson and Säljö 2001; Vygotsky 1997).

Data obtained via authentic assessment seems to be increasingly required as the majority of current knowledge is based on standardized assessments or surveys on reported behaviour (Downer et al. 2010). Several studies have documented the advantages of authentic assessment compared with standardized assessment (Bagnato and Macya 2010; Macya and Bagnato 2010) and, thus, this approach has become a recommended and accepted practice (Copple and Bredekamp 2009).

Recruitment and Participants

In total, 86 kindergartens in the Stavanger municipality participated in the project. Of these kindergartens, 61 were public institutions obliged to participate in the project by their owner (Stavanger municipality). The municipality invited all privately owned institutions, and 25 of them (50 %) accepted this invitation. In Norway, the differences between public and private kindergartens are rather small in terms of structural quality; the same law and regulations (e.g. curriculum framework) regulate all institutions. Differences in quality are in general relatively independent of ownership. The parents and guardians of children born between July 1, 2005, and December 31, 2007, in these kindergartens received oral and written information about the project and the implications for the children's participation in the study. Beyond the period of birth, no other criteria excluded a child from participating in the study.

At baseline (T1), educated staff members assessed the motor-life-skills of 1093 toddlers. All children had been enrolled in kindergarten before the age of 2:6 years:months. Between the first data collection (T1; 2:9) and the second one (T2; 4:9), 200 children moved out of the municipality. The total drop out between T1 and T2 (4:9), comprises 432 children (214 not observed in the correct time slot; 200 moved; 16 failures in registration; 2 withdraw of consent), equivalent 39.5 % of the baseline group at T1.

For the remaining 661 children (329 girls and 332 boys), data for both toddler age (T1) and preschool age (T2) were available. The group of children that dropped out after T1 comprised a slightly larger proportion of boys (229) than girls (203). In the dropout group, 15 % of the children were multilingual, which is somewhat less than that of the remaining group (19 %).

The mean difference in EYMSC Total score at T1 between the dropout group (M=39.38, SD =9.25) and the group of children still participating at T2 (M=39.83, SD=8.45) was small (.45; CI: -.623 to 1.512; Cohen's $d = .05$) and not significant (independent sample t-test; $t(1088) = .817$; $p = .414$; two tailed). We therefore assume that the remaining 661 children may still be considered as a representative sample for the municipality of Stavanger and, as such, for larger urban municipalities in Norway.

Instruments

Educated kindergarten staff applying the Early Years Movement Skills Checklist (EYMSC, Chambers and Sugden 2002, 2006) assessed the children's motor-life-skills. The total score for interrater reliability is .96 ($p < .01$), and the test-retest reliability is .95 ($p < .01$). EYMSC is validated against the Movement Assessment Battery for Children (Movement ABC, Henderson and Sugden 1992) revealing a validity coefficient of .76 ($p < .01$).

Moser and Reikerås (2016) provided information about the adaptation of the material to a Norwegian context. The material is divided into four sections, Self-help skills (six items), Desk skills (five items) General classroom skills (five items) and Recreational and playground skills (seven items). Each item is scored on a four-point scale to register how well a child masters the particular skills: Can do well = 1, Can just do = 2, Almost = 3 and Not close = 4. The item scores belonging to each section are summed to obtain a section score and the EYMSC total score. Before data analysis, the response categories were reversed coded so that

higher scores indicated higher skills (Not close = 1; Almost = 2; Can just do = 3; Can do well = 4).

EYMSC was developed for identifying movement difficulties in the age group of 3-5 years old (Chambers and Sugden 2002). Gundersen (2010) compared the EYMSC results of a Norwegian group of three year olds with the data from the English reference group (Chambers & Sugden, 2002) and found that Norwegian three year olds tended to perform better in section 1 and section 4 of the EYMSC. Furthermore, the 5 % weakest children scored significantly better than the 5 % weakest in the English group.

