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Ages & Stages Questionnaire-Brazil-2011: Adjustments in ASQ-BR cross cultural adaptation to public child daycare centers and preschools in Rio de Janeiro

DISSERTAÇÃO DE MESTRADO

Thesis presented to Programa de Pós-Graduação em Psicologia Clínica, PUC-Rio, as partial fulfillment of the requirements for the degree of Mestre em Psicologia Clínica.

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Abstract

Santana, Cristina Maria Teixeira; Landeira-Fernandez, Jesus (Advisor). **Ages & Stages Questionnaire-Brazil-2011: adjustments in ASQ-BR cross-cultural adaptation to public child daycare centers and preschools in Rio de Janeiro**. Rio de Janeiro, 2014. 128p. Masters Dissertation - Departamento de Psicologia, Pontifícia Universidade Católica do Rio de Janeiro

Day-care centers and pre-schools highly benefit from precise and reliable screening measures. Ages & Stages Questionnaire was adapted to Brazilian Portuguese in 2010 (Filgueiras et al., 2013) and renamed ASQ-BR. Regardless of its good results, modifications in a few items were required to improve the instrument's measure. The objective of the present study is to modify such ASQ-BR's items and verify if the changes increase the reliability of the test. This study researched 67,522 children from 972 public day-care centers and pre-schools of Rio de Janeiro, Brazil. The data was collected in November and December, 2011. The changes in the items were made considering Cronbach's alpha and item-to-total correlations in ASQ-BR. Reliability, dimensionality and item to total correlations were calculated. Regarding dimensionality, 86.2% of the scales in ASQ-BR-2011 were unidimensional. Internal consistency showed improvement from 2010 to 2011, 53.8% of the scales increased the alpha statistics against 41.2% that decreased – 5.0% remained the same. Finally, 65.2% of the modified items showed improvement based on item-to-total correlations. Though the objective of the present study was partially achieved, a few scales presented results below the established criteria. In contrast, the instrument's measure improved in several aspects from 2010 to 2011, especially in the Personal/social domain.

Keywords

Early Development; Child Day-care Centers; Pre-schools; Screening Methods; ASQ.

Resumo

Santana, Cristina Maria Teixeira; Landeira-Fernandez, Jesus (Orientador). **Ages & Stages Questionnaire-Brazil-2011: ajustes à adaptação transcultural do ASQ-BR a creches e pré-escolas públicas do Rio de Janeiro.** Rio de Janeiro, 2014. 128p. Dissertação de Mestrado - Departamento de Psicologia, Pontifícia Universidade Católica do Rio de Janeiro

Creches e pré-escolas podem beneficiar-se profundamente de instrumentos de triagem precisos e confiáveis. O *Ages & Stages Questionnarie* foi adaptado para o português brasileiro em 2010 (Filgueiras et al., 2013) e renomeado ASQ-BR. Independentemente de seus bons resultados, foram necessárias modificações em alguns de seus itens para melhorar a medida do instrumento. O objetivo do presente estudo é o de modificar tais itens e verificar se as mudanças lograram aumentar a confiabilidade do teste. Este estudo pesquisou 67.522 crianças de 972 creches públicas e pré-escolas do Rio de Janeiro, Brasil. Os dados foram coletados em novembro e dezembro de 2011. As mudanças nos itens foram feitas considerando-se o alfa de Cronbach e a correlação item-total do ASQ-BR. Foram calculadas a confiabilidade, dimensionalidade e correlações item-total. Quanto à dimensionalidade, 86,2% das escalas do ASQ-BR-2011 foram unidimensionais. A consistência interna mostrou melhora de 2010 para 2011 com 53,8% das escalas tendo aumentado o alfa contra 41,2% tendo diminuído e 5,0% tendo permanecido com os mesmos valores. Finalmente, 65,2% dos itens modificados apresentaram melhora com base nas correlações item totais. Embora o objetivo do presente estudo tenha sido parcialmente alcançado, algumas escalas apresentaram resultados abaixo dos critérios estabelecidos. Por outro lado, as medidas do instrumento melhoraram em vários aspectos de 2010 para 2011, especialmente no domínio pessoal / social.

Palavras-Chave

Desenvolvimento infantil; Creches; Pré-escolas; Métodos de triagem; ASQ.

Summary

1
Introduction

As a vast and useful field of knowledge, Psychology has gained more and more importance in the sense of providing solid basis to social action in countless domains all over the world. Empirical measuring in psychology is thus fundamental to define intervention strategies in a wide universe of possible actions. In Brazil, several spheres of society have undertaken growing action based on psychological knowledge and measuring. ASQ-3-BR is one of those initiatives. It is a screening instrument that aims at detecting possible developmental problems in children between one month and five and a half years old, developed by Diane Bricker, Jane Squires and colleagues in the United States in 1980 and adapted to several countries along the last 34 years. A Brazilian version of the instrument was produced in 2010. This master thesis will present the Brazilian version of the instrument, ASQ-BR, discuss its adaptation procedures as well as its result changes along application years 2010 and 2011.

Psychological tests have been important tools for managing human resources in public and private realms everywhere in the world. In Brazil, psychological tests are present in developmental/educational evaluation, selection for job positions, information on psychological aptitude for driving, clinical work in hospitals and mental health institutions (Pasquali, 2007, 2008), among others. Studying psychological measuring to fully understand its functioning and potential, as well as its limitations, is therefore of paramount importance.

Psychometrics is the field of Psychology that studies psychological measuring ('*psycho* = 'spirit' and '*metria* = measure'). It has developed along Psychology history as a field of knowledge that aims at helping psychologists

understand the characteristics of psychological instruments and especially the rationale underneath measuring a psychological construct. Cronbach (1990) states that

> "(…) a construct is some postulated attribute of people, assumed to be reflected in test performance."
>
> Cronbach (1990)

Therefore, to measure a psychological attribute, it is necessary to assume that human psyche is somehow measurable. The way through which human psyche becomes "measurable" is considering human behaviors as indicators of mental processes. Love, anxiety, attention, memory, etc. all entail associated behaviors, which is what is measured by tests (Cohen & Swerdlik, 2009). Hence it is possible to infer that measure extracts a numerical value from a set of behaviors. Measurements of a construct – or latent traits – are, therefore, possible. Latent traits are psychological factors that drive a person to behave somehow. The latent trait – more or less alert, in love, anxious, motivated, etc. – and the numerical result of the psychological testing should therefore vary accordingly.

Psychometrics has partly evolved in the last four decades thanks to the development of high capacity data processing in computer technology. Statistical analyses with increasing accuracy pushed test reviews and new kinds of psychological measurements were created. Unforeseen precision in psychological testing in several countries made empirical evidence of psychological constructs quite evident for psychologists and society in general. A vivid example of how the quality of a test might influence the evaluation of professionals involved in psychological assessment is the Australian program National Association for Gifted Children (NAGC, 2008). NAGC uses WISC-IV (Wechsler Intelligence Scale for Children) to help professionals find high ability children and refer them to specialized educational services to promote their latent potentials. The professionals involved in the program trust WISC-IV based on the quality and care in the validation and standardization of the instrument for the Australian population. Similar processes of assessing children latent cognitive traits to promote interventions by educational psychologists or educators with training in

neuropsychology have taken place in several countries – USA (Ross, Moiduddin, Meagher, & Carlson, 2008), England (Melhuish, 2006), France (Hurless, 2004), etc.

Nevertheless, psychometrics is not limited to studies of psychological tests. Various instruments in psychiatry undergo psychometric analyses, as Mini Mental State Examination (MMSE), a classical tool used to detect cognitive impairment and widely used in patients with mental disorders (Folstein, Folstein, & McHugh, 1975). MMSE's psychometric properties have had adaptations for numerous countries, *e.g.*, Australia (Galea & Woodward, 2005), Spain (Blesa et al., 2001) and Turkey (Kücükdeveci, Kutlay, Elhan, & Tennant, 2005). Sociology is another field of study that adopts scales to assess social indicators, such as income and education. Results of tests like the Sociometric Measure for Preschool Children – SMPC (Asher, Singleton, Tinsley, & Hymel, 1979) are studied psychometrically. That also happens in education. For example, the Program for International Student Assessment, PISA (OECD, 2000), a test of proficiency in reading and writing used in 65 countries, has had its characteristics analyzed psychometrically. From the beginning, PISA's developer committee were concerned about the preliminary statistical results. Such careful interest led to the maintenance of the psychometric properties of the instrument in several countries – Germany (Goldhammer, Naumann, &Kessel, 2013), Ethiopia, India, Peru and Vietnam (Cueto & Leon, 2012). In fact, Lee's study presented similar psychometric characteristics for PISA results in the 41 countries assessed (Lee, 2009). The participation of psychometrics in psychiatry, sociology, education, even economics (Kahneman, 2003) reveals the extent to which it has gone beyond the boundaries of psychology.

ASQ-3 is a screening instrument that aims at evaluating the development of children between 1 to 66 months old. It is a questionnaire filled by parents – or based on information provided by them – to assess their own children's development. ASQ-3's structure comprises 21 questionnaires that correspond to age intervals based on the Piaget and Gesell's development theories. Ages and Stages Questionnaire's history started at the end of the 1970's at University of Oregon, USA. Diane Bricker, Jane Squires and colleagues reviewed the literature on tests for children and created Infant Monitoring Questionnaire – IFMQ – based

on the data found. IFMQ was first published in 1980 and had 24 items to access four dimensions of children behavior from zero six and a half years of age. In 1995, six questions were added to the questionnaire in order to form the first version of ASQ and in 1997 Squires et al. modified a few items of the original ASQ in order to produce its second version – ASQ-2. ASQ got its final version in 1999 when the 2-month scale was added. It was then named Ages e Stages Questionnaire Third Edition – ASQ-3 (Squires et al., 2009).

ASQ-3 has been translated into over 20 languages and its viability as an international tool for screening children development has been supported by researchers worldwide (Charafeddine et al., 2013; Dionne, Squires, Leclerc, Péloquin, & McKinnon, 2006; Filgueiras, Pires, Maissonette, & Landeira-Fernandez, 2013; Heo, Squires, & Yovanoff, 2008; Janson & Squires, 2007; Juneja, Mohanty, Jain, & Ramji, 2011; Kerstjens et al., 2009; Tsai, McClelland, Pratt, & Squires, 2006). It is the screening instrument mostly chosen in the United States, by 70 % of the pediatricians (Squires, 2009). The city of Los Angeles adopted in its schools as part of LAUP – Los Angeles Universal Preschool from 2010 on (Xue, Atkins-Burnett, Caronongan, & Moiduddin, 2010).

In Canada, Québec has adopted it for its schools and well as Ontario, in the Mohawk Program (Dionne, McKinnon, Squires, & Clifford, 2014). In Europe, France (Troude, Squires, L'Hélias, Bouyer & La Rochebrochard, 2011), Denmark, Norway and Spain (Pomés, Squires & Yovanoff, 2014) have versions of ASQ-3 in action in several public policies for children. In South America, besides the initiative in Brazil, also Equador, Chile (Schonhaut, Armijo, Schönstedt, Alvarez, & Cordero, 2013) and Peru have adopted ASQ-3 in public policies for children. In Africa, Kenya (Omedo, Matey, Awiti, Ogutu, & Alaii, 2012) and Zambia have developed programs including ASQ-3 as well as Thailand, China (Bian, Yao, Squires, Hoselton, & Chen, 2012) and Korea in Asia. Besides the national initiatives above-mentioned, MAGPIE (Kvestad, Taneja, Kumar, Bhandari, & Strand, 2013), an international program joining 125 centers in 19 countries in Latin America, Africa and Asia, has been using ASQ-3 to follow up the development of children of mothers who received magnesium sulfate 24 hours before and after their child's birth.

In Brazil, there was a recommendation of the Strategic Issues Secretariat – Secretaria de Assuntos Estratégicos – in 2011 for the use of indicators for the development of children that were similar to the one adopted in Rio de Janeiro by the Municipal Secretary of Education – SME. The recommendation is in line with the international tendency to foster indicators of the development of children, as recommended by UNESCO and UNICEF (Humphrey, Wigelsworth, Barlow & Squires, 2013).

In Brazil, ASQ-BR was first used as a research tool by Filgueiras in 2010. Among the 21 scales, 19 had its psychometric properties analyzed by Filgueiras (2011, 2013), except for questionnaires 2 and 4 months of age. ASQ-BR's validity has not been established though it is necessary so that the instrument is considered adapted to Brazil. However, fundamental steps have been taken in order to reach that, taking into consideration the massive amount of data presented in this study. With respect to dimensionality, only three in ninety five scales showed bidimensionality (10, 54 and 60 months of domain Personal/Social). Likewise, a few scales in ASQ-BR showed unreliable data based on Cronbach's alpha. For example, 67% of the scales in Personal/Social domain had alphas below 0.65. Despite the classical standard for Cronbach's alpha is 0.70 (Cohen & Swerdlik, 2009; Pasquali, 2008), 0.65 was accepted by Filgueiras et al. (2013) due to the small number of items per scale: 6 (Dukes, 2005). Similar phenomenon was observed in three scales of domain Problem Solving as well as in two scales in both Gross and Fine Motor Coordination domains. Only Communication had all its alphas above 0.65. Other psychometric studies were conducted, but the present work will be limited to those data, since they will be the basis for the comparison between Filgueiras's and the new version proposed in this dissertation.

Based on those results, there is evidence that ASQ-BR can be improved in terms of internal consistency and dimensionality. For that, all the items with psychometric problems or issues of adaptation to the target audience were modified – according to this study's methodology. Validity studies should be performed in future studies, with the special recommendation of clinical validity, since ASQ-BR is a screening instrument.

This study will investigate the psychometric characteristics of screening instrument Ages & Stages Questionnaire – Third Edition (ASQ-3) regarding

comparison of its two adaptations to Brazilian Portuguese – (ASQ-BR and ASQ-BR-2011) in the context of municipal public daycare and preschools of Rio de Janeiro, Brazil, conducted by Filgueiras (2011) and published by Filgueiras, Pires, Maisonette and Landeira-Fernandez (2013). Two chapters were planned to help understand the theoretical basis of ASQ-3 and ASQ-BR: chapter 2 assesses the types of psychological tests, their validity, precision and standards; and chapter 3 briefly describes Piaget's and Gesell's theories since they provide the foundations of the constructs in ASQ-3 and ASQ-BR. ASQ-BR will be presented in detail in chapter 4 as well as its translation, adaptation and application in 2011. Chapter 5 will show the objectives of this thesis. Methodology will be discussed in chapter 6. Chapter 7 brings our conclusions and Chapter 8 will present the results of this study. Chapters 9 and 10 consist of the bibliographical references and the annex, respectively.

2
Types of psychological tests and their validity, precision and standards

Tests are usually classified in objective or projective, according to Pasquali (2008). In case of projective tests, a person is asked to have a certain behavior and project his/her latent traits on a paper sheet or object – as when describing what a person sees in Rorschach test. Normally, there are no right or wrong answers to projective tests: they are open to any possibility. The results are compared with those of other people and deeper investigations are performed when the answer of a respondent does not agree with most of the answers in a normative sample.

