Research in Developmental Disabilities 35 (2014) 1425–1432

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Motor and language abilities from early to late toddlerhood: Using formalized assessments to capture continuity and discontinuity in development

Ayelet Ben-Sasson [a,*], Simone V. Gill [b]

[a] Department of Occupational Therapy, Faculty of Social Welfare & Health Sciences, University of Haifa, Mount Carmel, Haifa 31905, Israel
[b] Department of Occupational Therapy, Boston University College of Health & Rehabilitation Sciences, Sargent College, Boston, MA, 02215 United States

ARTICLE INFO

Article history:
Received 3 December 2013
Received in revised form 15 March 2014
Accepted 16 March 2014
Available online 19 April 2014

Keywords:
MSEL
Developmental tests
Developmental change
Toddler
Discontinuity
ASD

ABSTRACT

Developmental tests reflect the premise that decreases in skills over time should be a sign of atypical development. In contrast, from a psychological perspective, discontinuity may be viewed as a normal part of typical development. This study sought to describe the variability in patterns of continuity and discontinuity in developmental scores over time. Seventy-six toddlers (55% boys) from a larger screening study were evaluated at 13 and 30 months using the Mullen Scales of Early Development (MSEL) in five areas: gross motor, fine motor, visual perception, receptive language, and expressive language. Parents completed the First Year Inventory (FYI) at 12 months as well. At 30 months, 23.68% of the sample received a clinical diagnosis (e.g., developmental delay, autism spectrum disorder [ASD]). Toddlers were classified as stable, increasing, or decreasing by at least 1.5 standard deviations (*SD*) on their scores in each of the five MSEL areas from 13 to 30 months. Between 3.9% and 51.3% of the sample was classified as increasing and 0–23.7% as decreasing across areas. Decreases in motor areas were associated with increases in language areas. None of the toddlers showed decreases greater than 1.5 *SD* on their MSEL composite scores. There was no single pattern that characterized a certain diagnosis. Higher FYI sensory-regulatory risk was associated with decreases in gross motor. Lower FYI risk was linked with increases in receptive language. Developmental discontinuity in specific developmental areas was the rule rather than the exception. Interpretations of decreases in developmental levels must consider concurrent increases in skill during this emerging period.

1. Introduction

Autism spectrum disorder (ASD) affects 1 out of 88 children worldwide (Center for Disease Control, 2013). ASD is well known for impairing children's social abilities (American Psychiatric Association, 2013). However, ASD is more complex than researchers once thought (Kantzer, Fernell, Gillberg, & Miniscalco, 2013). For example, many children with ASD demonstrate difficulty executing complex motor tasks (Duffield et al., 2013) and using language to communicate with others (Horovitz & Matson, 2010). These deficits in motor and language skills significantly affect children's development and future outcomes

* Corresponding author. Tel.: +972 4 8288388 fax: +972 4 8249753.
E-mail address: asasson@univ.haifa.ac.il (A. Ben-Sasson).

http://dx.doi.org/10.1016/j.ridd.2014.03.036
0891-4222/

(Kuhl et al., 2013). Risk for ASD has been linked with developmental outcomes (Turner-Brown, Baranek, Reznick, Watson, & Crais, 2012). Therefore, early screening and identification of impairments associated with ASD are critical. This is especially the case with toddlers because ASD is often undetected in this age group (Kleinman et al., 2008). Early verification of ASD risk often depends on developmental scores.

ASD may go undetected in toddlers due to the continuity and discontinuity inherent in development. The mixture of continuous and discontinuous trajectories observed during toddlerhood is substantial. Continuity reflects stability in development between time points. In contrast, discontinuity represents a decrease or increase in developmental level so that toddlers transition either from meeting, exceeding, or not meeting age norms from one time point to another. In clinical populations, health professionals interpret a decrease in skill as a potential indicator of a need for services. In contrast, in typical development, discontinuities can reflect periods of system reorganization (Thelen & Spencer, 1998). This system reorganization can be due to variability in strategies available for performance (Vereijken, 2010), concurrent improvements in other developmental domains (Berger, Adolph, & Kavookjian, 2010), or changes in environmental demands (Van Dijk & Van Geert, 2007). Differences in how discontinuity is interpreted have practical implications. For example, if parents express concerns about their toddlers' deterioration of motor or language abilities based on their observations, but clinicians do not observe changes in toddlers' skills based on traditional assessments, what does this imply? Should the number of areas in which discontinuity is observed or the magnitude of discontinuity matter? The current study aimed to address these questions by describing longitudinal patterns of domain-specific continuity and change at 13 and 30 months using a formalized assessment in a community sample.

The present study focused on one of the most widely used developmental tests for toddlers: the Mullen Scales of Early Learning (MSEL; Mullen, 1995). Both task hierarchy and scoring on this test assumes developmental continuity. However, a few studies show hints of discontinuity across areas (i.e., areas meant to be a measure of developmental domains) using the MSEL in typically developing toddlers. In a recent cross-sectional study of 47 36- to 60-month-old toddlers from South Africa, there were fluctuations in average scores within MSEL areas and across ages. However, continuity was not statistically tested (Bornman, Sevcik, Romski, & Pae, 2010). In a longitudinal study of Indian American toddlers followed from 6 to 36 months, the shape of change in MSEL scores differed across areas and was not linear throughout time. They had decreases in all areas with the exception of the gross motor area between 6 and 15 months. MSEL language scores remained stable between 15 and 36 months (Mitchell, Croy, Spicer, Frankel, & Emde, 2011). Both studies suggest the presence of inter- and intra-individual discontinuities in MSEL scores but do not classify toddlers based on their patterns of change.