Moser and Reikerås (2016) examined the appropriateness of EYMSC for a group of 2;9 year olds in Norway with the 3 year olds in the English sample (Chambers & Sugden, 2006). There were no differences between the samples when it comes to sections 3 and 4, whilst the English sample performed on a higher level in section 1 and 2 and in the total score. The standard deviations in the Norwegian and the English group were comparable in all sections and the total score (Moser & Reikerås 2016, table 3, p. 126). These findings supported our choice of applying the EYMSC for the age group 2 years and 9 months in Norway.

Procedure and Data Collection

The children's motor-life-skills were systematically observed during play and daily life activities by the staff in the ECEC institutions during a period of three months (T1: 30-33 months of age; T2: 54-57 months of age) to ensure a variety of situations and occasions where the children could apply and express the motor-life-skills.

To strengthen the reliability of the data collection, prior to the observation periods, staff at the participating ECEC institutions participated in a training course. A detailed description of each item and guidelines for scoring was developed (Iversen and Larsen 2007).

Two staff members observed each child independently. When both staff had observed the motor-life-skill of interest at least two times independently, they cooperatively scored this particular skill in the child's EYMSC registration scheme.

Data Analysis

The Statistical Package for the Social Science (SPSS) version 21.0 (IBM Corporation 2013) was used for all statistical analysis. Alternately, one research assistant entered the data while another controlled the results of the data input. Data were double entered for randomly selected 10% participants revealing a concurrence >95%. Frequency analyses for all variables were conducted in the whole sample to check whether the values were within the range of possible values.

The EYMSC section and total scores has been processed on an interval scale level. Kurtosis and skewness of the distribution of data at T1 were evaluated by Q-Q-plots according to Tabachnick and Fidell (2013) and no significant deviation from normal distribution appeared. We therefore considered the prerequisites for applying parametric statistics as satisfactory concerning data at T1. Due to a ceiling effect, data at T2 was not normally distributed.

Research question 1a is answered by a Spearman rank order correlation based on the section scores and the total score of EYMSC at T1 and T2. Due to the ceiling effect at T2, direct logistic regression was applied to answer research question 1b, assessing the impact of the T1-results in the four sections of EYMSC for the probability of belonging to the weak or not-weak group at T2.

To answer research questions 2a and 2b the sample was divided into two groups; one group comprised approximately 10% of the children with the weakest motor-life-skills at age 2:9 (weak-T1; children at risk), while the other group comprised the remaining 90% of the

children without weak motor-life-skills at T1 (not-weak-T1). In the same manner, for the assessments at age 4:9, we defined the 10 % of the children with weakest motor-life-skills at T2 (weak-T2; children at risk), while the remaining 90 % represents children with no weak motor-life-skills at T2 (not-weak-T2).

To analyse potential patterns of change in motor-life-skills a further grouping was conducted creating two subgroups out of the weak group at T1: the stable group with weak skills at both T1 and T2 (weak/weak) and the flux group that is weak only at T1 but not at T2 (weak/not-weak). In the same way, for the not-weak group at T1, a stable group (not-weak/not-weak) and a flux group (not-weak/weak) were created.

Multivariate Analyses of Variance (MANOVA) were used to examine the differences between these groups at T1 for both EYMSC total and section scores. Post-hoc tests were applied to explore the differences between these groups.

Ethical Considerations

Young children usually have less power in child-adult relations (Powell et al. 2012); they are vulnerable and therefore deserve special respect and consideration as participants in a research project (Docket, Einarsdottir, and Perry 2009). Researchers paid particular attention in order to not expose the toddlers to any physical or psychosocial risks of being harmed.

The general guidelines for research ethics as formulated by the The Norwegian National Research Ethics Committees (2016) has been followed. All parents and guardians gave written consent. Data Protection Official for Research at the Norwegian Social Science Data Services approved the study.

Results

The presentation of results follows the two research questions.