Though not always the case, criticisms of projective tests include some discrepancy between statistical and clinical validity. The criticism of lack of scientific evidence to support them has been referred to as the "projective paradox" (Cordón, 2005). It is usually said that projective tests rely too much on clinical judgment, lack proper statistical reliability and validity and have little standardized criteria to which results may be compared. The fact that projective tests are mainly used in clinical realms influenced some to think that projective tests could be validated in the clinical context itself, with no need of psychometric studies. In this respect it is also said that psychometric evaluation of projective tests could lead to impoverishment and categorization of their content and that would be contrary to the core intention of clinical evaluation (Cordón, 2005). The risk of impoverishment and categorization may have directed some psychologists to the opposite extreme, that is, refusing psychometric evaluation in their research. A dichotomy was created, then, between professionals that criticized the projective techniques of evaluation because they did not make use of systematic statistical methodology and those who fully trusted psychometrics possibilities in any kind of evaluation context.

Pasquali (2008) considers that a false issue. He thinks that it might be more challenging to use instruments of psychological evaluation in the clinical context because of its complex, idiosyncratic and ambiguous character. Projective instruments typical of clinical contexts are harder to quantify and standardize if compared to objective tests. Nevertheless, that would only mean more work would be necessary to perform psychometric studies. Actually, there have been many empirical studies based on projective tests (including the use of standardized norms and samples), particularly in the more established tests. Exner (1993), for example, performed hundreds of validity studies about interpretations of Rorschach test.

Objective tests, diversely, have standard answers and are basically divided in direct observation or self-report tests (Cohen & Swerdlik, 2009). Tests for direct observation are those in which the psychologist asks the respondent to perform a task or behavior and the psychologist is responsible for registering the respondent's score. Self-report tests (or self-report inventories) are those in which the very person responds test items (Cohen & Swerdlik, 2009).

Objective tests fully depend on the concept of precision. It is a very important characteristic of psychological instruments. Precision studies are a systematic way of evaluating error in measure. Since mistake is a possibility for any evaluation, being able to estimate the magnitude of the error is of paramount importance. Precision studies provide a new opportunity of evaluation and are an attempt to guarantee that the attribute tested has not changed between test applications. The objective is verifying fluctuations in test scores under similar application conditions. This way, it can be defined as how much test scores are immune to fluctuations that occur because of unexpected, irrelevant and/or undesirable factors (Pasquali, 2008).

Psychological measuring are always vulnerable to error and the practical goal of precision evaluation is what error magnitude is tolerable so that the measure is not disposable. Several sources of error are possible, *e.g.*, subjectivity in test application, differences in evaluation contexts, problems with the content of the tasks used for testing, and others. Therefore, in Brazil, the Federal Council of Psychology (CFP, 2003) requires specific precision analysis in order to

consider a test valid – equivalence (parallel forms), internal consistency, test-retest reliability, precision of evaluators, besides inquiring if the coefficients derived from such procedures are calculated for difference groups of subjects (CFP, 2003).

Though precision is necessary, it is not sufficient for the validation of an instrument. Tests with low precision may be influenced by many sources of error and that makes it hard to identify if score fluctuations are due to important or irrelevant factors. This way, scores are not very reliable and compromise the validity of the test interpretation. On the other hand, even though high precision means little vulnerability to error sources, it is not sufficient evidence that the interpretations associated to the scores are legitimate. High precision is, therefore, only the first step. Validity analysis is necessary to prove that the test really is evaluating whatever latent trait it was supposed to (Pasquali, 2008).

Validity is a fundamental characteristic of psychological tests. It attests whether interpretation made upon data collected through a test is legitimate, *i.e.*, if there are clear data to indicate that a certain interpretation is accurate and result from research planned specifically to test the assumptions of such interpretation. Validity refers to the scientific basis of psychological instruments. Therefore it justifies the relationship proposed between indicators and psychological characteristics (Muniz, 2004).

There are several ways to study the validity of test interpretation. They may be based on the test content – content validity – and refer to the extent to which a measure represents all facets of a given construct. For example, a depression scale may lack content validity if it only assesses the affective dimension of depression but fails to take into account its behavioral dimension. Consultation of experts in the area is fundamental for the decision of whether the content of a given test is fully valid.

Tests are also validated with regards to their constructs. Construct validity is the degree to which a test measures what it claims to be measuring. Constructs are abstractions created by researchers in order to conceptualize the latent variable, which, though not directly observable, is the cause of scores on a given measure. Construct validity examines whether the measure behaves like the theory says a

measure of that construct should behave. For that, several procedures may be adopted – convergent-discriminant validity (correlation with other tests), differences among groups, multitrait-multimethod matrix (MTMM), internal consistency or factor analysis (exploratory or confirmatory) and experimental design (Primi, 2003).

Criterium validity is the last aspect according to which psychological tests are studied and refer to the extent to which measures of a test are demonstrably related to concrete criteria in the "real" world. This type of validity is often divided into 'concurrent' and 'predictive' sub-types of validity. The term concurrent validity is reserved for demonstrations relating a measure to other concrete criteria assessed simultaneously while predictive validity refers to the degree to which any measure can predict future. In objective tests validation must be predictive.

Three categories of psychological tests are then known: (1) projective tests, (2) self-report and objective tests and (3) objective tests with direct observation. Although not necessarily psychological, screening is an important part in the realm of instruments studied by psychometrics. Some screening instruments aim at evaluating behaviors directly. Screening tests, however, have different characteristics other than the above-mentioned projective tests, self-report and objective tests. An example is measuring observations of other people, such as the Behavior Assessment System for Children - BASC (Reynolds & Kamphaus, 2011). BASC has three scales: (1) assessment by parents, (2) assessment by teachers, (3) self-report tests. The first two measures are, by definition, objective tests of assessment of others, *i.e.*, indirect observation. Those are not part of the list of psychological tests by Pasquali (2008) or Cohen and Swerdlik (2009). However, whether or not being a "real" psychological test, measures such as BASC must undergo rigorous psychometric analysis to be considered ready to assist professionals in intervention decisions.

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Another important aspect of psychological tests is standardizing the interpretation system of test scores. Results from other tests – similar ones – become reference groups and are used as standards against which the results of the new test are compared. This way, it is possible to define what results are very likely or unexpected (Pasquali, 2008). For example, Beck's Depression Inventory – BDI – (Beck, 1998) evaluates depression against normal behavior, that is, the average score of individuals who do not have depression. The results of the reference group are the standards for the comparison of the results of a tested person. Indeed, test scores are usually compared to the scores of normative groups (the latter case) and also to results of groups who are expected to present the researched latent trait. In BDI, for example, it is possible to compare the results of a tested person with the results of groups with depression and groups without depression. The professional is able, then, to decide which group results are closest to the condition of the tested person.

3
ASQ-3's theoretical developmental bases: Piaget & Gesell

3.1
Piaget's developmental theory for 2 to 66 month-old children

The well-known Swiss developmental psychologist Jean Piaget explains the cognitive development through a series of stages. Piaget focuses on the two very important processes assimilation and accommodation (Gruber & Voneche, 1977). Assimilation is how children perceive and adapt to new information, the process of fitting it into pre-existing cognitive schemas. In contrast, accommodation is the process of getting new information and altering pre-existing schemas in order to fit in the new information. Piaget believes that the human brain has been programmed through evolution to bring equilibrium, which is what he believes ultimately influences structures by the internal and external processes through assimilation and accommodation. Assimilation and accommodation alternate and connect so as to enable children development along stages (Gruber & Voneche, 1977).

Sensorimotor is the first of the four stages in cognitive development which extends from birth to the acquisition of language. In this stage, infants construct knowledge and understanding of the world by coordinating experiences such as vision and hearing with physical interactions with objects, such as grasping, sucking, and stepping (Gruber & Voneche, 1977). Infants gain knowledge of the world from the physical actions they perform progressing from reflexive, instinctual action at birth to the beginning of symbolic thought at the end of the stage.

For Piaget, the first stage children development is sensorimotor. Children learn that he/she is separate from the environment and that aspects of the environment continue to exist, although they may be outside the reach of the child's senses. The development of object permanence is one of the most important accomplishments of this stage.

Piaget divided the sensorimotor stage into six sub-stages. In sub-stage 1, from birth to 6 weeks, reflexive behaviors lead to coordination of sensation and action and three primary reflexes are described by Piaget: sucking of objects in the mouth, following moving or interesting objects with the eyes, and closing of the hand when an object makes contact with the palm (palmar grasp). Over the first six weeks of life, these reflexes begin to become voluntary actions (the palmar reflex becomes intentional grasping).

In sub-stage 2, from 6 weeks to 4 months, first habits and primary circular reactions take place. Babies become able to coordinate sensation and two types of schema: habits – reflex – and primary circular reactions, i.e. reproduction of an event that initially occurred by chance. The main focus is the baby's body. For example, babies may repeat the motion of passing the hand before the face. At this phase, passive reactions caused by classical or operant conditioning can begin.

Sub-stage 3 happens from 4 to 8 months, when secondary circular reactions and development of habits take place. Babies become more object-oriented, moving beyond self-preoccupation and repeat actions that bring interesting or results (Gruber & Voneche, 1977). This stage is associated with the development of coordination between vision and prehension and three new abilities occur: intentional grasping for a desired object, secondary circular reactions, and differentiations between ends and means. Babies will intentionally grasp the air in the direction of a desired object. Secondary circular reactions, (the repetition of an action involving an external object) begin like, for example, moving a switch to turn on a light repeatedly. The differentiation between means and ends also occurs, one of the most important stages of a child's growth as it signifies the beginning of logic.

Sub-stage 4 comprises coordination of secondary circular reactions stages, e.g. hand-eye coordination, from 8 to 12 months. It is associated with the development of logic and the coordination between means and ends, what Piaget calls the "first proper intelligence" (Gruber & Voneche, 1977). This stage marks the beginning of goal orientation, the deliberate planning of steps to meet an objective.

Sub-stage 5 is when tertiary circular reactions develop and curiosity for

novelty increases, from 12 to 18 months. Infants become intrigued by object properties and by the many things they can make happen. They experiment with new behavior and the stage is associated with the discovery of new means to meet goals. Piaget describes the child here as the "young scientist" conducting pseudo-experiments to discover new methods of meeting challenges (Gruber & Voneche, 1977).

The internalization of schemas define sub-stage 6, from 18 to 24 months, when infants develop the ability to use primitive symbols and form enduring mental representations (Gruber & Voneche, 1977). This stage is associated primarily with the beginnings of insight and marks the passage into the preoperational stage. By the end of the sensorimotor period, the child sees objects as something permanent and separate from the self.

Piaget's second stage – pre-operational – starts when the child begins to speak at two years old and lasts until the age of seven. At that point, children do not understand concrete logic nor mentally manipulate information, though there is increase in playing and pretending. Though the children's play is mainly categorized by symbolic play and manipulating symbols, he/she still cannot see things from different points of view. Their observations of symbols exemplifies the idea of play with the absence of the actual objects involved.

The pre-operational stage is sparse and logically inadequate in regard to mental operations. Though he child is able to form stable concepts as well as magical beliefs, he/she is still cannot perform 'operations' (tasks done mentally rather than physically). Thinking is still egocentric, meaning the child has difficulty seeing the viewpoint of others. This stage splits into two substages: 'symbolic function' and 'intuitive thought'. The symbolic function substage is when children are able to understand, represent, remember and picture objects in their mind without having the object in front of them. The intuitive thought substage is when children start to ask "why" and "how come".

At about two to four years of age, children cannot yet manipulate and transform information in a logical way. However, they can think in images and symbols, as well as use some language and pretend play. Symbolic play is when children develop imaginary friends or role-play with friends. Children's play

becomes more social and they assign roles to each other. Some examples of symbolic play include playing house, or having a tea party. The quality of their symbolic play can have consequences on their later development as, for example, young children whose symbolic play violent nature tend to exhibit less prosocial behavior and are more likely to display antisocial tendencies in later years (Dunn & Hughes, 2001).

In this stage, egocentrism is present and is defined by the fact that children tend to stick to their own viewpoint, rather than consider the view of others since they are not even aware that different viewpoints exists (Gruber & Voneche, 1977). In the experiment known as 'three-mountain problem', three views of a mountain are shown to a child and he/she is asked what a doll would see at the different angles. The child consistently answers according to the position he/she they is seated, regardless of the doll's perspective. Egocentrism also causes a child to believe that if he/she likes something, so will others.

Similarly, preoperational children use their own views – like in egocentrism – to explain cause-and-effect relationships. Three main concepts of causality displayed by children in this stage are animism, artificialism and transductive reasoning (Gruber & Voneche, 1977). Animism is the belief that inanimate objects are capable of actions and have human qualities, like children believing that stars twinkle in the sky because they are happy. Artificialism refers to environmental characteristics been attributed to human actions or interventions – it is windy outside because someone is blowing very hard. Finally, precausal thinking is categorized by transductive reasoning which is when a child fails to understand properly the relationship between cause and effect. For example, if a child hears the dog bark and then a balloon popped, the child would conclude that the balloon popped **because** the dog barked, (Gruber & Voneche, 1977).

Between ages 4 and 7, interest of reasoning emerges and the child wants to know 'why', what Piaget called "intuitive substage" (Gruber & Voneche, 1977). Children realize they have a lot of knowledge, but cannot realize how they acquired it. Centration, conservation, irreversibility, class inclusion, and transitive inference are characteristics this stage.

Centration is the act of focusing on one characteristic of a situation, while disregarding all others. Conservation is the awareness that altering a substance's appearance does not change its basic properties. The following Piaget's experiment exemplifies both concepts. A child is presented with two identical beakers containing the same amount of liquid, what is initially clear to the child. When one of the beakers is poured into a taller and thinner one, children who are under seven or eight say that the taller beaker holds the larger quantity (centration), without taking into consideration the fact that both beakers had the same amount of liquid (conservation) just before.

'Irreversibility' is closely related to 'centration' and 'conservation'. It refers to a child being unable to mentally reverse a sequence of events. The child does not realize that if the sequence of events with the beaker was reversed (the water from the tall beaker was poured back into the original one), the same amount of water would exist.

'Class inclusion' refers to children's inability to focus on two aspects of a situation, when one category can contain several different subcategories or classes (Gruber & Voneche, 1977). For example, a four-year child is shown a picture of 8 dogs and 3 cats but, if asked, cannot say if there are "more dogs" or "more animals", being likely to answer "more dogs". This is due to her difficulty focusing on the two subclasses (dogs and cats) and the larger class (animals) at the same time. 'Transitive inference' is using previous knowledge to determine the missing piece, using basic logic, as when a child cannot say that "A" is greater than "C" when presented with the information "A" is greater than "B" and "B" is greater than "C".