In clinical populations, the MSEL has been used to profile patterns of developmental change (Chawarska, Klin, Paul, Macari, & Volkmar, 2009; Landa & Garrett-Mayer, 2006; Macari et al., 2012). Longitudinal research shows significant increases between 2 and 3 years of age in MSEL verbal scores in toddlers with ASD but not in non-verbal scores (Chawarska, Klin, Paul, & Volkmar, 2007). Others documented a decrease in MSEL motor, visual perception, and expressive language scores in half of those with ASD between 14 and 24 months (Landa & Garrett-Mayer, 2006). In a screening study, patterns of change in MSEL scores from 24 to 42 months were compared among toddlers with ASD, toddlers with intellectual disabilities, and typically developing toddlers. Although most toddlers were stable in their scores, increases were observed in about a third of those with ASD who were functioning within average or below average ranges. In contrast, only 14% of those with intellectual disabilities and 5% of the typically developing group had increases in scores (Dietz, Swinkels, Buitelaar, & Daalen, 2007). At the same time, other studies indicate relative stability in scores of toddlers with ASD (Begovac, Begovac, Majić, & Vidović, 2009; Yang, Jong, Hsu, & Lung, 2011) and with language disorders (Clegg, Hollis, Mawhood, & Rutter, 2005). These findings raise questions about interpreting discontinuity to be an indicator of developmental impairments.

The current study sought to answer three primary questions: (1) what is the rate of continuity (i.e., stability in skills) and discontinuity (i.e., increase or decrease in skills) between 13 and 30 months across developmental areas in a community sample? (2) Do patterns of continuity and discontinuity overlap across areas? (3) How are factors such as the risk of developmental disability and incidence of clinical referrals associated with increases, decreases, or stability between 13 and 30 months? We used the MSEL to measure patterns of change via periods of continuity or discontinuity across five areas that map onto domains important in toddler development: gross motor, fine motor, visual perception, expressive language, and receptive language skills. Unlike previous studies, we looked for evidence of discontinuity or continuity in each area between two time points rather than using one score collapsed across all areas. We hypothesized that toddlers who showed discontinuity in one area would demonstrate a corresponding discontinuity in a related area. We also believed that discontinuity would be associated with the risk of ASD in toddlers. In the current study, toddlers with and without clinical diagnoses were included to reflect how the MSEL is typically interpreted in practice: with a community sample of toddlers not yet diagnosed.

2. Method

2.1. Measures

2.1.1. The mullen scales of early learning (MSEL: Mullen, 1995)

The MSEL is an assessment of motor and language functioning from birth to 68 months. It takes about 30 min to administer to toddlers ages 12–36 months. The MSEL yields five scale scores (fine motor, gross motor, visual reception, expressive language, and receptive language) and an Early Learning Composite score (ELCS) or developmental quotient (DQ) score. The ELCS is a standard score that does not include the gross motor scale and is clinically used to qualify toddlers for services. The DQ score represents an overall measure of motor and language abilities including visual perception as it relates to motor skills. Standardized assessments for toddlers such as the MSEL provide DQ scores rather than IQ scores. DQ and IQ scores are on the same scale and are relative to average age scores. DQ scores reflect the fact that early motor and language testing relies on performing tasks that are inherently different from later motor and language tests. In the normative sample of the MSEL, the ELCS had an internal reliability value of 0.91, and for the individual scales the internal reliability values ranged between 0.75 and 0.83. The 1- to 2-week test–retest reliability in the normative sample of 1- to 24-month-old toddlers was sufficient (0.82–0.96) as described in the manual.

The manual and scoring sheets were translated into Hebrew by the first author and research team to standardize administration and coding procedures. Each examiner was trained to establish at least 80% agreement with the first author. Agreement was based on video coding both the 13-month and 30-month MSEL evaluations. Cronbach's Alpha ranged from 0.83 to 0.98 for inter–rater reliability across the five MSEL scales.

2.1.2. The first year inventory (FYI: Baranek, Watson, Crais, & Reznick, 2003)

The FYI is a standardized parent questionnaire for ASD screening at 12 months of age. It includes 61 questions in two domains: social-communication and sensory-regulation. Items are answered on a four-point scale from ''never'' to ''often'' or as multiple choice questions. A risk algorithm score is computed that assigns risk of ASD by comparing answers with extremely low frequencies to a normative sample. The test provides a total score as well as domain scores. The total score is a mean of all risks in the social-communication and sensory-regulatory domains and can range from 0 to 50. The U.S. cutoff score corresponding to the 95th percentile was 17.5 and was used as the risk cutoff for ASD in the current study. This cutoff was based on findings from Reznick, Baranek, Reavis, Watson, and Crais (2007). Cronbach's Alpha for the U.S. English version of the FYI was 0.81 for the total risk, 0.71 for the social-communication domain, and 0.63 for the sensory-regulatory domain (Reznick et al., 2007; Personal communication, September 2007). The FYI was translated into Hebrew using a back-translation method (see Ben-Sasson & Carter, 2012). Internal consistency of the FYI Hebrew version was confirmed with a 0.69 Cronbach's Alpha value in one study (Ben-Sasson & Carter, 2012) and 0.76 in another study (Ben-Sasson et al., 2013).