The Relationship between Motor-Life-Skills at Ages 2:9 and 4:9

As expected, the children showed a clear increase of everyday motor-life-skills from toddler to preschool age (see table 1). While some individuals achieved maximum test scores for all sections at both T1 and T2, for the entire group mean values and minimum scores increased clearly from T1 to T2. The minimum total score improved from 38 to 46. The total EYMSC score at T2 (mean=89.54) is approximately 2.5 points lower than the highest attainable value of 92.0. This, again, indicates an obvious ceiling effect, which is also reflected in the distinct smaller standard deviations at T2 compared with T1.

[Table 1 near here]

The correlations between T1 and T2 for each section and the total score of EYMSC were all statistically significant ($p < 0.01$; Spearman's rho = .21-.28 for the four sections and .34 for the total score), i.e. small to medium strength according to Cohen (1988). This indicates a rather small potential for predicting the level of motor-life-skills from age 2:9 to 4:9.

For further assessing the possibility to predict children at risk for motor problems at T2 based on the EYMSC scores at T1 direct logistic regression was applied. The full model containing all predictors was statistically significant, $\chi^2(4, N=661) = 44,65$, $p < .05$, indicating that the model is able to distinguish between the weak and the not-weak group at T2. The model as a whole explained 6.5 % (Cox and Snell r square) and 13.4 % (Nagelkerke R square) of the variance, and correctly classified 88.7 % of the cases. Yet there were considerable differences in the classification for the two groups. While the assignment was correct for 99.5 % (582 out of 585 children) for the not-weak group at T2, the assignment was only correct for 5.3 % (4 out of 76 children) when it comes to the weak group at T2.

As shown in table 2, only two of the independent variables made a unique statistically significant contribution to the model (Self Help Skills and General Classroom Skills). An odd ratio less than 1 indicates that higher scores in this section make it more likely to end up in the not-weak group. The strongest predictor for not being in the weak group at T2 is having high scores on General Classroom Skills at T1.

[Table 2 near here]

Changes in the Compositions of Groups at Risk for motor Difficulties between T1 and T2

Based on EYMSC total score the 10.2 % of the children with the weakest motor-life-skills at age 2:9 are defined as group *weak T1* and the remaining 89.8 % without weak motor-life-skills at T1 as group *not-weak T1*. By the same token, at age 4:9, the 11.7 % of the children with weakest motor-life-skills at T2 (*weak T2*) were defined as at risk for motor difficulties, and the remaining 88.3 % of the children without weak motor-life-skills at T2 are defined as *not-weak T2* representing children not at risk. Because several children had identical test scores at T1 and T2, respectively, it was not possible to achieve a cut-off point of exactly 10 %.

Figure 1 gives an overview of the number of children in each group and illustrates the changes in the composition of the group of children from T1 to T2. The subgroups of children represented by the arrows reflects change (flux groups) versus stability (stable groups) regarding their belonging to either the weak group or the not weak group.

[Figure1 near here]

Only about one-third (24 children) of the 10 % (68) weakest children at T1 remain among the 11.7 % (76) weakest children at T2. This means, conversely, that about two-thirds (52) of the 10 % weakest children at T2 were not among the weakest at T1. These children show, compared with the motor development of the other children, a decrease in their motor-life-

skills from T1 to T2. Correspondingly, 44 children who were among the 10% weakest at T1 cross the line and are no longer part of the weakest group at T2. In total, 541 out of 593 children without weak motor-life-skills at T1 remain in the not-weak group at T2.

Table 3 presents EYMSC section scores and total scores for the four subgroups (two stable and two flux groups).

[Table 3 near here]

To explore differences between stable and flux groups at T1, a one-way analysis of variance (ANOVA) was conducted. Statistically significant differences ($p < .001$) were found between the groups in all four sections (Self Help skills, $F(3,657) = 57.53$; Desk skills, $F(3,657) = 61.35$; General Classroom skills, $F(3,657) = 109.08$; Recreational/Playground skills, $F(3,657) = 83.35$) as well as for the EYMSC total score ($F(3,657) = 169.97$).