3.2
Gesell's developmental theory for 2-66 month children

Arnold Gesell, as director of the Yale Clinic of Child Development for 37 years, observed and registered the changes along human growth. As a maturationist, he emphasized physical and mental growth establishing typical behaviors throughout childhood. He categorized these typical behaviors into 10 major areas – the gradients of growth – that became patterns according to which development would unfold, from birth to adolescence. They include the evaluation of motor characteristics (bodily activity, eyes, and hands), personal hygiene (eating, sleeping, elimination, bathing and dressing, health and somatic complaints, and tensional outlets), emotional expression (affective attitudes, crying, assertion, and anger), fears and dreams, self and sex, interpersonal relations (mother-child, child-child, and groupings in play), play and pastimes (general interests, reading, music, radio, and cinema), school life (adjustment to school, classroom demeanor, reading, writing, and arithmetic), ethical sense (blaming and alibiing; response to direction, punishment, praise; response to reason; sense of good and bad; and truth and property), and philosophic outlook (space, language and thought, war, death, and deity).

For Gesell, development is thought to process through an orderly sequence – babies first learn how to roll on their backs, then sit, creep, walk, run and climb. That is primarily determined by biological maturation and may be altered only to some extent. His theory is especially useful for examining motor development.

Gesell conceived five principles of development thought to be characteristic of every child's growth pattern in motor, adaptive, language and personal-social behavior. They describe typical development as a predictable and orderly process, that is, it should be possible to predict how most children will develop, that they will develop approximately at the same rate time as other children. Gesell's five principles according to which children develop are: developmental direction, reciprocal interweaving, functional asymmetry, individual maturation and self regulatory fluctuation.

The principle of developmental direction states that development unfolds in a systematic direction as a programmed function of genetic mechanisms

(Wolraich, 2003). Development follows two patterns. Firstly, in the cephalocaudal phase, it happens from head to down. An example would be the embryo's arm buds appearing before the leg buds. The same way the infant shows voluntary motor control of the head and shoulders before control of the lower limps. According to Gesell's second pattern, development is proximodistal. That means it proceeds from near the organism to the periphery. In the embryo, for example, the spinal cord develops before the arms buds as well as in the early development, infants gain control over the entire arm before finer control of the individual finger (Wolraich, 2003). Similarly, to pick up an object the child initially uses his/her whole hand. It is only possible to pick up a object using the fingers at a later stage.

The principle of reciprocal interweaving states that inhibition, exhibition and excitation of different muscles operate complementarily to produce a different movement. In walking and handedness, walking is viewed as a series of alterations between flexor (bending) and extensor (extending) movements of arms and legs in coordination. The movements oppose each other but result in integration and progression to a mature movement (Wolraich, 2003). This can be observed in babies using two arms when reaching for small objects toward the end of their 1st year (Bremner &Wachs, 2011). This tendency is associated with the development of a new motor skill, specifically, the emergence of upright locomotion, sitting, crawling, or walking.

The principle of functional asymmetry describes development as a sequence. Certain prerequisite physiological structures must be present for other development or learning to occur. For example, it is important for an infant to have certain degree or of trunk stability for walking to occur (Wolraich, 2003). Gesell illustrates this complex principle with a basic response called the tone neck reflexes. This reflex is present when the child assumes the position like that of the fencer, with the head turned one side, one arm extended to that side and the leg one that side straight, and the other leg bent at the knee and the other arm folded across the chest. This behavior is a precursor to later development of systemically reaching.

The principle of self regulatory fluctuation is similar to the principle of

interweaving since it understands development as alternating periods of stability and instability (Wolraich, 2003). There is a distant sequence of stages that occurs and allows the organism or function while accommodating growth (Wolraich, 2003).

The principle of self individualizing maturation also describes development as a process of sequential patterning. The child's environment and the learning that occurs as a result of the child's experiences largely determine whether the child will reach optimal development. A stimulating environment and varied experiences allow a child to develop to his or her potential. Stimuli have impact over the changes in the brain and nervous system that occur along maturation and consequently help children improve cognitive and motor skills.

Language acquisition is also studied by Gesell. According to his timetable, the essential milestones for language development happen between the ages of 40 weeks and 5 years. A child begins to produce meaningful sounds, simple words or childish nicknames at 40 to 50 weeks of age. Between one to two years old, the child's vocabulary expands and pronunciation becomes clearer. Infants begin to use longer phrases and very simple sentences.

From two to three years of age, the child begins to communicate in complete sentences. Language becomes a tool for thinking and the child moves beyond very simple ideas to more abstract ones. From three to four years old, the child tends to ask many questions, using language as a means to expand his/her knowledge of the world. He or she will also become able to make generalizations. From four to five years of age the child has basic mastery of the language.

4
ASQ-3 and ASQ-BR

ASQ-3 is a screening instrument that aims at detecting possible developmental problems in children between one month and five and a half years old (Squires et al., 2009). The objective of each questionnaire is forwarding the child to proper professional care in case of suspicion of delay in some cognitive or motor domain.

In most countries early detection of development disorders is a key element to decrease gaps and provide children with proper healthcare so as to grow properly (Fiester, 2010; Salvia, Ysseldike, & Bolt, 2010). There is plenty of evidence in the literature that daycares and preschools provide children with healthier development as well as better cognitive indicators ahead in life if compared to strictly residential programs – when children are exclusively cared by parents (Lonigan, Burgess, & Anthony, 2000; Nelson, Westhues, & MacLeod, 2003; Thatcher Kantor, Wagner, Torgesen, & Rashotte, 2002). Therefore, it can be assumed that periodical evaluations are recommended to those institutions with three main objectives: (1) identify as early as possible domains in which there may be developmental delay in order to establish psycho-educational strategies of intervention to improve children conditions, (2) identify children with high latent cognitive potential so as to implement psycho-educational strategies to improve their abilities and (3) be the foundation for the improvement of educational programs aiming at better performance. (Brenneman, Stevenson-Boyd, & Frede, 2012; Cipani & Shock, 2011; Fiester, 2010; Leung, Mak, Lau, Cheung, & Lam, 2004; A. J. Reynolds, Temple, & Ou, 2010; Salvia et al., 2010; Verkerk et al., 2011, 2012).

ASQ-3 has been used in several educational programs with periodical evaluations – Head Start in the United States (Vinovskis, 2005); Mohawk in Canada (Dionne, McKinnon, Squires, & Clifford, 2014); Latino do Sul in California, U.S.A. (Melendez, 2012); A-Tempo in Galicia, Spain (Campos, Squires, & Ponte, 2011) and LAUP in Los Angeles, U.S.A. (López, 2013). In Brazil, SME-RJ has implemented the first initiative for an integrated evaluation and intervention program for children enrolled in daycares and preschools, *Primeira Infância Completa* (Pádua, 2011). For that, the first two instruments adopted were ASQ-3 (Filgueiras, 2011; Squires et al., 2009) and Early Childhood Environmental Rating Scale – ECERS (Campos-de-Carvalho & Bhering, 2006; Harms, Clifford, & Cryer, 2009; Harms & Clifford, 1980). The measure adaptation was done through two research groups with different goals: ASQ-3 evaluates global development and tries to identify latent potentials in Rio de Janeiro's children; ECERS carefully evaluates educational programs, environment and teacher-child interaction. The two types of measuring, though different, complement each other.

The instrument is used by parents through the fulfillment of one among 21 possible questionnaires according to the age of the child. The intervals were determined according to empirical evidence found by the authors of the instrument and are based on Piaget and Gesell's development theories, addressed on the last topic. The age categories start at the first month of age, have variable lengths and are designated: 2, 4, 6, 8, 9, 10, 12, 14, 16, 18, 20, 22, 24, 27, 30, 33, 36, 42, 48, 54 and 60 months (Squires et al., 2009). Illustration 1 (IBNeC, 2011), on the next page, shows ASQ-3's age categories.

Illustration 1

Questionnaire	Age range	Interval
2	1 month and 0 day to 2 months and 30 days	2 months
4	3 months and 0 days to 4 months and 30 days	2 months
6	5 months and 0 days to 6 months and 30 days	2 months
9	7 months and 0 days to 8 months and 30 days	2 months
8	9 months and 0 days to 9 months and 30 days	1 month
10	9 months and 0 days to 10 months and 30 days	2 months
12	11 months and 0 days to 12 months and 30 days	2 months
14	13 months and 0 days to 14 months and 30 days	2 months
16	15 months and 0 days to 16 months and 30 days	2 months
18	17 months and 0 days to 18 months and 30 days	2 months
20	19 months and 0 days to 20 months and 30 days	2 months
22	21 months and 0 days to 22 months and 30 days	2 months
24	23 months and 0 days to 24 months and 15 days	2 months
27	24 months and 0 days to 28 months and 15 days	2 months
30	28 months and 0 days to 31 months and 15 days	2 months
33	31 months and 0 days to 34 months and 15 days	3 months
36	34 months and 0 days to 38 months and 30 days	3 months
42	39 months and 0 days to 44 months and 30 days	3 months
48	45 months and 0 days to 50 months and 30 days	4 and 1/2 months
54	51 months and 0 days to 56 months and 30 days	6 months
60	57 months and 0 days to 65 months and 30 days	6 months

ASQ-3-BR age intervals (IBNeC, 2011).

Since children tend to present faster development during the first stages of life and slower development as they get older (Piaget, 1953), questionnaires of older children encompass smaller intervals if compared to questionnaires of younger children. Each age interval evaluated five domains of development: (1) Communication, (2) Gross Motor Coordination, (3) Fine Motor Coordination, (4)

Problem Solving and (5) Personal/Social. According to Filgueiras (2011), that corresponds to one of the largest ranges of age intervals and developmental domains evaluated by a single screening instrument. Table 1 shows the definition of each domain according to Squires et al. (2009).

Table 1. ASQ-3 domains and theoretical definitions for item construction.

ASQ-3 domain:	Definitions (Squires et al., 2009; our translation):
Communication	"Ability to babble, vocalize, speak, listen and understand. Structure and express some thought so that his/her interlocutor understands it. Simple verbal structures, some speech complexity and correct use of plurals, complex and conditional verbal tenses".
Gross Motor Coordination	"Broad bodily movements. Move arms to complete simple tasks as throwing an object or leaning against walls or handrails. Leg and feet coordination for balance and moving,"
Fine Motor Coordination	"Movement and coordination of fingers and fingertips, ability to use tools like knobs, scissors, taps, pencils and pens".
Problem solving	"Respond appropriately to external and internal demands of the environment, such as: taking an object from inside another, handling two pieces of information at the same time, imitating or copying adults, attributing meaning, recognizing and categorizing objects and people."
Personal/Social	"Ability to be independent and relate to other children and adults. Verify if: the child looks for help when needs something, is able to engage in relationships with other people, can identify with elements socially established for his/her individuation, is independent in daily tasks like eating, getting dressed, and cleaning him/herself."

4.1
The importance of good transcultural adaptation

Good psychometric analyses are important not only because of the characteristics of scales. They should comply also with the peculiarities of the culture from which the sample is extracted. The literature offers several reasons in favor of careful adaptation instruments, so that they are not limited to a mere translation (Borsa, Damasio & Banner, 2012). The first reason is the language barrier. Instruments created in languages other than those of the respondents must necessarily be translated. However, how to ensure that the content and meaning of a question remains intact after translation and that respondents really have access to what the original author of the scale meant?

An example of this problem is the translation of ASQ-3's (Squires, Bricker, Twonbly, & Potter, 2009) item "Does your child eat cookies by him/herself?" into the Brazilian Portuguese version as "*A criança come biscoitos sozinha?*" (Filgueiras, 2011). The translation was direct and there was virtually no change in the text but the item showed poor psychometric properties and jeopardized the reliability of the scale it belonged to. One possible explanation for the problem is the difficulty keeping the semantic content identical in both. The term 'cookie' refers to a specific type of sweet pastry in the United States usually baked with chocolate chips, be it homemade or industrially processed. Crackers in American English are commonly considered snacks while homemade cookies are called biscuits. The term 'cookie' (*biscoito*) has a much broader sense in Brazilian Portuguese and refers to "any mass or cluster of spices cooked in the oven" (Holland, 2010). So, the semantic meaning of 'cookie' is different from the meaning of *biscoito* in Brazilian Portuguese. That is an example of variables that can jeopardize internal consistency in a scale.

Borsa et al. (2012) teach that adapted versions should respect not only the fluency of the target language but also: a) linguistic peculiarities, as the example above; b) cultural features – children in northeastern Brazil usually eat with hands or a spoon while children in southern Brazil eat with forks in comparably younger ages; c) contextual particularities – an instrument made for the therapeutic setting is different from one to be applied on a large scale and d) scientific evidence

about the construct being assessed. The latter is of utmost importance when an item or a scale is being adjusted. The item mentioned above (Filgueiras, 2011; Squires et al, 2009) is part of a scale that assesses a construct regarding children's personal and social contexts. According to Squire's definition (Squires et al., 2009), the purpose of that scale is:

> "Presenting topics related to children's independence and their relationships with other children and people. Identify whether: the child seeks help when he/she need something, the child develops relationships with other children, identifies with socially established elements aiming at individuation, shows independence in daily tasks such as eating, dressing and personal cleaning."
>
> (Squires et al., 2009; our translation)

Following her definition, the construct assessed by the item is the child's independence at mealtime: "(...) shows independence in daily tasks, like eating (...)" (Squires et al., 2009). The goal is determining if the child is independent enough to eat an appetizer or some food not considered a meal by him/herself. The literature on child development asserts that very young children are able to quickly learn how to interact with the environment and perform motor activities related to picking up and eating small portions of food, like a cookie (Piaget, 1953; Squires et al, 2009), but not small to the point of being eaten by the child with only one bite. In the latter condition, the child would not show proper management of his/her cognitive and motor functions. Considering the definition of 'biscuit' in Brazilian Portuguese, it may be inferred that a cookie is small enough to be swallowed with one bite by the child. Because of that, the item in Brazilian Portuguese would refer to the same construct as the one in the American version – the child's independence – but ultimately whether the child can chew and/or swallow. That is a possible explanation for the statistical problems of the item in ASQ-BR, *i. e.*, the Brazilian item does not refer to the semantic content of the original construct.

The International Test Commission (ITC, 2010) has met since 1992 to build guidelines for the translation, adaptation and validation of instruments for varied application contexts. The most recent guidelines date back to 2010 and can

be found at the link http://www.intestcom.org/upload/sitefiles/40.pdf (ITC, 2010). ITC highlights that the adaptation must consider the application context. ASQ-3 (Squires et al., 2009) was developed to be responded by parents regarding their children's behavior. ASQ-BR (Filgueiras, Pires, Maissonette, & Landeira-Fernandez, 2013; Filgueiras, 2011) was, in turn, adapted to be used in the context of public municipal daycares and preschools of Rio de Janeiro. The different respondents might be an influential variable regarding items.