2.2. Procedures

Families were recruited as part of a larger developmental screening study (see details in Ben-Sasson & Carter, 2012) primarily from public daycares in Israel whereas some joined through advertisement. Parents were asked to complete the FYI within one week of their toddlers' first birthday. Following the arrival of the FYI to the researchers, the in-home assessment was scheduled. The 13-month assessment (time 1) included the administration of the MSEL (Mullen, 1995) by a clinician who was not blinded to toddlers' developmental risk status. Due to information revealed to the time 1 examiner by daycare providers and parents, this examiner could not remain blind. At 30 months (time 2), the MSEL was completed at home by a clinician who was blind to toddlers' time 1 developmental risk and clinical referral status. The research team was comprised of clinicians with expertise in early childhood development and in ASD. At time 2, parents completed a parent booklet that included an intervention history questionnaire developed for this study. At both ages, parents received a video of the assessment. We also provided a report of the results and a referral for an evaluation at local child developmental centers upon parents' request. At time 2, families received a $22 gift certificate as a token of appreciation.

2.3. Participants

In the current study, we administered the MSEL to 76 toddlers at two time points: 13 and 30 months. Thirteen additional toddlers were not included because they only contributed MSEL scores at time 1. Attrition of these 13 toddlers occurred either because families refused to complete the assessment or because we lost contact with the families. At time 1, toddlers had an average corrected chronological age of 12.51 months ($SD = 0.66$) and at time 2, 29.29 months ($SD = 0.59$). If infants are born prematurely (i.e., earlier than 37 weeks gestation), then corrected chronological ages are typically used. To correct their age, the number of weeks that they were premature is subtracted from their actual age in weeks (e.g., a 30-week-old baby that was 6 weeks premature would have a corrected chronological age of 24 weeks). We used corrected chronological ages to facilitate equal comparisons in developmental skills across toddlers. The sample included 55.3% boys, 42.1% first-borns, and 2.6% classified as preterm. At time 1, 73.3% of the toddlers attended public daycare, 17.35% attended private daycare, and 10.3% were in a play group setting with a nanny or in the home. The average age of mothers at time 1 was 32 years old ($SD = 5.25$) and of fathers 35 years old ($SD = 7.18$). Thirty five percent of the mothers and 50% of fathers had a non-academic education (i.e., not holding a bachelor's degree or above), 85.5% were married, and 17.1% were unemployed. There were three sets of siblings in the dataset: two of which were of twins.

Since our participants came from a community sample, we had access to toddlers with developmental disorders and who were typically developing. Of the 76 toddlers, 31 had FYI scores that exceeded the 95th percentile cutoff. A total of 23 toddlers were referred at time 1 and/or 2 for further developmental evaluations. Parents of 17 toddlers referred at time 2 reported that their toddlers were evaluated (i.e., non-routine developmental evaluation) between times. However, only 7 received developmental interventions between times. Fifty-three percent of those referred at time 1 were evaluated in the community between times. At time 2, there were four toddlers with ASD and 14 toddlers with other types of developmental disorders (i.e., six with language delay, five with a developmental delay, two with hyperactivity and regulation problems, and one with epilepsy) based on clinical diagnoses. Toddlers were diagnosed by experts at the local child developmental centers and/or research team which comprised of occupational therapists and speech and language pathologists.

2.4. Data analysis

To characterize patterns of change between times 1 and 2, difference scores were computed. We subtracted time 1 from time 2 DQ scores for each of the five MSEL scale areas. Toddlers were classified into three groups based on their difference scores for each scale. The stable group was defined by a difference score between −23 and 23. The increasing group had difference scores above 23, and the decreasing group had difference scores below −23 (as 22 represents 1.5 *SD*s). If a group had less than 5 members, it was excluded from statistical comparisons. Independent sample *t*-tests were conducted to compare each of the five sets of difference groups on their initial time 1 scores within domain. To correct for multiple comparisons, Bonferroni adjustments were made. Toddlers were also grouped based on whether they had increased, decreased, or remained the same on their ELCS scores. The degree of overlap in patterns of change across domains was tested using Fisher's exact tests. MSEL groups were compared based on FYI scores using independent sample *t*-tests. Chi-squared or Fisher's exact tests were conducted as appropriate to examine the association between difference group membership and clinical referral factors at both time points. This included being referred at time 1, having a non-routine evaluation between times, or receiving intervention between times. Only significant differences are reported. We reported a measure of effect size for all *t*-tests using Cohen's *d* (.20–.50 small, .50–.80 medium, >.80 large, Cohen, 1988) and phi correlations for Fisher's tests (.10–.20 small, .20–.40 moderate, ≥.40 relative to very strong, Rea & Parker, 1992).