Post-hoc comparison (Bonferroni test) revealed that the not-weak/not-weak group had better Self Help skills and a better Total score at T1 than the not-weak/weak group, while there were no differences for the remaining three sections.

Post-hoc comparison further showed that the weak/not-weak group had better Recreational and playground skills at T1 than the weak/weak group, while there were no significant differences regarding the other three sections and the Total score.

The post-hoc comparison (Bonferroni) further revealed that the two flux groups (not-weak/weak and weak/not-weak) differ significantly from each other in all four sections of the EYMSC as well as in the total score. This means that the children in the not-weak group at T1 who dropped to the weak group at T2 had better motor-life-skills in all four sections and the Total score at T1 compared with children who were in the weak group at T1 and ascended to the not-weak group at T2.

Finally and not surprisingly, considerable differences in the motor-life-skills between the two stable groups has been confirmed. The Bonferroni test revealed that the not-weak/not-weak group outperformed the weak/weak group largely in all four sections and in the Total score at T1.

Discussion

This study focuses on the motor development from toddler- to preschool-age children and places special attention on children at risk for motor difficulties investigating the relationship between motor-life-skills at ages 2:9 and 4:9. In addition, the predictive potential of the four sections of EYMSC at T1 has been examined regarding the children's belonging to the at risk group (i.e. the weakest 11.7 %) at T2. Furthermore, variability or stability in the composition of the group of children at risk for motor difficulties change between T1 and T2 has been explored. Finally changes in group composition has been analysed in terms of how the level of motor-life-skills at T1 affect the allocation of children to flux or stable groups between T1 and T2.

As body and movement represent a prominent domain of developmental change in young children's lives (von Hofsten 2004), it is not surprising that this study reveals a tremendous increase of the level of motor-life-skills from age 2:9 to 4:9, reflected in an increase of the mean EYMSC scores from 75.04 to 89.54.

Motor-life-skill scores between T1 and T2 have a shared variance between 4.41 % and 11.56 %, suggesting that between 89 % and 96 % of the variance at T2 is explained by other factors than the motor-skill level at T1. This result may imply an expression for individual dynamics in motor-life-skill development (Adolph et al. 2008; Gasser et al. 2010). In addition, one must consider that the children at T1 are somewhat younger than the age range that EYMSC was designed for. The development in such an early age might have a limited

potential for predication of the later development due to individual dynamics in skill development. Therefore, even if we considered the EYSMC as appropriate for this age group in Norway, the results should be interpreted carefully.

Even if the EYMSC is developed for age 3 to 5, the Norwegian sample in the current study scored very high at T2 (see table 1). The mean values of the sections are about 0.5. to 1.5 scores below the attainable maximum scores in the sections. The mean total score (89.54) is just about 2.5 points below the achievable maximum score (92). This skewed distribution contributed to clearly reduced standard deviations compared to T1. Thus, the rather weak relationship between the sections of EYMSC (and the moderate relationship for EYMSC total score) over a time period of approximately two years might also be explained by a ceiling effect at T2.

Yet, the main focus of this study is on children at risk for motor developmental problems, defined as the 10 % with weakest motor-life-skills at T1 and T2, respectively. For this group we assumed considerable larger variance at both points of time and thus we would expect minor consequences of the ceiling effect. EYMSC has been developed with particular focus on identifying children with weak motor skills and it has been proven to be reliable and valid for this group (Chambers and Sugden 2002).

The logistic regression model applying the dichotomy weak and not-weak group at T2 achieved to classify nine out of ten children correctly from T1 to T2. However, these were mainly the children belonging to the not-weak group at T2. The EYMSC sections Self Help Skills and General Class Room Skills at T1 were statistically significant predictors for belonging to the not-weak group at T2.