Another topic to be taken into consideration is that the Municipal Secretary of Education of Rio de Janeiro (SME-RJ) follows nutritional recommendations by the National Program of School Nutrition (PNAE) according to federal law Nr. 11947 from 16/06/2009 (Brasil, 2009). It states the advertisement of food items in public municipal daycares and preschools in Rio de Janeiro is only allowed according to certain rules – available at the Rio de Janeiro City Hall website (Rio de Janeiro, 2014). PNAE makes no specific reference to 'cookies' in daycare menus and that allows wondering if some teachers understood that *biscoitos* could also refer to 'cookies'. This way some teachers may not have observed the behavior mentioned in the item, what may have increased the chances of the item to have been compromised. Issues regarding adaptation to the context of test application must be carefully evaluated so that scales are properly adapted (Borsa et al., 2012).

4.2
ASQ-3's transcultural adaptation into ASQ-BR

ASQ-3's adaptation to the Brazilian version, ASQ-BR, was made by Filgueiras (2011) and deeper psychometric analyses were published in 2013. The process of transcultural adaption consisted of back translation and evaluation by experts, two of the methods recommended by Borsa et al. (2012). According to Filgueiras (2011), the first step was providing translations by three bilingual independent translators. The versions produced by each translator were evaluated

by the panel of experts according to each construct. No assertion is made in Filgueiras (2011) about concerns of experts regarding the daycare and preschool samples. They just knew who the target audience for ASQ-BR was. That could actually be an indication that not all ITC's recommendations were accomplished during the adaptation process (ITC, 2010).

After the translated version, ASQ was back-translated into English by an independent American translator who was fluent in Portuguese. Afterwards, the final version was evaluated by the panel of experts (all Portuguese-English speakers) who compared the semantic content of the original version to the back-translated one. Filgueiras et al. (2013) inform that a pilot study was performed among 120 children before the final version of the test. Issues regarding adequacy of the items to those children's real context may have arisen though there are no reports of those. Despite that, Filgueiras et al. (2013) state that suggestions of the children's teachers were incorporated into ASQ-BR. That may be seen as evidence that adaptation to the target audience was an important issue during the pilot test.

An important criterion to recognize the quality of a cultural adaptation is the similarity between the statistical results of the original and adapted versions (Borsa et al., 2012). Filgueiras's results (2011, 2013) are quite similar to those of the American sample (Squires et al., 2009) in terms of the reliability measured by Cronbach's alpha. Nevertheless, the descriptive statistics of the Brazilian sample seem to be lower than the American sample's, with a variance ranging from ½ SD – in domain Communication in age interval 6 months – to 1 SD – in domain Personal/Social, age interval 10 months. Despite those data, no conclusion about statistical differences in the descriptive data can be provided, since null hypothesis inferential tests were not performed in order to empirically show some difference in the averages.

The authors informed that the first version of ASQ-BR was successfully adapted, thus with a few psychometric problems in items and scales. Besides such limitation, validity could only be attested regarding ASQ's content – content validity is supposed to be verified by a panel of experts in the instrument's field of knowledge (Cohen & Swerdlik, 2009). None of the other types of validity –

predictive, clinical, convergent and divergent – were observed (Borsa et al., 2012; Pasquali, 2007, 2008). This study agrees with the comment by Filgueiras (2011) about the absence of other types of validity in his study and his recommendation that the other validity types should be verified in further studies on ASQ-BR, though that was not the focus of this dissertation.

5
Objectives

5.1
General objectives

Verify if adjustments made on selected ASQ-BR's (2010) items in order to produce a better instrument – ASQ-BR-2011 – improved the latter's psychometric characteristics.

For that, provide a review of ASQ-3 and ASQ-BR including the history of both instrument versions, relevance in the international scenario, a brief description of the theoretical bases of the developmental approaches adopted by the author of the test, and a discussion of types of tests and their psychometrics.

5.2
Specific objectives

- Study the internal consistency of ASQ-BR-R application in 2011;
- Identify the number of factors in each scale and age interval of ASQ-BR-R;
- Analyze the contribution of ASQ-BR-R's items to its overall score in 2011.
- Compare results of ASQ-BR-R (2010) and ASQ-BR-R (2011).

6
Methodology

The objective of the present methodology is performing adjustments in Ages and Stages Questionnaire - Brazil – ASQ-BR – (Filgueiras, Pires, Maissonette, & Landeira-Fernandez, 2013; Filgueiras, 2011) in order to improve its reliability and adaptation to the context of Brazilian municipal daycare and preschools of Rio de Janeiro. Two different approaches were adopted to identify the elements that needed more improvement in ASQ-BR: (1) items with psychometric indexes lower than the established criteria should be modified and (2) items considered inadequate to the Brazilian context by directors – with a Pedagogy degree – of Rio de Janeiro municipal daycare and preschools should be as well modified.

The first step was identifying items with psychometric inconsistencies. That was established based on two psychometric criteria reported by Filgueiras (2011): item-total correlation lower than 0.30 ($r<.30$), and Loevinger H lower than 0.20 ($h<.20$). The criteria were based in different theoretical premises. Pearson product-moment correlation coefficient, which relates the item score and the total score of each respondent, is proposed by the Classical Test Theory (CTT) while Loevinger H (rho), which analyses consistency based on a scales's scalability, derives from Item Response Theory (ITR). This study does not discuss theoretical differences between CTT and IRT nor questions regarding the methodology adopted by Filgueiras (2011). Alternatively, the psychometric characteristics revealed by the above-mentioned study were used to detect items with problems in order to modify them for ASQ-BR's following version, ASQ-BR-2011. Further information on CTT and IRT can be found especially in Pasquali (2008) and Cohen & Swerdlik (2009) as well as in the psychometric literature as a whole.

The second step consisted of working with a team with experts on ASQ-BR and directors of Rio de Janeiro public municipal preschools. Three experts on ASQ-BR met 24 directors of Rio de Janeiro public municipal preschools in groups

of seven people, each consisting of one expert and six directors. All the directors had been trained on the instrument by virtue of the 2010 application. All the items with psychometric problems were introduced and the directors were free to express their opinions on any issue they considered relevant, including items without psychometric indexes below the established criteria.

A multidisciplinary team with experts on child development formed by psychologists (*N*=2), educationalists (*N*=1), health scientists (*N*=1) and economists (*N*=2) were gathered in order to examine the opinions given by the daycare and preschool directors and suggest modifications to the items with psychometric problems. Based on that, a new provisional version of ASQ-BR was prepared. That version with all the changes made by the multidisciplinary team was evaluated and agreed upon by the author of the original ASQ, Prof. Jane Squires.

Afterwards, ASQ-BR's revised version – ASQ-BR-2011 – was applied to 67.522 children from 9 to 66 months of age enrolled in the municipal daycare and preschools of Rio de Janeiro. A total of 11.664 directors, teachers and caregivers filled 16 types of questionnaires according to the child age. New CTT analyses were performed based on the collected data to compare ASQ-BR and ASQ-BR-2011. The present study aimed at the internal improvement of ASQ-BR measure, and did not deal with validity issues. The details of the methodology are described below.

6.1
Criteria for item selection

The criteria used to select the items to be modified were a continuation of the criteria used by Filgueiras (2010): item-total correlation; Loevinger's *h* (R. J. Cohen & Swerdlik, 2009; Pasquali, 2008); and expert reports of inadequacy to the actual context of the municipal daycare and preschools of Rio de Janeiro. The three methods were selected according to the corresponding literature as well as social demand surveyed by educationalists regarding ASQ-BR context adequacy (Fórum Permanente de Educação Infantil do Estado do Rio de Janeiro, 2011; Oliveira & Guimarães, 2013).

Performing item-total correlation (*r*) is a classic procedure for item evaluation in CTT. Item-total correlation algorithm uses Pearson product-moment correlation coefficient to statistically evaluate the linear correlation between a respondent score on a given item and the total score of the scale (R. J. Cohen & Swerdlik, 2009). In ASQ-BR each scale is formed by a group of 6 items that evaluate a specific developmental domain in a given age category. Hence, the correlation of the item to the total of the scale statistically reflects the linear relationship between an item of a certain domain in a given age category (for example, item 1 of domain Gross Motor Coordination of the 10-month age category). The raw total score is reached by adding up all the items of the scale (for example, summing all the items in domain Gross Motor Coordination of the 10-month category). Item-total coefficient reveals the internal consistency, *e.g.*, the reliability of the scale. According to CTT, a group of items should contribute evenly to the total score of the scale (Pasquali, 2008). Thus, an item belonging to a scale is expected to correlate positively to the total score. Moreover, the item is supposed to have moderate to high correlation with the total score. Correlation coefficients vary from 0 to 1 and have classic classification criteria: 0.00-0.29 – low correlation; 0.30-0.69 – moderate correlation and 0.70-1.00 – high correlation (R. J. Cohen & Swerdlik, 2009). An item with low correlation to the total score is actually lowering its internal consistency instead of contributing to the scale.

Moderate and high correlations show convergence of the variables to the same direction, while low correlations lack an adequate linear association with the rest of the scale. According to Cohen e Swerdlik (2009), there are three basic reasons for an item not to relate to the total of the scale it belongs to: (1) the item does not belong to the dimension evaluated by the remaining items of the scale and therefore is not associated with that sum; (2) the item indeed evaluates the desired factor but is obscure to the respondent thus inducing him/her to misinterpreting the item and (3) the item evaluates the desired dimension and its content is clear but the very construct has more than one dimension and should, as well as the ones associated to it, be understood as part of a multidimensional structure. In the latter case, the scale should be considered multidimensional and, as such, use factor analysis and not the sum of the raw score. Illustration 1, on the next page, shows the three examples.
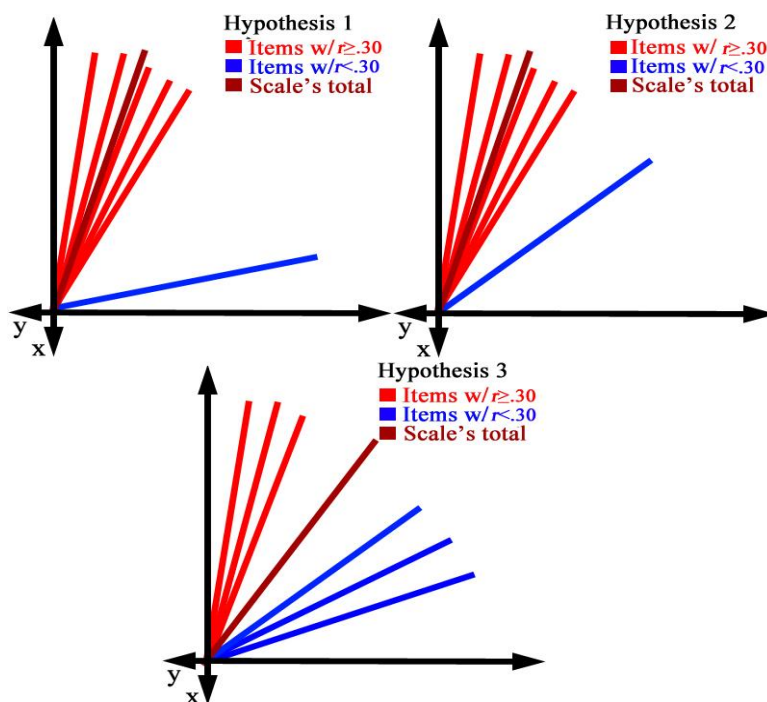
Illustration 1.
Cartesian plans of Cohen e Swerdlik's (2009) three hypotheses on items with item-total correlation problems containing 6 items – similar item quantity as in ASQ-BR-2011 scales.

Each item with item-total correlation lower than 0.30 in Filgueiras et al.'s (2013) results were listed and evaluated to be modified according to the three possibilities above-mentioned. The most noteworthy aspect of internal consistency is that, once an item is changed, the whole structure of the scale may change with it. Being so, two different consequences may occur to the data when item-total correlation increases, that is, the item contributes more than before to the sum: (1) the scale becomes more consistent or (2) the sum of the items associate better with the altered item but other items dissociate from the sum thus generating consistency problems in the scale and causing item-total correlation lower than 0.30 in unchanged items. Because of that, careful examination should take place to detect possible flaws regarding situation (2) and try to adjust items to a single scale domain.

Loevinger *h* coefficient is a scalability index that derives from nonparametric IRT Mokken-Molenaar model (Filgueiras, 2011). Few studies on the technique have been published in Brazilian scientific journals (*e.g.*, Filgueiras et al., 2012; Sá et al., 2011). According to IRT, a scales items contribute

differently to the score – diversely from CTT approach (Pasquali, 2008). Some of the items contribute considerably to the sum of the raw score but do not discriminate subjects well, since almost all respond similarly to the item (in ASQ-BR-2011, that would be all the children answering "yes"). On the other hand, a few items contribute little to the scale total but help discriminate subjects who present large scores in a certain cognitive domain, that is, have large amounts of certain latent trait (in ASQ-BR those would be the children who had more "yes" in the most difficult items or rarely answered positively).

Between the extremes, part of the items discriminate or contribute to the total score in different amounts. That is when concept 'scalability' arises: every scale has items with different probabilities of being answered positively, depending on how the respondent scores in that domain (Filgueiras et al., 2012; Sá et al., 2011). For example, most of the children researched by ASQ-BR have "not yet" answers to an item. But if a child already performs a certain behavior ("yes"), it is probable that he/she has a better development in that domain if compared with most of the other children. The item can be considered difficult, *i. e.*, an item that contributes little to the total score in most of the cases but reveals a lot, since only children with abilities well developed in the domain respond positively to it. According to Sá et al. (2011), a scale must have items that are able to evaluate the levels of a given domain or construct in equal intervals so that it is considered consistent and scalable.

Loevinger *h* coefficient was proposed by researcher Jane Loevinger in 1948 as a scalability index of items and scales. Similarly to item-total correlation, the coefficient varies between 0 and 1. Nevertheless, values above 0.20 are considered adequate so that an item is scalable (Filgueiras, 2011; Filgueiras et al., 2012). Illustration 2 shows two situations regarding Loevinger *h*: (a) when a six-item scale – like ASQ-BR – has perfect scalability: and (b) when the same scale has an item with scalability problems, *i.e.*, *h*<.20.
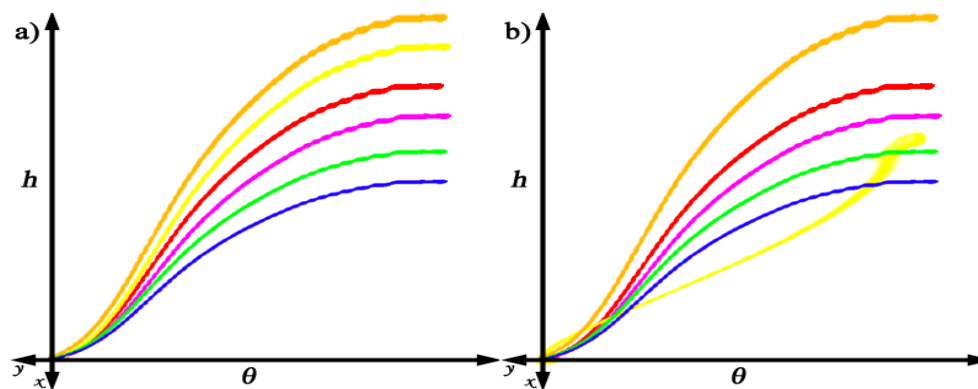
Illustration 2: On the left (a), item characteristic curves (ICC) of a six-item scale with perfect scalability and (b) on the right, a scale with a problematic item that will be considered for the calculation of Loevinger *h*.