3. Results

3.1. Group classifications

Fig. 1 shows mean MSEL difference scores for increasing, decreasing, and stable groups in each area. Table 1 displays the distribution of toddlers among groups. Independent sample *t*-tests showed that the increasing subgroups (i.e., visual perception and expressive and receptive language) had significantly lower scores at time 1 compared to the stable subgroups ($p < .01$, $d = 1.26$, $d = 1.45$, $d = 0.80$, respectively). In contrast, the decreasing subgroups (i.e., gross motor and fine motor) had significantly higher time 1 scores than the stable subgroups ($p < .001$, $d = 1.24$, $d = 2.09$, respectively). Table 1 shows that the majority of toddlers who were identified as stable in specific areas were also identified as such by the ELCS. At least a third of the increasing toddlers increased according to the ELCS. The ELCS did not identify toddlers who decreased on MSEL scores.

We sought to explain differences in time 1 MSEL scores among the groups. Lower time 1 MSEL DQ scores were associated with higher FYI social-communication risk scores (gross motor $r(76) = -.20$, $p = .08$; fine motor $r(76) = -.30$, $p = .01$; visual perception $r(76) = -.28$, $p = .02$; receptive language $r(76) = -.58$, $p < .001$; Expressive Language $r(76) = -.43$, $p < .001$).

3.2. Overlap between change patterns across developmental areas

Fig. 2 illustrates the percentage of toddlers who showed increasing, decreasing, or stable patterns of change in one, two, three, four, or all MSEL areas. About half (54.5%) of those with a pattern of decrease in one MSEL area had an increase in at least one area. Seventy eight percent had two decreasing areas ($\chi^2(6) = 17.85$, $p < .007$, $phi = .49$).

Next, we examined overlaps in patterns of change across specific areas for subgroups with more than 4 toddlers. In the decreasing gross motor subgroup, 22.2% decreased in fine motor skills, and 61.1% increased on at least one language area. In the decreasing Fine Motor subgroup, all had an increase in a language score. Twenty-five percent of this subgroup had a decrease in gross motor and 12.5% decreased in visual perception. Thirteen percent decreased in expressive language, but increased in visual perception. In the increasing visual perception subgroup, 66.7% showed increases in at least one language score, and 40% decreased in fine motor or gross motor areas. In the increasing Expressive Language subgroup, 52.2% also increased in receptive language, and 21.7% in visual perception. Twenty six percent decreased in at least one motor score. For the increasing Receptive Language subgroup, 30.8% also increased in expressive language, and 30.8% decreased in at least one motor score.

3.3. Factors explaining difference groups

3.3.1. Group analyses on the FYI

FYI social-communication and sensory-regulatory scores were compared between the MSEL difference groups. For the gross motor area, independent sample *t*-tests showed that toddlers in the decreasing group had significantly higher sensory-regulatory risk scores than toddlers in the stable group ($M = 19.51$, $SD = 10.79$, $M = 13.13$, $SD = 9.24$ respectively, $t(70) = -2.43$, $p = .02$, $d = 0.64$). For Receptive Language, toddlers in the increasing group had significantly lower risk on the sensory-regulatory domain than the stable group ($M = 12.33$, $SD = 9.55$, $M = 17.32$, $SD = 9.61$ respectively, $t(74) = 2.27$, $p = .03$, $d = 0.52$).

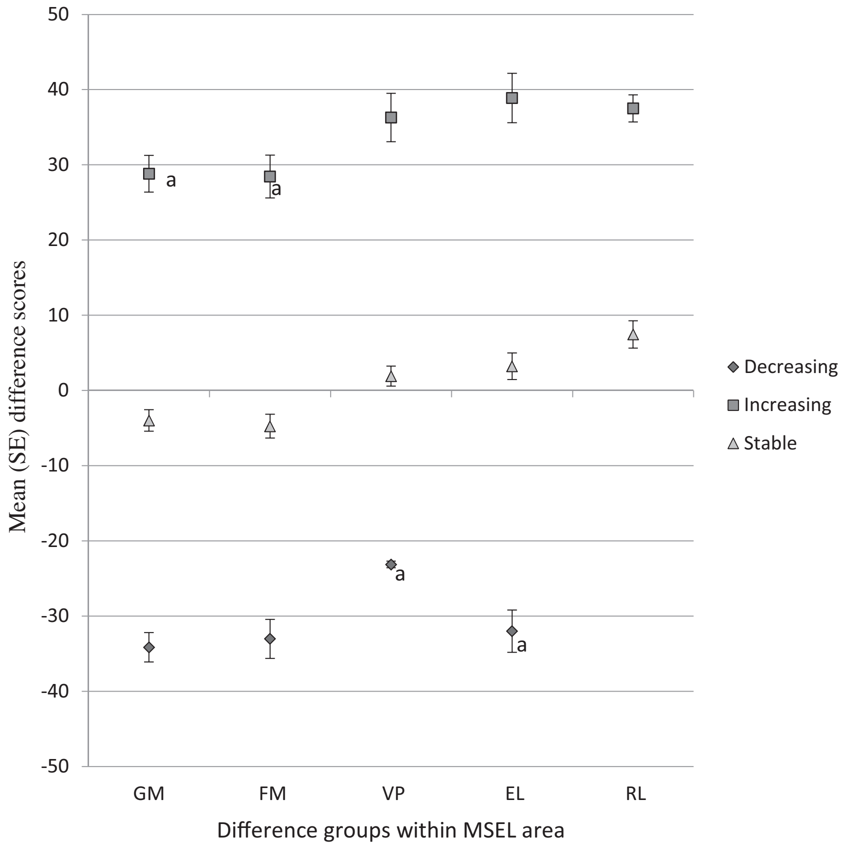

Fig. 1. MSEL DQ difference scores for the difference groups within areas. *Note*. GM, gross motor; FM, fine motor VP, visual perception; EL, expressive language; RL, receptive language. (a) Group has less than 5 members.