Hemgren and Persson (2009) have studied a comparable age group (3 and 6:5 years of age), but this Swedish sample consisted only of children in need of neonatal intensive care. The authors applied three age appropriate and standardized tests at age 6:5 to define motor

deviations and achieved clearly better predictions than we did in our study. This may indicate a certain superiority of such standardized instruments for predictive purposes compared with the EYMSC, which has its strength in identifying children with lower motor-life-skills and conforms the basic ideas of authentic assessment.

In our study, approximately one-third of the group with weak motor-life-skills (24 children) at age 2:9 remained in the weak group at age 4:9 while 44 children developed their motor-life-skills considerable from T1 to T2 and moved to the not-weak group. Children that moved the opposite way, from the not-weak group at T1 to the weak group at T2 nevertheless outperformed the children in the weak/not-weak group in all four EYMSC sections at T1. That indicates that an unambiguous identification of children at risk for motor difficulties is seemingly difficult to achieve in toddler age. Beside the methodological concerns mentioned above, this might be an indication of systematically inter-individual variability in motor development (Gasser et al., 2010; Largo et al. 2001a, 2001b). The onset of developmental motor processes may vary in the sense that children who have weaker motor-life-skills in toddler age (T1) may have a later onset of motor development processes and that individual differences in the timing of developmental processes might be responsible for the later onset. On the other hand, children who have attained a high level of motor-life-skills relatively early (T1) may have less progression motor development in a later period and thus being bypassed by children moving upward.

Among the children who were not-weak at T1, those who dropped to the weak group at T2 had lower Self Help skills than their peers who remained in the not-weak group and with a lower Total score. Thus, low Self Help skills at an early age may deserve special attention in regard to preventing a negative development in motor skills. The children who were in the weak group at T1 and increased their motor-life-skills in a way that they became

part of the not-weak group at T2 showed better Recreational and Playground skills at T1 compared with their peers who remained among the 10 % weakest at T2.

These results might indicate that Self Help skills and Recreational and Playground skills possibly have a greater potential as indicators for dynamics in the development of motor-life-skills than the two other sections of EYMSC. Furthermore, one could also consider whether Self Help skills and Recreational and Playground skills might have potential as domains for interventions to prevent negative and support positive development for children at risk for motor difficulties.

This study only partly supports the claimed advantages of authentic assessment compared with standardized assessments (Bagnato et al. 2010; Copple and Bredekamp 2009; Macya and Bagnato, 2010). Field experiences (Jølbu 2014) indicate that EYMSC has sharpened and widened the staff's everyday observations and made them more sensitive regarding children's motor-life-skills. As such, authentic assessment may contribute to a higher awareness for challenging and stimulating the motor development and learning of toddlers. Focusing systematically on skills and skill development of each individual child might be a crucial factor to support motor-life-skill development for all children.

Critical Reflections and Limitations

Several factors relevant for this study may limit the trustworthiness and generalizability of the findings.

Firstly the age-group at T1 in the current study lies outside the age range the EYMSC was designed for (age 3 to 5). However, the results of EYMSC section scores and the total score at T1 does not indicate severe problems, since the scores are mainly normal distributed,

have satisfactory standard deviations, and the mean values in the middle of the scale range (see table 1). Yet, a cautious interpretation of the findings is necessary.

Secondly, the ceiling effect at T2 reduced the variance of the level of motor-life-skills and thereby limited the opportunity to utilize a variety of statistical analysis. In general, the majority of children at age 4:9 in Norway appear to have good motor skills according to their EYMSC scores. Therefore, drawing robust conclusions for the whole sample would have required another instrument for assessing motor skills. EYMSC, as a tool for identifying particular children at risk for motor difficulties, seemingly do not have the power to assess motor skills of the average and high performing children adequately at age 4:9. The rather low correlations between T1 and T2 may be primarily explained by the ceiling effect.