Loevinger index is associated with scalability and, as mentioned before, its theoretical paradigm is other than item-total correlation paradigm. That has caused a few ASQ-BR items to present item-total correlation problems, though not related to index *h*, and vice-versa.

The last criterion adopted for item selection and alteration was item inadequacy to daycare and preschool contexts. Although that has not been reported by Filgueiras (2011), there were several ASQ-BR item adequacy discrepancies relative to the daycare and preschool daily activities (Fórum Permanente de Educação Infantil do Estado do Rio de Janeiro, 2011; Observatório da Educação, 2011; Oliveira & Guimarães, 2013). Based on that criticism, members of the multidisciplinary committee decided to hear the directors of the researched municipal daycare and preschools. A meeting held at the Municipal Secretary of Education premises in August 2011, brought together 24 of those directors. They were divided in discussion groups and worked with one of the members of ASQ-BR's multidisciplinary team as a mediator. The directors were invited to examine ASQ-BR and point out flaws or problems regarding item adequacy to their daycare and preschool context. For example, they discussed about how the words chosen for certain items could possibly jeopardize the understanding of the item content by ASQ-BR respondents.

Besides referring to problems, the discussion groups suggested changes in the ASQ-BR-2011 items to be applied later that year. Those suggestions, together with items that had psychometric problems, formed the group of items to be modified in order to improve ASQ-BR internal consistency and adequate it to the

actual application context. Table 1 shows the items chosen to be changed in ASQ-BR and the criteria adopted in the modifications for ASQ-BR-2011.

Table 1. ASQ-BR items (per domain) that had at least one of the above-mentioned problems in order to be modified from 2010 to 2011 application.

Item in ASQ-BR to be modified for ASQ-BR 2011	Modification criteria		
	Item-total correlation	Loevinger *h*	Context inadequacy
Communication			
Quando está brincando com sons, o bebê faz grunhidos, sons que lembram rugidos ou outros sons graves?	X		
Quando ocorre um barulho alto, o bebê se vira para ver de onde veio o som?	X	X	
Se você imita os sons que o bebê costuma fazer, ele repete os mesmos sons para você?	X	X	
O bebê fala **três** palavras, como, por exemplo, "Mamã", "Papá" e "Nenê"? *(Uma "palavra" é um ou mais sons que o bebê fala regularmente referindo-se a alguém ou a alguma coisa.)*	X		X
Se você aponta para a figura de uma bola (gato, copo, chapéu, sapato, carro etc.) e pergunta à criança "O que é isso?", ela nomeia corretamente pelo menos uma figura?	X	X	
Gross Motor Coordination			
A criança desce escadas se você segurar uma das mãos dela? Ela pode se apoiar também no corrimão ou na parede. (Você pode observar isso numa loja, no parquinho, em casa ou na creche.)		X	X
A criança sobe ou desce sozinha pelo menos dois degraus? Ela pode se apoiar no corrimão ou na parede. (Você pode observar isso numa loja, no parquinho, em casa ou na creche.)		X	X
A criança sobe escadas colocando apenas um pé em cada degrau? *(Quando o pé esquerdo está num degrau, o direito deve estar no outro.)* Ela pode se apoiar no corrimão ou na parede. (Você pode observar isso numa loja, no parquinho, em casa ou na creche.)		X	X

Fine Motor Coordination

O bebê estende o braço para alcançar um pedacinho de pão ou biscoito e o toca com o dedo ou a mão? (Se ele já pega um objeto pequeno do tamanho de um grão de milho, marque "sim" para esta questão).	X	X	
Depois de você rabiscar de um lado para o outro (posição horizontal) um papel com um giz de cera (ou lápis ou caneta), a criança imita você, rabiscando também? (Se ela já rabisca sozinha, marque "sim" nesta questão.)	X	X	
A criança liga e desliga interruptores de luz?	X		X
Faça uma linha em uma folha de papel. Usando tesoura sem ponta, a criança **corta** o papel ao **meio**, mais ou menos em linha reta, fazendo com que as lâminas se abram e se fechem? *(Observe cuidadosamente o uso da tesoura por razões de segurança.)*	X		X

Problem Solving

O bebê pega dois brinquedos pequenos, um em cada mão, e os segura por cerca de 1 minuto?	X		
O bebê cutuca ou tenta pegar um pedacinho de pão ou biscoito que está dentro de uma garrafa transparente (como uma garrafa de refrigerante ou mamadeira)?	X		X
Depois de ver você desenhar uma linha que vai **de cima para baixo (direção vertical)** em uma folha de papel com um giz de cera (ou lápis ou caneta), a criança imita você, desenhando uma única linha no papel em *qualquer* **direção**? *(Marque "ainda não" se a criança rabisca em várias direções.)*	X		
Se você fizer algum dos seguintes gestos, a criança imita **pelo menos um** deles?	X	X	X
Enquanto a criança observa, alinhe **quatro**		X	X

objetos, como blocos ou carrinhos, em uma **fileira** (como se fosse um trenzinho). A criança copia ou imita você e também alinha *quatro* objetos em uma fileira? *(Você também pode usar carretéis de linha, caixinhas ou outros brinquedos.)*			
Se a criança quer alguma coisa que não consegue alcançar, ela procura uma cadeira ou uma caixa para subir e alcançar o objeto (por exemplo, para pegar um brinquedo sobre um balcão ou para "ajudar" você na cozinha)?	X	X	X
Quando você aponta para a **figura ao lado** e pergunta à criança "O que é isso?", ela diz uma palavra que se refere a uma pessoa ou algo similar? *(Marque "sim" para respostas como "boneco", "menino", "menina", "papai", "astronauta" e "macaco".)* Escreva a resposta da criança aqui:	X	X	
Personal/Social			
Quando diante de um espelho grande, o bebê sorri ou faz sons suaves para si mesmo?	X		
O bebê age com estranhos de maneira diferente do que faz com você e com outras pessoas conhecidas? (Reações a estranhos podem incluir olhar fixamente, franzir a testa, retrair-se ou chorar).	X		
O bebê toma água, suco ou leite em uma caneca enquanto você segura a caneca? (N*ão use caneca com tampa nem bico*).	X		X
O bebê come sozinho um biscoito?	X	X	X
Quando você está jogando bola com o bebê, ele rola ou joga a bola para você de forma que você possa jogá-la de volta?	X		X
Quando você tira a roupa da criança, ela ajuda você tirando peças como meias, boné ou sapatos? (Se ela já tira as peças sozinha, marque	X	X	X

"sim")			
A criança come sozinha com uma colher, ainda que derrame um pouco de comida?	X		X
A criança brinca com um(a) boneco(a) ou bicho de pelúcia, abraçando-o(a)?	X	X	X
Ao se olhar no espelho, a criança oferece um brinquedo à própria imagem?	X		
A criança bebe no copo ou caneca e coloca de volta na mesa sem derramar quase nada?	X	X	X
A criança copia atividades que você faz, como secar algo que derramou, varrer, fazer a barba ou escovar os cabelos?	X	X	X
Quando está brincando com um bichinho de pelúcia ou com um boneco, a criança faz de conta que está embalando, alimentando, trocando fraldas, colocando o brinquedo para dormir e assim por diante? (*Basta que a criança faça uma dessas brincadeiras*).	X	X	X
A criança come com garfo?	X	X	X
Se você faz algum dos seguintes gestos, a criança imita pelo menos um deles?	X		X
A criança usa colher para se alimentar sem derramar quase nada?	X	X	
A criança se serve, tirando comida de um recipiente para outro, usando talheres? Por exemplo, ela utiliza uma colher grande para pegar comida da travessa e colocar no prato?	X		X
A criança veste casaco, jaqueta **ou** camisa sozinha?	X	X	X
A criança informa pelo menos quatro dos seguintes dados pessoais? Marque os itens que ela sabe.	X	X	X
A criança põe e tira a roupa sem ajuda (exceto no caso de colchetes, botões e zíperes)?	X	X	
A criança lava as mãos com água e sabão e depois se seca com uma toalha, **sem** ajuda?	X		X

6.2
Item modification

The Municipal Secretary of Education of Rio de Janeiro (SME-RJ) invited 24 public daycare and preschool directors with a degree in pedagogy. The multidisciplinary committee was composed of four specialists (one psychologist, two educationalists and one economist) to conduct the discussions about ASQ-BR material. They were randomly divided in groups of six directors and one specialist and met for two sessions of 4 hours each. They read all ASQ-BR material and indicated what items they thought had problems. Afterwards, the committee introduced the items with psychometric problems and asked suggestions for changes on all the items – including the ones the directors found inadequate to the daycare and preschool actual context.

The directors of the daycare and preschools gave suggestions regarding the adequacy of the items to the context of their institutions. They suggested several changes in the way the items were written so that they could be more easily understood by individuals responding to the questionnaire. The director's suggestions were added to ASQ-BR-2011. The multidisciplinary committee met weekly for 4 hours during August and September of 2011 to verify if the modifications suggested were implemented according to children's proper cognitive capacity. Further suggestions from the committee were discussed and became the basis for the preparation of a new version of ASQ-BR. All the changes in the items are shown in table 2, on the next page. The new version was back translated into English by a North American translator also fluent in Portuguese ('back translation' is the process of translating a document that has already been translated into a foreign language back to the original language, preferably by an independent translator).

The back translation was then sent to Prof. Jane Squires, main author of the original scale – ASQ-3 (Squires, Bricker, Twonbly, & Potter, 2009). After making a few suggestions, Prof. Squires analyzed and authorized the modifications. They were added to ASQ-BR in order to be applied in 2011. The term ASQ-BR is used to identify the instrument used in 2010 and the one used in 2011 was called Ages & Stages Questionnaire-Brasil-2011 (ASQ-BR-2011).

Table 2. Changes from ASQ-BR's to ASQ-BR-2011 per domain, age interval and corresponding position in questionnaire.

ASQ-BR Item	ASQ-BR-2011 Item	Age Interval (number of item in scale)																	
		6	8	10	12	14	16	18	20	22	24	27	30	33	36	42	48	54	60
Communication																			
Quando está brincando com sons, o bebê faz grunhidos, sons que lembram rugidos ou outros sons graves?	Quando está brincando com sons, o bebê faz ruídos ?	3																	
Quando ocorre um barulho alto, o bebê se vira para ver de onde veio o som?	Quando você faz um barulho alto, o bebê se vira para ver de onde veio o som?	2	3																
Se você imita os sons que o bebê costuma fazer, ele repete os mesmos sons para você?	Se você imita os sons que o bebê faz, ele repete de volta?	2	1	2															
O bebê fala **três** palavras, como, por exemplo, "Mamã", "Papá" e "Nenê"? *(Uma "palavra" é um ou mais sons que o bebê fala regularmente referindo-se a alguém ou a alguma coisa.)*	O bebê fala **três** palavras como, por exemplo, "Mamã", "Papá" e "Dá" (*Uma "palavra" é um som que o bebê fala regularmente referindo-se a alguém ou a alguma coisa*).			6	4	1													
Se você aponta para a figura de uma bola (gato, copo, chapéu, sapato, carro etc.) e pergunta à criança "O que é isso?", ela nomeia corretamente pelo menos uma figura?	Se você aponta para figuras e pergunta à criança "O que é isso?", ela nomeia corretamente pelo menos uma figura? (Exemplos de figuras: bola, gato, carro, casa, etc.)										6	1	2	1	1				
Gross Motor Coordination																			
A criança desce escadas se você segurar uma das mãos dela? Ela pode se apoiar também no corrimão ou na parede. (Você pode observar isso numa loja, no parquinho, em casa ou na creche.)	A criança desce escadas se você segurar uma das mãos dela? Ela pode se apoiar também no corrimão ou na parede. (Você pode observar isso na creche, no parquinho, em casa ou numa loja.)										1								
A criança sobe ou desce sozinha pelo menos dois degraus? Ela pode se apoiar no corrimão ou na parede. (Você pode observar isso numa loja, no parquinho, em casa ou na creche.)	A criança sobe ou desce sozinha pelo menos dois degraus? Ela pode se apoiar no corrimão ou na parede. (Você pode observar isso na creche, no parquinho, em casa ou numa loja.)												3	1					
A criança sobe escadas colocando apenas um pé em cada degrau? *(Quando o pé esquerdo está num degrau, o direito deve estar no outro.)* Ela pode se apoiar no	A criança sobe escadas colocando apenas um pé em cada degrau? *(Quando o pé esquerdo está num degrau, o direito deve estar no outro.)* Ela													6	5	4	3		

corrimão ou na parede. (Você pode observar isso numa loja, no parquinho, em casa ou na creche.)	pode se apoiar no corrimão ou na parede. (Você pode observar isso na creche, no parquinho, em casa ou numa loja.)