3.3.2. Group analyses on clinical referral factors

Fisher's exact tests indicated that the only significant difference was for toddlers whose Expressive Language score increased. These toddlers had a higher rate of time 1 referral (47.8%) compared to the stable group (16.3%, $p = .009$, $phi = 0.36$). However, they did not differ in actual rates of those who received intervention and/or evaluation between times.

There was not one pattern of change that characterized toddlers with time 2 diagnoses. Table 1 shows the percentage of toddlers with a developmental diagnosis in each group. Out of the 18 toddlers with diagnoses at time 2, 10 showed an increase in a language score. Five of those toddlers had isolated increases in expressive and/or receptive language and two increased in at least one language score together with visual perception. One toddler increased in receptive language, but decreased in both the expressive language and gross motor areas. Another toddler had an increase in expressive language with a decrease in fine motor. The last toddler increased in expressive language and

Table 1
Groups with stable, increasing or decreasing MSEL DQ scores between times.

	Stable	Increasing	Decreasing
Gross motor *N* (males %, diagnoses %)	54 (57.40, 22.22)	4[a] (50.00, 50.00)	18 (50.00, 22.22)
ELCS difference grouping %[b]	77.80	75.00	0
Fine motor *N* (males %, diagnoses %)	57 (57.90, 22.81)	3[a] (33.33, 33.33)	16 (50.00, 18.75)
ELCS difference grouping %	75.40	100	0
Visual perception *N* (males %, diagnoses %)	59 (55.90, 22.03)	15 (53.30, 13.33)	2[a] (50.00, 0)
ELCS difference grouping %	79.70	40.00	0
Receptive language *N* (males %, diagnoses %)	37 (45.90, 32.43)	39 (64.10, 15.38)	0 (0, 0)
ELCS difference grouping %	86.50	33.30	0
Expressive language *N* (males %, diagnoses %)	49 (46.90, 18.37)	23 (69.60, 21.74)	4[a] (75.00, 25.00)
ELCS difference grouping %	83.70	43.50	0

Note: All groups are based on a 1.5 *SD* difference between years.
[a] Due to small group size they were excluded from comparisons.
[b] Percent of toddlers within each area difference group that qualify for the same definition of change (i.e., stable within 1.5 *SD*, decreasing > 1.5 *SD*, increasing > 1.5 *SD*) based on their ELCS difference score.

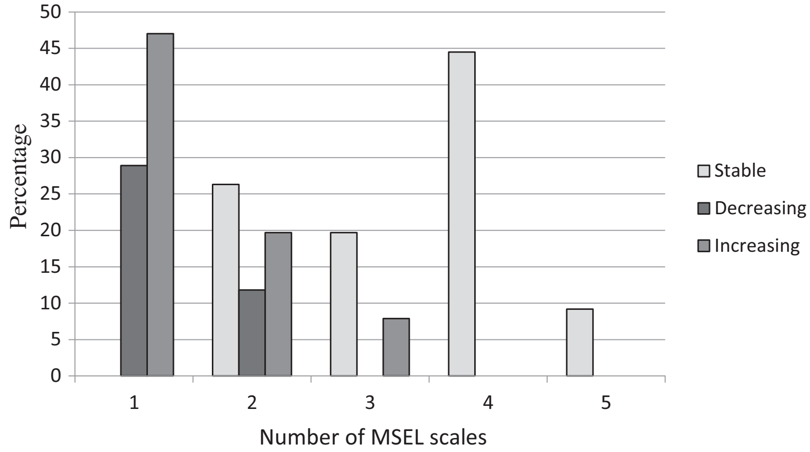

Fig. 2. Percentage of toddlers with 1, 2, 3, 4, or 5 stable, increasing, or decreasing scores across MSEL scales.

fine motor scores. Aside from these, ten decreased in fine motor and/or gross motor scores, and two increased in one motor score.

4. Discussion

Developmental assessments in early childhood aim to determine the need for services. Developmental tests assume that typical development occurs within a normal range of variation, is universal, and is continuous over time. Findings from this study show that discontinuity was prominent from 13 to 30 months in this community sample. A higher percentage of toddlers who showed increases in performance in at least one MSEL area had decreases in other areas between times (27.6%, 11.8%, respectively). A longitudinal pattern of developmental increase has been previously reported in specific populations at risk for developmental disorders (Dietz et al., 2007; Hack et al., 2005). Categorizing toddlers based on their change in overall MSEL composite scores occluded significant declines over time in specific areas. Our findings of discontinuity in development support previous research with typically developing toddlers (Darrah, Hodge, Magill-Evans, & Kembhavi, 2003). Realizing the wide range of developmental profiles within toddlers has implications for the interpretation of early low standardized scores and of intervention outcomes.