Furthermore, what is perceived as a strength of an authentic measurement approach may, in terms of methodological rigour, also emerge as problematic. Even if the EYMSC has proven to be a reliable instrument (Chambers and Sugden 2002 2006; Moser and Reikerås 2014) and the staff are trained in applying the instrument, the large number of data collectors still might be a problem. The rating scale still provides room for interpretation and varying evaluations of the children's motor behaviour. We also assume that kindergarten teachers in Norway tend to evaluate children's skills in a positive way, due to positive attitudes to children in general and to the desire that the children in their units are doing well. The latter aspect however, will, have a systematic effect that should be equal for all observers. On the other hand, at T1, a normal distribution of the results was partly achieved and the variance in the results (variation in motor skills) was sufficient. In addition, the fact that two staff members have conducted all observations independently strengthens the reliability of the results.

One may also question the generalizability of the findings based on a sample from one municipality and a 39.5 % dropout rate. The drop out analysis revealed no significant

difference between participants and non-participants in their motor-life-skills. There were somewhat more boys and somewhat fewer multilingual children in the dropout group than in the participating group, but the differences were minor. Thus, we assume that the sample still is representative for children of this age group in the municipality of Stavanger. It is a general weakness of the study that there is no information available on the children's socio-economic background, parental education and the kindergartens themselves. The reason for this is that it was an explicit requirement in the agreement between the municipality of Stavanger and the University of Stavanger that no data other than motor, social, linguistic and mathematical should be collected in this project.

Conclusions

There is a significant but rather weak or moderate correlation between motor-life-skills (EYMSC total score and section scores) at ages 2:9 and 4:9. This may support a perspective of individual variability and dynamics in the development of motor-life-skills but must be interpreted with great caution due to ceiling effects at age 4:9. In general, the predictive value of motor-life-skills at age 2:9 is considered to be rather low. The predictive value concerning the group at risk, which are the 10 % children with weakest motor-life-skills at T1, is also considered low. In terms of predicting motor skill development, Self Help skills and Recreational and Playground skills might be of greater importance than the two other EYMSC sections.

Apart from the two research questions, one can ascertain that systematic observation through authentic assessment conducted by kindergarten staff might have the potential to become a suitable approach that can provide trustworthy information about toddlers' motor development.

Finally, even if this study does not include any quality characteristics of the kindergartens and therefore cannot relate developmental processes to quality issues, the knowledge gained through a systematic and authentic assessment of children's motor development from 2:9 to 4:9 may be a useful contribution to quality assurance and development in terms of competence requirements for the employees.

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Table 1

EYMSC scores for each of the four sections and the total score at 2:9 (T1) and 4:9 (T2) years of age and correlations between motor-life-skills at T1 and T2 (N=661)

	Age ^{a)}	Self Help skills (6 items)	Desk skills (5 items)	General Classr. skills (5 items)	Recreational /Playgr. skills (7 items)	EYMSC Total score (23 items)
Mean ^{b)}	2:9 (T1)	16.90 (3.63)	15.02 (2.67)	18.49 (1.92)	24.66 (2.94)	75.07 (8.34)
(SD)	4:9 (T2)	22.81 (2.08)	19.48 (1.20)	19.73 (0.87)	27.52 (1.21)	89.54 (4.14)
min/ max	2:9 (T1)	8/24	6/20	8/20	10/28	38/92
	4:9 (T2)	9/24	10/20	11/20	15/28	46/92
Correlation T1-T2 (r_s)		.26**	.27**	.28**	.21**	.34**

^{a)} All mean differences between T1 and T2 are statistically significant ($p < 0.001$; Effect size EYMSC Total score: Cohen's $d = 3.17$).