ASQ-BR Item	ASQ-BR-2011 Item	Age Interval (number of item in scale)																	
		6	8	10	12	14	16	18	20	22	24	27	30	33	36	42	48	54	60
Fine Motor Coordination																			
O bebê estende o braço para alcançar um pedacinho de pão ou biscoito e o toca com o dedo ou a mão? (Se ele já pega um objeto pequeno do tamanho de um grão de milho, marque "sim" para esta questão).	O bebê estende o braço para alcançar um pão ou biscoito e o toca com o dedo ou a mão? (Se ele já pega um objeto pequeno do tamanho de uma chupeta, marque "sim" para esta questão).		2																
Depois de você rabiscar de um lado para o outro (posição horizontal) um papel com um giz de cera (ou lápis ou caneta), a criança imita você, rabiscando também? (Se ela já rabisca sozinho, marque "sim" nesta questão.)	Depois de você rabiscar um papel com um giz de cera (ou lápis ou caneta), a criança imita você, rabiscando também? (Se ela já rabisca sozinha, marque "sim"nesta questão.)						5												
A criança liga e desliga interruptores de luz?	A criança liga e desliga interruptores de luz? Abre a maçaneta ou trinco da porta? Abre e fecha torneiras? Caso a criança faça uma dessas atividades marque "sim".										4	2							
Faça uma linha em uma folha de papel. Usando tesoura sem ponta, a criança **corta** o papel ao **meio**, mais ou menos em linha reta, fazendo com que as lâminas se abram e se fechem? *(Observe cuidadosamente o uso da tesoura por razões de segurança.)*	Faça uma linha dividindo ao meio uma folha de papel. Usando tesoura sem ponta, a criança **corta** o papel ao **meio**, mais ou menos em linha reta, fazendo com que as lâminas se abram e se fechem? *(Observe cuidadosamente o uso da tesoura por razões de segurança.)*																	3	
Problem Solving																			
O bebê pega dois brinquedos pequenos, um em cada mão, e os segura por cerca de 1 minuto?	O bebê pega dois brinquedos pequenos, um em cada mão, e os segura por algum tempo?			4															
O bebê cutuca ou tenta pegar um pedacinho de pão ou biscoito que está dentro de uma garrafa transparente (como uma garrafa de refrigerante ou mamadeira)?	O bebê percebe ou tenta pegar um pedacinho de biscoito ou um brinquedo que está dentro de um recipiente transparentes (garrafa, pote ou copo fechado)?			5															

ASQ-BR Item	ASQ-BR-2011 Item	Age Interval (number of item in scale)																	
		6	8	10	12	14	16	18	20	22	24	27	30	33	36	42	48	54	60
Depois de ver você desenhar uma linha que vai **de cima para baixo (direção vertical)** em uma folha de papel com um giz de cera (ou lápis ou caneta), a criança imita você, desenhando uma única linha no papel em *qualquer* **direção**? *(Marque "ainda não" se a criança rabisca em várias direções.)*	Depois de ver você desenhar uma linha em uma folha de papel com um giz de cera (ou lápis ou caneta), a criança imita você, desenhando uma *única* linha em *qualquer* **direção**? *(Marque "ainda não" se a criança rabisca em várias direções.)*							5	3	4	5								
Se você fizer algum dos seguintes gestos, a criança imita **pelo menos um** deles? - Puxar a orelha. - Bater de leve na bochecha.	Se você fizer algum dos seguintes gestos, a criança imita **pelo menos um** deles? - Colocar a mão na cabeça. - Mandar beijo.							2											
Enquanto a criança observa, alinhe **quatro** objetos, como blocos ou carrinhos, em uma **fileira** (como se fosse um trenzinho). A criança copia ou imita você e também alinha *quatro* objetos em uma fileira? *(Você também pode usar carretéis de linha, caixinhas ou outros brinquedos.)*	Enquanto a criança observa, alinhe **quatro** objetos, como blocos ou carrinhos, em uma **fileira,** como se fosse um trenzinho. A criança copia ou imita você e também alinha *quatro* objetos em uma fileira? *(Você também pode usar carretéis de linha, caixinhas ou outros brinquedos.)*											4	3						
Se a criança quer alguma coisa que não consegue alcançar, ela procura uma cadeira ou uma caixa para subir e alcançar o objeto (por exemplo, para pegar um brinquedo sobre um balcão ou para "ajudar" você na cozinha)?	Se a criança quer alguma coisa que não consegue alcançar, ela procura alguma coisa para subir e alcançar o objeto (por exemplo, para pegar um brinquedo sobre uma preteleira ela sobre no bloco de espuma)?												4	2	3				
Quando você aponta para a **figura ao lado** e pergunta à criança "O que é isso?", ela diz uma palavra que se refere a uma pessoa ou algo similar? *(Marque "sim" para respostas como "boneco", "menino", "menina", "papai", "astronauta" e "macaco".)* Escreva a resposta da criança aqui:	Quando você aponta para a **figura ao lado** e pergunta à criança "O que é isso?", ela diz uma palavra que se refere a uma pessoa ou algo similar? *(Marque "sim" para respostas como "boneco", "menino", "menina", "papai", "mamãe", "homem-aranha", "Ben 10" ou "macaco".)* Escreva a resposta da criança aqui:													4	4	1			

ASQ-BR Item	ASQ-BR-2011 Item	Age Interval (number of item in scale)																	
		6	8	10	12	14	16	18	20	22	24	27	30	33	36	42	48	54	60
Personal/Social																			
Quando diante de um espelho grande, o bebê sorri ou faz sons suaves para si mesmo?	Quando diante de um espelho grande, o bebê sorri ou faz sons para si mesmo?	2																	
O bebê age com estranhos de maneira diferente do que faz com você e com outras pessoas conhecidas? (Reações a estranhos podem incluir olhar fixamente, franzir a testa, retrair-se ou chorar).	O bebê estranha pessoas desconhecidas? (Estranhar pode incluir olhar fixamente, franzir a testa, retrair-se ou chorar).	3																	
O bebê toma água, suco ou leite em uma caneca enquanto você segura a caneca? (Não use caneca com tampa nem bico).	O bebê toma água, suco ou leite em uma caneca enquanto você segura a caneca? (*Marque "sim" se a criança já faz um movimento diferente do de sucção*).			2																
O bebê come sozinho um biscoito?	O bebê come sozinho um biscoito ou uma fruta?			3																
Quando você está jogando bola com o bebê, ele rola ou joga a bola para você de forma que você possa jogá-la de volta?	Quando você está jogando bola com o bebê, ele joga a bola de volta para você?					2														
Quando você tira a roupa da criança, ela ajuda você tirando peças como meias, boné ou sapatos? (Se ela já tira as peças sozinha, marque "sim")	Quando você tira a roupa da criança, ela ajuda você tirando peças como meias, boné ou sapatos? (Se ela já tira as peças sozinho, marque "sim").						2													
A criança come sozinha com uma colher, ainda que derrame um pouco de comida?	A criança tenta comer sozinha com uma colher, ainda que derrame a comida.					3	3		1											
A criança brinca com um(a) boneco(a) ou bicho de pelúcia, abraçando-o(a)?	A criança brinca com uma boneca ou boneco de pano, abraçando-o(a)?						4													
Ao se olhar no espelho, a criança oferece um brinquedo à própria imagem?	Ao se olhar no espelho, a criança oferece um brinquedo à própria imagem?							1												
A criança bebe no copo ou caneca e coloca de volta na mesa sem derramar quase nada?	A criança bebe no copo ou caneca e coloca de volta na mesa sem derramar muito?								5	3	1	1								
A criança copia atividades que você faz, como secar algo que derramou, varrer, fazer a barba ou escovar os cabelos?	A criança copia atividades que você faz, como secar algo que derramou, varrer, lavar a roupa ou escovar os cabelos?										4	2								
Quando está brincando com um bichinho de pelúcia ou com um boneco, a	Quando está brincando com um bicho ou um boneco de pano, a criança faz											5	3							

criança faz de conta que está embalando, alimentando, trocando fraldas, colocando o brinquedo para dormir e assim por diante? (*Basta que a criança faça uma dessas brincadeiras*).

de conta que está embalando, alimentando, trocando fraldas, colocando o brinquedo para dormir e assim por diante? (*Basta que a criança faça uma dessas brincadeiras*).

ASQ-BR Item	ASQ-BR-2011 Item	Age Interval (number of item in scale)																	
		6	8	10	12	14	16	18	20	22	24	27	30	33	36	42	48	54	60
A criança come com garfo?	A criança escova os dentes.								6	4	5	1							
Se você faz algum dos seguintes gestos, a criança imita pelo menos um deles? - Puxar a orelha. - Bater de leve na bochecha.	Se você faz algum dos seguintes gestos, a criança imita pelo menos um deles? - Colocar a mão na cabeça. - Mandar beijo.								6		2	1							
A criança usa colher para se alimentar sem derramar quase nada?	A criança usa colher para se alimentar sem derramar muito?												3	2					
A criança se serve, tirando comida de um recipiente para outro, usando talheres? Por exemplo, ela utiliza uma colher grande para pegar comida da travessa e colocar no prato?	A criança sabe utilizar o potinho de sobremesa, jogando fora aquilo que não quer ou não deve comer, como caroço, casca ou bagaço.															2	2	1	3
A criança veste casaco, jaqueta **ou** camisa sozinha?	A criança veste casaco **ou** camisa sozinha?											4			4	5			
A criança informa pelo menos quatro dos seguintes dados pessoais? Marque os itens que ela sabe. - Cidade onde mora - Número do telefone	A criança informa pelo menos quatro dos seguintes dados pessoais? Marque os itens que ela sabe. - *Localidade onde mora* - *Nome da mãe, ou do pai, ou do responsável.*																3	3	
A criança põe e tira a roupa sem ajuda (exceto no caso de colchetes, botões e zíperes)?	A criança põe e tira a roupa sem ajuda? Ela pode pedir sua ajuda no caso de colchetes, botões e zíperes.																5		
A criança lava as mãos com água e sabão e depois se seca com uma toalha, **sem** ajuda?	A criança lava as mãos com água e sabão e depois se seca com uma toalha, **sem** ajuda? (Você pode mandá-la lavar as mãos e secar).																6	6	5

6.3
Subjects

This study researched 76.850 children between 7 and 66 months old. Their questionnaires were completed by 11.664 preschool and daycare directors, teachers and caretakers in 972 municipal public daycare and preschools of Rio de Janeiro (471 daycare and 501 preschools). There were no respondents in age categories 2, 4 and 6 months due to lack of data – 'missing data' – and age categories with few participants – age category 8 months had only 17 children, thus making the statistical analysis impossible. The total of 9.328 children were considered 'missing data'. The initial sample was reduced to 67.522 children between 9 and 66 months old. The characteristics of the final sample are described on table 3.

Table 3. Sample's characteristics per age category: sample size (partial and total), biological sex, age mean and standard deviation.

Age category (in months)	Sample	Boys			Girls		
		Percentage	Age Mean	Standard Deviation	Percentage	Age Mean	Standard Deviation
10	73	54%	9.93	0.35	46%	10.00	0.42
12	141	57%	11.97	0.60	43%	11.93	0.61
14	216	47%	14.08	0.53	53%	14.14	0.52
16	545	53%	16.20	0.50	47%	16.18	0.52
18	972	54%	18.04	0.58	46%	18.02	0.57
20	1143	53%	20.05	0.57	47%	20.04	0.58
22	1259	54%	22.01	0.56	46%	22.00	0.57
24	1637	55%	24.27	0.73	45%	24.24	0.72
27	2390	53%	27.02	0.89	47%	27.01	0.86
30	3264	52%	30.02	0.89	48%	30.01	0.87
33	3375	53%	32.99	0.86	47%	32.99	0.86
36	4689	53%	36.80	1.30	47%	36.79	1.34
42	7703	53%	42.04	1.70	47%	42.09	1.69
48	6921	52%	47.72	1.60	48%	47.70	1.61
54	9511	51%	53.87	1.87	49%	53.81	1.85
60	23683	49%	61.73	1.94	51%	61.83	1.99
Total	67522	51%	44.83	12.67	49%	44.39	13.48

6.4
Application procedures

The first phase of this study took place with the 972 daycare and preschool directors. They were invited to take part in a training given by 11 professionals, 4 psychologists and 7 educationalists hired by the Municipal Secretary of Education of Rio de Janeiro for eight hours along two weeks. The professionals, including the author of this study, were trained on ASQ-BR by Alberto Filgueiras, author of ASQ-3's translation and adaptation in Brazil. Table 4, at the end of this chapter, shows all the steps taken for the preparation of this thesis, including the application procedures.

A Powerpoint presentation was prepared for the training of the directors so that all the directors had the same content in their training. The initial group of trained professionals transmitted the training received as accurately linked to the original training as possible to groups of 20 or 30 daycare and preschool directors. The second round of trainings took two more weeks and ASQ-BR was introduced to the directors. Items that could possibly present difficulties at the moment of the application were discussed. The changes on the ASQ-BR implemented from 2010 to 2011 were informed to the trainees, especially because many had taken part in the application of the previous year.

Impression, distribution and application of the instrument were SME-RJ's responsibility and were based on the procedure described next. From the birth date of each child and period when he/she would be interviewed, it was possible to select the proper questionnaire according to the child's age category. The child's birth date was subtracted from each child's application date – between November 11th, 2011 and December 9th, 2011. This way, the name of the child to be interviewed and the respective ASQ-3 age category to be used by each child could be printed on the questionnaires by SME-RJ beforehand. The directors were then scheduled to take all the filled questionnaires back to their respective Regional Educational Coordination (CRE).

SME-RJ collected and keyed in the material with the help of a typing mask especially developed to register the data. The data bank was built with coding 1, 2 and 3. Those were the values respective to the columns of answers of ASQ-BR: 1

represented the 1st column ("yes"); 2 represented the 2nd column ("sometimes") and 3 was the code for the 3rd column ("not yet"). ASQ-3 manual set 10 points to category "yes", 5 points to category "sometimes" and no points to category "not yet". The transformation of the data bank ASQ-3 value type was made through *Microsoft Excel*.

Incomplete and incorrect data – '9.328 missing data' – were dealt with according to ASQ-3 manual: (1) if a scale has up to 2 items unanswered, replace them with the mean, and (2) if a scale had more than three items unanswered, exclude the participant because it is not possible to calculate the score for the scale. Despite the *missing data* were replaced by the average of the remaining items, the present study is a psychometric comparison between the data from 2010 and 2011. ASQ-BR answers use a Likert scale, thus presuppose equal intervals between answers. Categories were 0, 5 and 10 and averages of the responded items could be 6.7, 8.7, or others. If the averages were actually included, the main characteristic of the instrument, ordinal answers, would be lost. With the purpose of respecting the measure characteristics and avoiding the inclusion of non-ordinal answers in the Likert scale, this study replaced the missing data whenever possible – case #1 – through the measures of categorical central tendency not to lose the properties of the Likert categories. For that reason, mode was used instead of arithmetic mean to replace missing data, according to the procedure previously adopted by Filgueiras (2011). From that point on, the statistical analyses were developed.

6.5
Statistical Analyses

The first step was analyzing ASQ-BR-R through descriptive and inferential statistics. Reliability coefficients derived from psychometric analyses were used in ASQ-BR-R similarly to Filgueiras et al. (2011, 2013). Factor analyses were performed to detect each ASQ-BR-R scale dimensionality. The results of the present study were compared to those found by Filgueiras et al. (2011, 2013) and item modifications were evaluated according to empirical evidences.

In order to keep the same descriptive method as the first application of ASQ-BR in 2010, the descriptive methods for the comparison between ASQ-BR applications in 2010 and 2011 were the same used by Filgueiras et al. (2013): arithmetic average of each scale, standard deviation and reports organized according to the child's age. As the objective of the present study was comparing ASQ-BR psychometric results between 2010 e 2011, inferential analyses were also performed comparing the age category data banks in both years. According to classic recommendations of the literature (Pasquali, 2008), when there are two independent samples to be statistically compared, the hypothesis test should be carefully chosen between Student's *t*-test for independent samples with parametric data or Mann-Whitney-Wilcoxon for two samples (R. J. Cohen & Swerdlik, 2009). The first is a parametric test, that is, the parameters of the samples are known and there is a normal distribution of the variance. Therefore Student's *t*-test is supposed to be used in samples with normal distribution. Mann-Whitney-Wilcoxon test can be used for independent samples with non-parametric data – distributions other than normal. That is because the technique ranks the data to prioritize them in order to produce inferential results for the null hypothesis test.

The proper selection method was chosen according to Fischer's law of large numbers. According to Cohen e Swerdlik (2009), the British statistician Ronald Fisher empirically demonstrated that when the sample equals or outpasses 30 elements, normality is assumed and parametric tests can be performed. Since all the samples in ASQ-BR (2010) and ASQ-BR-R (2011) are larger than 30 elements, this study used Student's *t*-test for independent samples with a significance criterion to be lower than 0.05 to consider significant differences

between samples. All the analyses were conducted through SPSS and Microsoft Excel software.