Plasticity and rapid developmental change during the first three years of life (Dawson, 2008) may explain the discontinuity that we observed within and across toddlers. Increases in developmental scores in one area with decreases in another may reflect a biological coping mechanism: diverting energy toward emerging skills at the expense of other areas. Such a mechanism makes it difficult to maintain continuity (Berger et al., 2010). This notion is supported by our findings that decreases in motor scores may reflect a payoff with corresponding increases in language scores and vice versa (Tittnich, Bloom, Johnson, Muss, & Frank, 1990). Toddlers with developmental difficulties may divert energy from an area to a greater degree given their limited developmental resources. Consistent with our hypothesis we also observed discontinuity in related areas; one motor score was associated with discontinuity in another motor score. The same occurred within language areas. This has implications for how decreases in performance are interpreted in clinical and non-clinical samples. Rather than interpreting an overall low composite score as a need for services, an examination of each toddler's profile across areas could indicate concurrent emerging skills in some areas with decrements in others.

We found a surprising increase in MSEL language scores specifically for toddlers who were referred for clinical evaluations following the time 1 assessment. These findings are especially interesting in light of the high test–retest reliability with the MSEL (i.e., change was not related to retest effects). The number of parents who reported seeking community diagnostic or intervention services for their toddlers between times was not higher for the increasing groups. Therefore, it is not likely that services led to this increase. It is plausible that referrals triggered parents to facilitate improvements in their toddlers' communication skills. Additionally, as toddlers mature, they may develop other capacities, which enable them to compensate for their initially poor skills and catch-up. This pattern of language increase has been reported in previous research in toddlers with ASD (Chawarska et al., 2007; Dietz et al., 2007). A general cognitive increase was documented in toddlers with developmental disabilities (Yang, Lung, Jong, Hsu, & Chen, 2010), and those with low birth weight (Hack et al., 2005). The specific involvement of language areas in our study is not surprising because this was part of an early screening study for social-communication disorders. Due to the limited number of toddlers per diagnosis in our sample, it was difficult to draw conclusions regarding change profiles associated with one particular type of diagnosis. The dramatic increases in language do raise questions regarding the interpretation of toddlers' early social-communication risk status in the third year of life. Moreover, these findings call for disentangling the influence of normal variation in interpreting intervention outcomes.

Area specific changes in MSEL were associated with sensory-regulatory markers on the FYI providing some support to our initial hypothesis of a relation between discontinuity and early ASD risk. Toddlers who decreased in the gross motor area had higher sensory risk at 12 months than those with stable scores. The sensory-regulatory domain of the FYI consists of questions describing repetitive and rigid motor patterns as well as sensory over-responsive behaviors (e.g., avoiding or demonstrating increased sensitivity to stimuli). These behaviors may contribute to poor performance on more complex motor tasks involving balance and coordination (Reynolds & Lane, 2009). Lower sensory risk was associated with increases in receptive language. Aspects of toddlers' temperament may influence the development of receptive language abilities (Slomkowski, Nelson, Dunn, & Plomin, 1992). The capacity to self-regulate responses to sensory stimuli may play a compensatory role by allowing toddlers to be readily available for learning and for following instructions: a critical component of the demands in the MSEL receptive language domain. These findings suggest a need for the early identification of sensory risk to facilitate toddlers' motor development, and the importance of early sensory-regulation as a foundation for language development.

Early social-communication competence was associated with time 1 levels across MSEL domains but not with change. This is in contrast to our hypothesis based on other research with toddlers at risk for ASD. Our findings may reflect the fact that we studied toddlers at risk for a developmental disorder as opposed to clinical samples. For instance, Dietz et al. (2007) found that ASD risk status at 14–15 months was not associated with concurrent cognitive or language scores. However, lower ASD risk characterized toddlers with an increase in IQ between 14 and 43 months, and higher IQ and expressive language scores at 43 months. In our study, developmental changes in the MSEL did not corresponded with initial social-communication risk. This may be because those who decreased were not at risk at 12 months, and those who increased in risk may not have been extreme enough to warrant clinical services.

5. Limitations

The criterion for classifying toddlers into subgroups via patterns of change in the present study was more stringent (1.5 *SD* from age norms) than the 1 *SD* cutoff applied in other studies (e.g., Darrah et al., 2003; Dietz et al., 2007). Consequently, we identified fewer toddlers with decreasing patterns of change. However, we were more confident in the extent to which their patterns of change were atypical. Further research using a larger sample and more time points with shorter intervals will provide valuable evidence for the trajectory of these patterns (Adolph, Robinson, Young, & Gill-Alvarez, 2008) and their generalizability. In addition, although our sample included toddlers with developmental delays, we did not capture patterns of change with an extremely impaired group as indicated by the low evaluation and intervention rates between times. Examining clinical populations may provide more power for identifying population specific change profiles. Studying a sample of typically developing toddlers may help illuminate indicators of problems that occur during development related to change or stability or time.

Although we did not evaluate temperament as a moderator of developmental performance, differences in toddlers' temperament at 13 and 30 months may partly explain decreases in MSEL motor scores. Fine and gross motor items involve observations of many naturally occurring movements some of which can be facilitated by the parent (e.g., standing up or grasping a block). For older toddlers, items in these areas require higher order skills (e.g., walking on tip toes on a line or copying lines) demanding attention to demonstration and compliance, which can be a barrier at 30 months: an age of independence regardless of toddlers' motor capacities. Typically developing toddlers in the second and third year of life vary in their comfort around strangers and in the degree to which they express negativity and demand autonomy (Dix, Stewart, Gershoff, & Day, 2007). Therefore measuring temperament is important to consider when determining developmental concern based on developmental testing.