^{b)} Years:months

**Correlation (Spearman's rho, r_s) is significant ($p < .01$; 1-tailed)

Table 2

Logistic Regression Predicting being in the weak group at T2

	B	S.E	Wald	df	p	Odds Ratio	95% C.I. for Odds Ratio	
							Lower	Upper
Self Help skills	-.10	.05	5.21	1	.02	.90	.83	.99
Fine Motor skills	-.04	.06	.59	1	.44	.96	.86	1.07
Classrooms skills	-.18	.07	6.55	1	.01	.84	.73	.96
Playground skills	-.07	.05	2.53	1	.11	.93	.85	1.02
Constant	5.03	1.14	19.44		.00	152.49		

Table 3

EYMSC section scores and total score for the four subgroups at T1 (mean; standard deviation)

Subgroups		Self Help	Desk skills	General	Recreational	EYMSC
		skills (6 items)	(5 items)	Classroom skills (5 items)	/Playground skills (7 items)	Total score (23 items)
not weak/not weak**	Mean	17.57	15.50	18.90	25.21	77.17
	SD	(3.39)	(2.39)	(1.38)	(2.38)	(6.50)
not weak/weak**	Mean	16.10	14.77	18.44	24.87	74.17
	SD	(2.60)	(2.28)	(1.89)	(2.47)	(4.57)
weak/not weak**	Mean	12.32	11.16	15.59	20.86	59.93
	SD	(2.12)	(2.35)	(2.36)	(3.20)	(4.57)
weak/weak**	Mean	11.88	11.79	14.71	18.96	57.33
	SD	(2.27)	(2.14)	(2.60)	(3.84)	(6.77)

** ANOVA revealed statistically significant differences between all four subgroups and the EYMSC total score ($p < .001$).

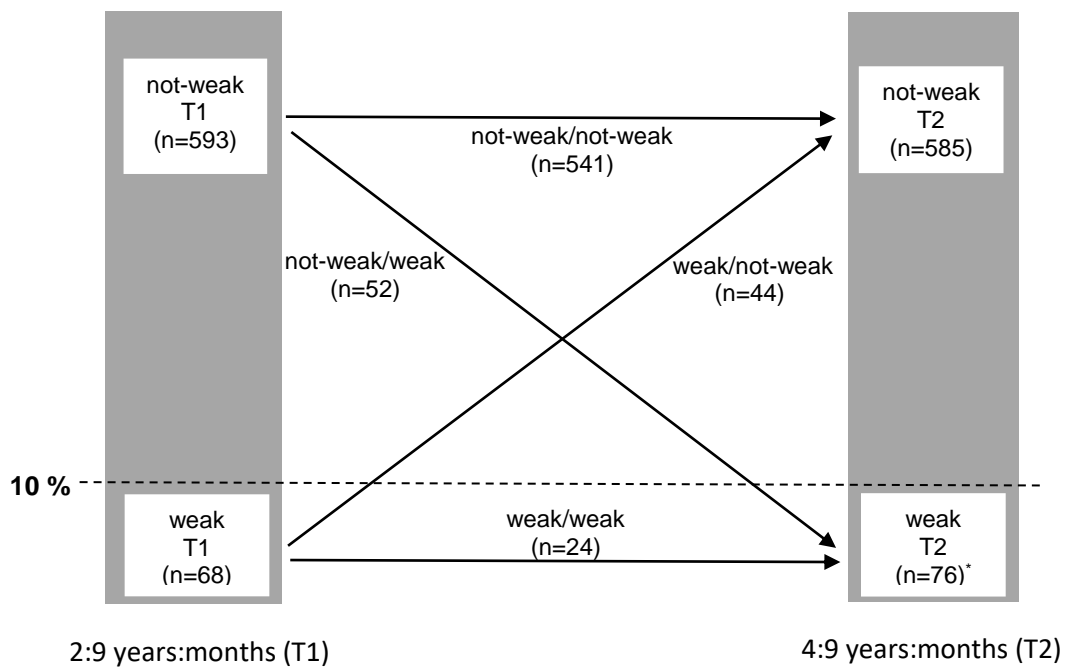


Figure 1. Dynamics and stability in motor-life-skill development between T1 and T2 (n=661): the flux of children at risk (10 % weakest) and not at risk (90 % not-weak) for motor difficulties.

*Due to ceiling effects, it was not possible to create a weak motor group of precisely the same