The first psychometric analysis done was exploratory factor analysis (EFA) – following the descriptive and inferential initial analyses. EFA consists of a set of techniques that reduce a group of elements or items – data – to groups that covariate among themselves, considering their shared covariance. That differentiates EFA from main components that reduce items into components using total variance (Damásio, 2012). Each set of six items that evaluate a cognitive domain of the given ASQ-BR age categories presuppose unidimensionality. Filgueiras et al. (2013) detected factorability problems in only 3 scales: 10, 54 and 60 months of domain Personal/Social. The three scales showed diverse dimensions according to the technique adopted to extract the factors. Several authors propose specific EFA in case of psychological data. For example, the literature recommends 'maximum likelihood' or 'generalized least squares' when the data have psychological nature (R. J. Cohen & Swerdlik, 2009). Inadequate use of EFA techniques in data with psychological nature may produce imprecise results and conclusions (Holgado–Tello, Chacón–Moscoso, Barbero–García, & Vila–Abad, 2008). Two techniques were adopted in this study to determinate the number of factors for each scale: eigenvalue above 1.0 (Cohen & Swedlik (2009) and minimum average partial (MAP) test (Velicer, 1976). Whenever there were two or more factors, maximum likelihood was used to extract factors and an oblique Promax rotation was applied as recommended by Filgueiras et al. (2011). SPSS was the software chosen for this analysis.

After EFA, two other CTT indexes were used to detect reliability problems in the scales. The first coefficient chosen was Cronbach's alpha (α). That is an index of internal consistency that reveals how much a group of items measuring a specific domain is contributing to a homogeneous scale (R. J. Cohen & Swerdlik, 2009; Pasquali, 2008). A homogeneous scale has significant contribution from all the items to the final score. According to Pasquali (2008), low alphas also mean that the scale has several estimation errors. The classic criterion for considering a good alpha value is 0.70. Nevertheless, as ASQ-BR's scales have few items (six) and alpha is indeed affected by the number of items in the scale, Filgueiras et al.'s (2013) recommendation was adopted, with 0.65 also as an acceptable value. Feldt's W test was used to compare alphas on both samples (Bar-Anan, 2012;

Feldt, 1969). The test compares alphas in two different samples considering sample sizes and sample error probability. This way it is possible to say whether there was significant difference between 2010 and 2011 applications.

Finally, item-total correlation, an index associated with Cronbach's alpha that indicates each item's contribution to the total score of the scale, was used. Item-total correlation, Pearson product-moment correlation coefficient, is an index that estimates the linear association between two variables (R. J. Cohen & Swerdlik, 2009). In the item-total correlation specific case, each item is considered a variable that has to associate linearly with the sum of all the items – excluding itself from the total. Item-total correlation has been a very useful index in CTT as an indicator when a particular item is investigated. The correlation level of the item reveals its contribution to the total of the scale. Besides, if the item's correlation is low relatively to the sum of the other items, there is strong indication that its presence may jeopardize the reliability of the measure. Being so, Pasquali (2009) recommends the item to be withdrawn from the scale – that may or not improve the alpha – or be replaced by a more adequate item.

The correlation of each item in application years 2010 and 2011 were compared through Cohen & Cohen's test (1983). This test for comparing correlations was developed to compare product-moment correlations between two variables in different samples when transforming Fisher's r to z (J. Cohen & Cohen, 1983). In the process, Pearson correlation coefficient's values are transformed in z scores considering the sample error relatively to the sample size (Preacher, 2002).

The second option of modifications was adopted by Filgueiras (2011) to change the items from the 2010 version to the 2011 one, used in this study. The decision was based on the recommendations of Prof. Squires, who asked this study's authors to change the item according to the actual cultural context, as long as the six-item structure was kept. The internal consistency analyses – Cronbach's alpha and item-total correlation – were performed through software SPSS. Alpha comparisons through Feldt test were performed through a Microsoft Excel calculator programmed by Bar-Anan (2012). Cohen & Cohen's test (1983) to unveil correlations through transforming Fisher's r-to-z was performed through a java application developed by Preacher (2002).

Table 4. Summary of the methodological steps in this master thesis.

Step	Action	Observation
1	Identify items with psychometric inconsistencies in the first application of ASQ-BR (Filgueiras, 2010).	Criteria chosen: $r < 0.30$ and $h < 0.20$
2	Meetings of experts on ASQ and directors of Rio de Janeiro municipal daycare and preschools to collect reports on items considered inadequate to the Brazilian context.	Four meetings of 4 hours each, 1 meeting with each group. Groups consisted of 1 expert and 6 directors: preschool and daycare directors (N=24), psychologists (N=2), educationalists (N=1), health scientists (N=1) and economists (N=2)
3	A provisional version of ASQ-BR was made based on steps 1 and 2.	_
4	Back tanslation of the new provisional version.	_
5	Production of the printed tests by SME.	
6	The provisional version was evaluated, modified and fully approved ASQ-3 author (Prof. J. Squires).	_
7	Training on the last version of ASQ-BR was given to 972 municipal public daycare and preschool directors.	2 rounds of trainings given by 4 psychologists and 7 educationalists to goups of 20 to 30 directors of daycare and preschools.

8	ASQ-BR's revised version – ASQ-BR-2011 – was applied to 76.850 children from 9 to 66 months in 471 municipal public daycare and 501 preschools of Rio de Janeiro (N=972).	11.664 directors, teachers and caregivers filled 16 types of age-category questionnaires.
9	New CTT analyses were performed upon 67.522 children (missing data considered).	–
10	Production of this thesis	–

7
Results

Descriptive results – mean and standard deviation – were calculated for each scale. In Communication, mean values varied between 29.9 (minimum) in the 16-month interval to 51.6 (maximum) in the 33-month interval. In Gross Motor Coordination, mean values varied between 44.6 (minimum) in 10 months to 56.4 (maximum) in 36 months. In Fine Motor Coordination, means varied between 38.7 in 14 months to 48.7 (maximum) in 34 months. In Problem Solving, means varied between 39.1 (minimum) in 14 months to 51.9 (maximum) in 27 months. Finally, Personal/Social showed mean variation between 35.0 (minimum) in 14 months to 51.7 (maximum) in age category 36 months.

When compared to 2010 data, averages in 2011 had 17 significant differences in a total of 80 scales (21.3%). The largest concentration of significant differences in the averages of 2010 and 2011 was in Fine Motor Coordination: 7 in 17 (41.2%). Personal/Social had significant differences in 5 of the 17 (29.4%) age intervals; Problem Solving had 4 in 17 (23.5%), while Gross Motor Coordination had only one significant difference in 17 (5.9%) scales each. Table 4, on the following page, shows means and standard deviations.

Table 4. Means and standard deviations (SD) per domain and age interval in 2010 and 2011. Sample size according to year and *T*-Student test for independent samples comparing year means according each domain and age interval.

Age Interval (in months)	Year	Sample	Communication		Gross Motor		Fine Motor		Problem Solving		Personal/Social	
			Mean (SD)	T - test (*p*-value)	Mean (SD)	T - test (*p*-value)	Mean (SD)	T - test (*p*-value)	Mean (SD)	T - test (*p*-value)	Mean (SD)	T - test (*p*-value)
10	2010	236	26.7 (17.2)	p=0.45	38.5 (16.9)	p<0.05*	37.6 (17.2)	p<0.05*	35.5 (16.6)	p=0.12	35.8 (13.8)	p<0.05*
	2011	73	30.4 (18.1)		44.6 (14.8)		42.7 (16.6)		40.1 (20.3)		41.4 (16.4)	
12	2010	434	36.4 (16.6)	p=0.13	43.3 (17.9)	p=0.13	38.1 (17.5)	p=0.47	35.7 (17.6)	p=0.19	33.8 (17.1)	p=0.13
	2011	141	39.8 (16.9)		44.9 (16.6)		40.1 (19.0)		40.2 (18.4)		36.1 (17.3)	
14	2010	752	31.3 (16.7)	p=0.19	47.5 (17.9)	p=0.16	35.8 (17.4)	p=0.29	34.1 (15.5)	p=0.26	30.6 (16.5)	p=0.08
	2011	216	34.6 (17.9)		49.0 (17.6)		38.7 (18.0)		39.1 (18.8)		35.0 (17.9)	
16	2010	987	29.9 (14.6)	p=0.29	52.2 (13.7)	p=0.28	43.2 (16.7)	p=0.31	36.7 (18.2)	p<0.05*	34.0 (15.5)	p=0.09
	2011	545	32.0 (15.8)		53.7 (11.7)		46.7 (15.8)		42.6 (17.6)		38.3 (16.1)	
18	2010	1103	33.5 (16.3)	p=0.35	55.8 (7.9)	p=0.36	44.7 (14.6)	p=0.19	37.3 (15.3)	p=0.18	41.6 (14.5)	p=0.29
	2011	972	33.4 (16.4)		54.9 (10.5)		47.0 (14.0)		40.1 (15.0)		43.8 (15.0)	
20	2010	1031	33.1 (19.2)	p=0.43	52.3 (11.5)	p=0.33	41.2 (14.8)	p=0.10	38.2 (13.9)	p<0.05*	36.2 (12.9)	p<0.05*
	2011	1143	36.7 (18.8)		54.8 (9.4)		45.3 (13.5)		43.1 (11.9)		42.7 (13.7)	
22	2010	955	35.4 (18.4)	p=0.54	48.2 (13.0)	p=0.21	40.4 (13.6)	p<0.05*	39.3 (13.9)	p<0.05*	38.1 (12.6)	p<0.05*
	2011	1259	39.2 (17.3)		52.0 (10.5)		46.2 (11.9)		45.1 (12.1)		47.0 (12.1)	
24	2010	1454	44.1 (17.5)	p=0.16	52.1 (10.6)	p=0.10	42.8 (12.6)	p<0.05*	41.1 (13.4)	p=0.22	35.7 (13.1)	p<0.05*
	2011	1637	48.1 (15.5)		54.1 (.9.4)		48.7 (11.3)		45.9 (11.9)		45.2 (12.7)	
27	2010	2222	48.1 (14.3)	p=0.17	50.9 (11.9)	p=0.09	34.1 (15.2)	p<0.05*	47.8 (12.5)	p=0.14	34.3 (11.4)	p<0.05*
	2011	2390	50.7 (12.9)		53.4 (9.2)		40.8 (14.3)		51.9 (10.3)		44.1 (24.2)	
30	2010	2814	50.3 (13.0)	p=0.31	53.5 (10.1)	p=0.13	34.2 (17.7)	p<0.05*	45.0 (14.8)	p=0.32	46.2 (11.7)	p=0.16
	2011	2786	49.9 (13.1)		54.9 (9.9)		39.5 (17.6)		47.2 (14.0)		48.4 (14.6)	
33	2010	3316	47.8 (14.3)	p=0.24	52.2 (11.2)	p=0.15	36.4 (18.7)	p<0.05*	46.8 (14.1)	p=0.23	46.8 (12.9)	p=0.31
	2011	3002	51.6 (12.3)		53.1 (12.3)		44.9 (31.0)		51.3 (22.0)		50.3 (11.2)	
36	2010	5291	46.8 (12.4)	p=0.25	53.8 (10.4)	p=0.11	42.2 (17.9)	p<0.05*	48.4 (13.4)	p=0.17	49.5 (10.7)	p=0.14
	2011	4416	49.3 (11.1)		56.4 (17.3)		48.6 (21.5)		51.3 (12.0)		51.7 (9.8)	
42	2010	8859	46.9 (12.8)	p=0.47	54.8 (8.7)	p=0.29	41.3 (15.5)	p=0.07	48.7 (13.2)	p=0.15	48.0 (10.4)	p=0.18
	2011	6631	48.3 (12.4)		55.9 (8.2)		45.1 (14.3)		49.9 (14.3)		50.8 (10.3)	
48	2010	8528	48.2 (13.9)	p=0.21	53.3 (10.4)	p=0.31	39.0 (16.4)	p=0.06	44.1 (14.5)	p=0.51	47.6 (11.2)	p=0.17
	2011	6347	50.6 (12.7)		55.1 (9.3)		44.0 (15.6)		46.0 (14.1)		50.6 (10.7)	
54	2010	7452	52.4 (11.7)	p=0.11	54.3 (9.8)	p=0.13	44.4 (14.5)	p=0.08	40.6 (14.5)	p=0.78	49.3 (10.5)	p=0.12
	2011	9511	48.8 (14.0)		51.7 (12.1)		41.9 (15.3)		39.5 (21.8)		47.6 (11.5)	
60	2010	47	47.9 (15.2)	p=0.07	48.5 (17.0)	p=0.23	46.8 (15.4)	p=0.49	46.7 (15.3)	p<0.05*	51.6 (11.3)	p=0.26
	2011	23683	45.4 (13.2)		51.9 (16.2)		45.5 (14.8)		41.2 (16.5)		49.5 (15.3)	

Obs: *significant difference in null hypothesis test. Significance value is 0.05.

Inferential results in the null hypothesis test revealed that the 60-month age interval had significant difference in Communication. In Gross Motor Coordination, the difference occurred in the 10-month age interval. In Fine Motor Coordination, the differences occurred in the 10-month age interval and in all the intervals between 22 and 36 meses. In Problem Solving, scales 16, 20, 22 and 60 had significant differences in the means. Finally, in Social/Personal the 10-month interval and all the intervals between 20 and 27 months had significant differences between averages of 2010 and 2011.

Exploratory factor analysis (EFA) was conducted according to the methodology before-mentioned: factor extraction through maximum likelyhood with eigenvalue above 1.0 (tables in the appendix). Among the 80 scales evaluated, only 1 (1.3%) showed multidimensionality. This value is higher than the one in ASQ-BR (2010). In 2010, 3 scales had 2 dimensions: scales 10, 54 and 60 in Personal/Social domain. In 2011, only 60 months presented

bidimensionality in Personal/Social, which shows improvement in homogeneity of constructs evaluated by ASQ.

Using Velicer's MAP, the same phenomenon was found. Only the personal-social scale in the 60 months interval presented more than one factor. Results of the Velicer's MAP are presented in the annex.

The reliability analysis showed 14 among the 80 scales (17.5%) with values lower than 0.65, against 18.3% in 2010 (Filgueiras, 2011). Regarding domains, Communication has not shown reliability problems based on Cronbach's alpha. One scale in Gross Motor Coordination, 22-months, presented problems; one in Fine Motor Coordination, 22-months; in Problem Solving, 5 scales were compromised: 20, 22, 24, 27 and 54 months; and in Personal/Social domain, 7 scales had alfas lower than 0.65: 22, 27, 36, 42, 48, 54 and 60 months.

Using coefficient Feldt's *W* as established in this study's methodology (Bar-Anan, 2012; Feldt, 1969), comparison among alphas alowed observing significant differences in 53 of the 80 compared scales (66.3%). Among them, 43 (81.1%) had alfas improved significantly, while in 10 (18.9%) alphas got worse. Alpha values in 2010 and 2011, besides *p* values in Feldt's test that compared alfas between the years can be seen in table 5. The values of the alfas are found in the appendix.