6. Conclusions

Findings from this research underscore the importance for documenting continuity and discontinuity in multiple developmental domains (i.e., motor and language development) as well as their interrelations. Using the developmental composite to identify toddlers with developmental concerns misses toddlers with significant decreases in particular developmental areas. This longitudinal study provided an opportunity for examining the predictive validity of early developmental scores and to examine developmental changes over time. A mixture of continuous and discontinuous patterns of change represents the dynamic and rapid nature of development and is the rule rather than the exception. An investigation of discontinuity within and across developmental domains may help in creating informative profiles for research, assessment, and intervention in toddlerhood.

Acknowledgements

This study has been supported by a European International Reintegration Grant (# 203715). We are grateful to the FYI and AOSI authors for sharing their measures. Special thanks to the participating families and infants who shared their journey with us.

References

Adolph, K. E., Robinson, S. R., Young, J. W., & Gill-Alvarez, F. (2008). What is the shape of developmental change? *Psychological Review, 115*(3), 527–543 http://dx.doi.org/10.1037/0033-295X.115.3.527

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Association.

Baranek, G. T., Watson, L. R., Crais, E. R., & Reznick, J. S. (2003). *First year inventory (FYI; version 2.0)*. Chapel Hill, NC: The University of North Carolina at Chapel Hill.

Begovac, I., Begovac, B., Majić, G., & Vidović, V. (2009). Longitudinal studies of IQ stability in children with childhood autism-literature survey. *Psychiatria Danubina, 21*(3), 310–319.

Ben-Sasson, A., Amit-Ben-Simhon, H., & Meyer, S. (2013). Cross-parent reliability in rating ASD markers in Infants. *Journal of Developmental Neurorehabilitation* [Epub ahead of print] PMID: 23924084.

Ben-Sasson, A., & Carter, A. S. (2012). The application of the First Year Inventory for ASD screening in Israel. *Journal of Autism and Developmental Disorders, 42*(9), 1906–1916 http://dx.doi.org/10.1007/s10803-011-1436-1

Berger, S. E., Adolph, K. E., & Kavookjian, A. E. (2010). Bridging the gap: Solving spatial means-ends relations in a locomotor task. *Child Development, 81*, 1367–1375.

Bornman, J., Sevcik, R. A., Romski, M., & Pae, H. K. (2010). Successfully translating language and culture when adapting assessment measures. *Journal of Policy and Practice in Intellectual Disabilities, 7*(2), 111–118 http://dx.doi.org/10.1111/j.1741-1130.2010.00254.x

Center for Disease Control. (2013). *Autism spectrum disorders (ASDs) – data & statistics* Retrieved from: http://www.cdc.gov/ncbddd/autism/data.html.

Chawarska, K., Klin, A., Paul, R., Macari, S., & Volkmar, F. (2009). A prospective study of toddlers with ASD: Short-term diagnostic and cognitive outcomes. *Journal of Child Psychology and Psychiatry, 50*(10), 1235–1245 http://dx.doi.org/10.1111/j.1469-7610.2009.02101.x

Chawarska, K., Klin, A., Paul, R., & Volkmar, F. (2007). Autism spectrum disorder in the second year: Stability and change in syndrome expression. *Journal of Child Psychology and Psychiatry, 48*(2), 128–138 http://dx.doi.org/10.1111/j.1469-7610.2006.01685.x

Clegg, J., Hollis, C., Mawhood, L., & Rutter, M. (2005). Developmental language disorders – a follow-up in later adult life. Cognitive, language and psychosocial outcomes. *Journal of Child Psychology and Psychiatry, 46*(2), 128–149 http://dx.doi.org/10.1111/j.1469-7610.2004.00342.x

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Darrah, J., Hodge, M., Magill-Evans, J., & Kembhavi, G. (2003). Stability of serial assessments of motor and communication abilities in typically developing infants—implications for screening. *Early Human Development, 72*(2), 97–110 http://dx.doi.org/10.1016/S0378-3782(03)00027-6

Dawson, G. (2008). Early behavioral intervention, brain plasticity, and the prevention of autism spectrum disorder. *Development and Psychopathology, 20*(3), 775–803 http://dx.doi.org/10.1017/S0954579408000370

Dietz, C., Swinkels, S. H. N., Buitelaar, J., & Daalen, E. (2007). Stability and change of IQ scores in preschool children diagnosed with autistic spectrum disorder. *European Child & Adolescent Psychiatry, 16*(6), 405–410.

Dix, T., Stewart, A. D., Gershoff, E. T., & Day, W. H. (2007). Autonomy and children's reactions to being controlled: Evidence that both compliance and defiance may be positive markers in early development. *Child Development, 78*(4), 1204–1221 http://dx.doi.org/10.1111/j.1467-8624.2007.01061.x

Duffield, T. C., Trontel, H. G., Bigler, E. D., Froehlich, A., Prigge, M. B., Travers, B., et al. (2013). Neuropsychological investigation of motor impairments in autism. *Journal of Clinical and Experimental Neuropsychology, 35*(8), 867–881 http://dx.doi.org/10.1080/13803395.2013.827156

Hack, M., Taylor, H. G., Drotar, D., Schluchter, M., Cartar, L., Wilson-Costello, D., et al. (2005). Poor predictive validity of the Bayley Scales of Infant Development for cognitive function of extremely low birth weight children at school age. *Pediatrics, 116*(2), 333–341 http://dx.doi.org/10.1542/peds.2005-0173

Horovitz, M., & Matson, J. L. (2010). Communication deficits in babies and infants with autism and pervasive developmental disorder–not otherwise specified (PDD-NOS). *Developmental Neurorehabilitation, 13*(6), 390–398 http://dx.doi.org/10.3109/17518423.2010.501431

Kantzer, A., Fernell, E., Gillberg, C., & Miniscalco, C. (2013). Autism in community pre-schoolers: Developmental profiles. *Research in Developmental Disabilities, 34*(9), 2900–2908 http://dx.doi.org/10.1016/j.ridd.2013.06.016

Kleinman, J. M., Robins, D. L., Ventola, P. E., Pandey, J., Boorstein, H. C., Esser, E. L., et al. (2008). The modified checklist for autism in toddlers: A follow-up study investigating the early detection of autism spectrum disorders. *Journal of Autism and Developmental Disorders, 38*(5), 827–839 http://dx.doi.org/10.1007/s10803-007-0450-9

Kuhl, P. K., Coffey-Corina, S., Padden, D., Munson, J., Estes, A., & Dawson, G. (2013). Brain responses to words in 2-year-olds with autism predict developmental outcomes at age 6. *PLoS ONE, 8*(5), e64967 http://dx.doi.org/10.1371/journal.pone.0064967

Landa, R., & Garrett-Mayer, E. (2006). Development in infants with autism spectrum disorders: A prospective study. *Journal of Child Psychology and Psychiatry, 47*(6), 629–638 http://dx.doi.org/10.1111/j.1469-7610.2006.01531.x

Macari, S. L., Campbell, D., Gengoux, G. W., Saulnier, C. A., Klin, A. J., & Chawarska, K. (2012). Predicting developmental status from 12 to 24 months in infants at risk for autism spectrum disorder: A preliminary report. *Journal of Autism and Developmental Disorders, 42*(12), 2636–2647 http://dx.doi.org/10.1007/s10803-012-1521-0

Mitchell, C. M., Croy, C., Spicer, P., Frankel, K., & Emde, R. N. (2011). Trajectories of cognitive development among American Indian young children. *Developmental Psychology, 47*(4), 991–999 http://dx.doi.org/10.1037/a0024011

Mullen, E. M. (1995). *Mullen scales of early learning*. Circle Pines, MN: American Guidance Service.

Rea, L. M., & Parker, R. A. (1992). *Designing and conducting survey research*. San Francisco: Jossey-Bass.

Reynolds, S., & Lane, S. J. (2009). Sensory overresponsivity and anxiety in children with ADHD. *American Journal of Occupational Therapy, 63*(4), 433–440.

Reznick, J. S., Baranek, G. T., Reavis, S., Watson, L. R., & Crais, E. R. (2007). A parent-report instrument for identifying one-year-olds at risk for an eventual diagnosis of autism: The first year inventory. *Journal of Autism and Developmental Disorders, 37*(9), 1691–1710 http://dx.doi.org/10.1007/s10803-006-0334-4

Slomkowski, C. L., Nelson, K., Dunn, J., & Plomin, R. (1992). Temperament and language: Relations from toddlerhood to middle childhood. *Developmental Psychology, 28*(6), 1090–1095 http://dx.doi.org/10.1037/0012-1649.28.6.1090

Thelen, E., & Spencer, J. P. (1998). Postural control during reaching in young infants: A dynamic systems approach. *Neuroscience and BioBehavioral Reviews, 22*, 507–514.

Tittnich, E., Bloom, L. A., Johnson, C., Muss, C. B., & Frank, M. (1990). The integrative nature of language development. *Journal of Children in Contemporary Society, 21*, 15–34.

Turner-Brown, L. M., Baranek, G. T., Reznick, J. T., Watson, L. R., & Crais, E. R. (2012). The first year inventory: A longitudinal follow-up of 12-month-old to 3-year-old children. *Autism, 17*(5), 527–540 http://dx.doi.org/10.1177/1362361312439633

Van Dijk, M., & Van Geert, P. (2007). Wobbles, humps and sudden jumps: A case study of continuity, discontinuity and variability in early language development. *Infant and Child Development, 16*(1), 7–33 http://dx.doi.org/10.1002/icd.506

Vereijken, B. (2010). The complexity of childhood development: Variability in perspective. *Physical Therapy, 90*(12), 1850–1859.

Yang, P., Jong, Y., Hsu, H., & Lung, F. (2011). Role of assessment tests in the stability of intelligence scoring of pre-school children with uneven/delayed cognitive profile. *Journal of Intellectual Disability Research, 55*(5), 453–461 http://dx.doi.org/10.1111/j.1365-2788.2011.01396.x

Yang, P., Lung, F., Jong, Y., Hsu, H., & Chen, C. (2010). Stability and change of cognitive attributes in children with uneven/delayed cognitive development from preschool through childhood. *Research in Developmental Disabilities, 31*(4), 895–902 http://dx.doi.org/10.1016/j.ridd.2010.02.011