When individually analized, 45 of the 480 items (9.4%) in the 16 questionnaires – 30 items per questionnaire equaly divided in 5 developmental domains – had item-total correlation lower than 0.30. The number of items with item-total correlation problems is about the same as in Filgueiras et al. (2013) – 8% (Filgueiras et al., 2013; Filgueiras, 2011). Tables with all item-total correlations for all the age intenvals and Cronbach's alpha values in both application years as well as Cronbach's alpha if item is deleted (in 2011), all divided per age interval are in the appendix. Table 6 shows the delta of the correlations between 2011 and 2010 (algorithm: 2011 *minus* 2010), providing a *p* value for the Cohen & Cohen test comparing the correlations between both years through Fischer *r*-to-*z* transformation for the modified years and accepting significant difference of *p*<0.05. (Cohen & Cohen, 1983; Preacher, 2002). The objective of the present study is the items that were modified between 2010 and 2011, reason why Cohen & Cohen test was performed specifically for those. The results shows that, regarding item-total correlation, 23 of the 33 modified items

(69.7%) empirically tested – just the item itself, not considering its versions along age intervals – had significant differences between application years.

Age Interval (in months)	Cronbach's Alpha														
	Communication			Gross Motor			Fine Motor			Problem Solving			Personal/Social		
	2010	2011	Feldt test (p-value)	2010	2011	Feldt test (p-value)	2010	2011	Feldt test (p-value)	2010	2011	Feldt test (p-value)	2010	2011	Feldt test (p-value)
10	0.78	0.81	0.23	0.79	0.79	0.51	0.75	0.81	0.08	0.69	0.89	>0.01*	0.65	0.80	>0.01*
12	0.76	0.78	0.27	0.85	0.83	0.19	0.74	0.84	>0.01*	0.76	0.83	>0.01*	0.79	0.79	0.51
14	0.77	0.81	0.02*	0.88	0.90	0.06	0.77	0.83	>0.01*	0.80	0.85	>0.01*	0.72	0.79	>0.01*
16	0.72	0.79	>0.01*	0.86	0.83	>0.01*	0.81	0.82	0.23	0.80	0.77	0.03*	0.64	0.74	>0.01*
18	0.77	0.79	0.07	0.63	0.82	>0.01*	0.72	0.76	>0.01*	0.71	0.74	0.04*	0.64	0.75	>0.01*
20	0.77	0.83	>0.01*	0.64	0.73	>0.01*	0.72	0.70	0.13	0.72	0.59	>0.01*	0.64	0.69	>0.01*
22	0.82	0.67	>0.01*	0.74	0.63	>0.01*	0.67	0.64	0.07	0.63	0.63	0.50	0.57	0.62	>0.01*
24	0.81	0.82	0.18	0.71	0.66	>0.01*	0.64	0.67	0.06	0.65	0.63	0.14	0.59	0.66	>0.01*
27	0.84	0.75	>0.01*	0.67	0.65	0.06	0.62	0.71	>0.01*	0.63	0.62	0.10	0.63	0.62	0.10
30	0.76	0.74	0.02*	0.67	0.67	0.50	0.77	0.80	>0.01*	0.69	0.71	0.04*	0.61	0.65	>0.01*
33	0.75	0.70	>0.01*	0.69	0.77	>0.01*	0.78	0.83	>0.01*	0.67	0.76	>0.01*	0.66	0.66	0.50
36	0.66	0.65	0.22	0.71	0.77	>0.01*	0.79	0.79	0.50	0.67	0.68	0.20	0.57	0.59	0.10
42	0.66	0.69	>0.01*	0.65	0.67	>0.01*	0.71	0.71	0.50	0.67	0.67	0.50	0.52	0.57	>0.01*
48	0.78	0.77	0.02*	0.70	0.71	0.07	0.72	0.75	>0.01*	0.68	0.70	>0.01*	0.52	0.57	>0.01*
54	0.78	0.80	>0.01*	0.70	0.78	>0.01*	0.72	0.75	>0.01*	0.68	0.59	>0.01*	0.53	0.58	>0.01*
60	0.78	0.66	>0.01*	0.71	0.78	>0.01*	0.72	0.77	>0.01*	0.70	0.76	>0.01*	0.52	0.65	>0.01*

Table 5. Cronbach's alpha for ASQ-BR's each domain, scale and age interval, considering years 2010 and 2011. Significance value (*p-value*) for comparing alphas in each of the samples is shown.

Considering the several appearances of the items along age intervals, (for example, item *"A criança escova os dentes"* appears in four age intervals) the proportion of significant differences were 37 among 69 (53.6%). Among the 37, only 8 (24.2%) got worse between years, while 29 (75.8%) had significant improvement in item-total correlation. If only modified items with significant difference and not the several appearances of the item along age categories (*N* = 23) are considered, we can see that just 2 items (8.6%) got worse in all age categories they appear.

Table 6 shows that there was no significant difference among the data in Communication in modified items from 2010 to 2011. Therefore, we believe that the modifications did not have the expected empirical effect. A table showing the correlation differences between 2011 and 2010 are the appendix. The next part of these comments will be based on table 6.

In Gross Motor Coordination, 2 items had significant difference. Item *"A criança sobe ou desce sozinha pelo menos dois degraus? Ela pode se apoiar no corrimão ou na parede. (Você pode observar isso na creche, no parquinho, em casa ou numa loja.)"* had a 0.28 statistical drop in correlation with the total in 27 months between years 2010 and 2011. Item *"A criança sobe escadas colocando*

apenas um pé em cada degrau? (Quando o pé esquerdo está num degrau, o direito deve estar no outro.) Ela pode se apoiar no corrimão ou na parede. (Você pode observar isso na creche, no parquinho, em casa ou numa loja.)" showed significant difference in 36 months having increased 0.34 in correlation between 2010 and 2011.

Table 6. Delta of item-total correlations of modified items comparing 2010 and 2011 (cont.).

Changed Item	Delta (Δ) of item-total correlations of modified items (2011 *minus* 2010)															
	10	12	14	16	18	20	22	24	27	30	33	36	42	48	54	60
Communication																
O bebê fala **três** palavras como, por exemplo, "Mamã", "Papá" e "Dá" (*Uma "palavra" é um som que o bebê fala regularmente referindo-se a alguém ou a alguma coisa*).	0.09	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Se você aponta para figuras e pergunta à criança "O que é isso?", ela nomeia corretamente pelo menos uma figura? (Exemplos de figuras: bola, gato, carro, casa, etc.)	-	-	-	-	-	0.03	-0.03	-	-	-0.02*	-	-	-	-	-	-
Gross Motor Coordination																
A criança desce escadas se você segurar uma das mãos dela? Ela pode se apoiar também no corrimão ou na parede. (Você pode observar isso na creche, no parquinho, em casa ou numa loja.)	-	-	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-
A criança sobe ou desce sozinha pelo menos dois degraus? Ela pode se apoiar no corrimão ou na parede. (Você pode observar isso na creche, no parquinho, em casa ou numa loja.)	-	-	-	-	-	-	-	0.06	-0.28*	-	-	-	-	-	-	-
A criança sobe escadas colocando apenas um pé em cada degrau? *(Quando o pé esquerdo está num degrau, o direito deve estar no outro.)* Ela pode se apoiar no corrimão ou na parede. (Você pode observar isso na creche, no parquinho, em casa ou numa loja.)	-	-	-	-	-	-	-	-	0.06	-0.01	-0.05	0.34*	-	-	-	-
Fine Motor Coordination																
Depois de você rabiscar um papel com um giz de cera (ou lápis ou caneta), a criança imita você, rabiscando também? (Se ela já rabisca sozinha, marque "sim"nesta questão.)	-	-	-	-	-	-0.01	-	-	-	-	-	-	-	-	-	-
A criança liga e desliga interruptores de luz? Abre a maçaneta ou trinco da porta? Abre e fecha torneiras? Caso a criança faça uma dessas atividades marque "sim".	-	-	-	-	-	-	-	-	0.10	0.00	-	-	-	-	-	-
Faça uma linha dividindo ao meio uma folha de papel. Usando tesoura sem ponta, a criança **corta** o papel ao **meio**, mais ou menos em linha reta, fazendo com que as lâminas se abram e se fechem? *(Observe cuidadosamente o uso da tesoura por razões de segurança.)*	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05*	-	-
Problem Solving																
O bebê pega dois brinquedos pequenos, um em cada mão, e os segura por algum tempo?	0.15*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O bebê percebe ou tenta pegar um pedacinho de biscoito ou um brinquedo que está dentro de um recipiente transparentes (garrafa, pote ou copo fechado)?	0.26*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Problem Solving																
Depois de ver você desenhar uma linha em uma folha de papel com um giz de cera (ou lápis ou caneta), a criança imita você, desenhando uma **única** linha em **qualquer** direção? *(Marque "ainda não" se a criança rabisca em várias direções.)*	-	-	-	-	-	0.05	0.01	0.03	0.00	-	-	-	-	-	-	-
Se você fizer algum dos seguintes gestos, a criança imita **pelo menos um** deles? Colocar a mão na cabeça. Mandar beijo.	-	-	-	-	-	-0.05	-	-	-	-	-	-	-	-	-	-

Enquanto a criança observa, alinhe **quatro** objetos, como blocos ou carrinhos, em uma **fileira,** como se fosse um trenzinho. A criança copia ou imita você e também alinha *quatro* objetos em uma fileira? *(Você também pode usar carretéis de linha, caixinhas ou outros brinquedos.)*	-	-	-	-	-	-	-	-	-0.09*	0.00		-	-	-	-
Se a criança quer alguma coisa que não consegue alcançar, ela procura alguma coisa para subir e alcançar o objeto (por exemplo, para pegar um brinquedo sobre uma preteleira ela sobre no bloco de espuma)?	-	-	-	-	-	-	-	0.01	-0.05*	0.06*		-	-	-	-
Quando você aponta para a **figura ao lado** e pergunta à criança "O que é isso?", ela diz uma palavra que se refere a uma pessoa ou algo similar? *(Marque "sim" para respostas como "boneco", "menino", "menina", "papai", "mamãe", "homem-aranha", "Ben 10" ou "macaco".)* Escreva a resposta da criança aqui:	-	-	-	-	-	-	-	-	0.00	0.01	0.02	-	-	-	-

Table 6. Delta of item-total correlations of modified items comparing 2010 and 2011 (cont)

Changed Item	Delta (Δ) of item-total correlations of modified items (2011 *minus* 2010)															
	10	12	14	16	18	20	22	24	27	30	33	36	42	48	54	60
Pessoal-Social																
O bebê toma água, suco ou leite em uma caneca enquanto você segura a caneca? (*Marque "sim" se a criança já faz um movimento diferente do de sucção*).	0.37*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O bebê come sozinho um biscoito ou uma fruta?	0.47*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quando você está jogando bola com o bebê, ele joga a bola de volta para você?	-	-	-0.15*	-	-	-	-	-	-	-	-	-	-	-	-	-
Quando você tira a roupa da criança, ela ajuda você tirando peças como meias, boné ou sapatos? (Se ela já tira as peças sozinho, marque "sim").	-	-	-	0.10*	-	-	-	-	-	-	-	-	-	-	-	-
A criança tenta comer sozinha com uma colher, ainda que derrame a comida.	-	-	0.05	0.14*	-	0.10*	-	-	-	-	-	-	-	-	-	-
A criança brinca com uma boneca ou boneco de pano, abraçando-o(a)?	-	-	-0.07	-	-	-	-	-	-	-	-	-	-	-	-	-
Ao se olhar no espelho, a criança oferece um brinquedo à própria imagem?	-	-	-	-	-	0.09	-	-	-	-	-	-	-	-	-	-
A criança bebe no copo ou caneca e coloca de volta na mesa sem derramar muito?	-	-	-	-	-	0.13*	0.09*	0.08*	0.00	-	-	-	-	-	-	-
A criança copia atividades que você faz, como secar algo que derramou, varrer, lavar a roupa ou escovar os cabelos?	-	-	-	-	-	-	0.08	0.00	-	-	-	-	-	-	-	-
Quando está brincando com um bicho ou um boneco de pano, a criança faz de conta que está embalando, alimentando, trocando fraldas, colocando o brinquedo para dormir e assim por diante? (*Basta que a criança faça uma dessas brincadeiras*).	-	-	-	-	-	-	0.18*	0.15*	-	-	-	-	-	-	-	-
A criança escova os dentes.	-	-	-	-	-	-	0.26	0.05	0.04	0.12*	-	-	-	-	-	-
Se você faz algum dos seguintes gestos, a criança imita pelo menos um deles?																
Colocar a mão na cabeça.	-	-	-	-	-	-	-	0.03	-	0.17*	0.08*	-	-	-	-	-
Mandar beijo.																
A criança usa colher para se alimentar sem derramar muito?	-	-	-	-	-	-	-	-	-0.08*	-0.04*	-	-	-	-	-	-
A criança sabe utilizar o potinho de sobremesa, jogando fora aquilo que não quer ou não deve comer, como caroço, casca ou bagaço.	-	-	-	-	-	-	-	-	-	-	0.06*	0.01	0.12*	-0.21*		
A criança veste casaco **ou** camisa sozinha?	-	-	-	-	-	-	-	0.02	-	-	0.08*	0.05*	-	-	-	-
A criança informa pelo menos quatro dos seguintes dados pessoais? Marque os itens que ela sabe.																
Localidade onde mora	-	-	-	-	-	-	-	-	-	-	-	0.06*	0.04*	-		
Nome da mãe, ou do pai, ou do responsável.																
A criança põe e tira a roupa sem ajuda? Ela pode pedir sua ajuda no caso de colchetes, botões e zíperes.	-	-	-	-	-	-	-	-	-	-	-	0.07*	-	-		
A criança lava as mãos com água e sabão e depois se seca com uma toalha, **sem** ajuda? (Você pode mandá-la lavar as mãos e secar).	-	-	-	-	-	-	-	-	-	-	-	0.07*	0.06*	0.03*	-	

Obs: Items (*) had *p* value in Cohen & Cohen´s test (1983) comparing the transformation of Fischer' s correlation (*r*) for the z score of each item with its respective total of scale in 2010 and 2011 was lower than 0.05.

In Gross Motor Coordination, 2 items showed significant difference. Item *"A criança sobe ou desce sozinha pelo menos dois degraus? Ela pode se apoiar no corrimão ou na parede. (Você pode observar isso na creche, no parquinho, em casa ou numa loja.)"* had a 0.28 statistical drop in correlation with the total in the 27-month interval between 2010 and 2011. Item *"A criança sobe escadas colocando apenas um pé em cada degrau? (Quando o pé esquerdo está num degrau, o direito deve estar no outro.) Ela pode se apoiar no corrimão ou na parede. (Você pode observar isso na creche, no parquinho, em casa ou numa loja.)",* on the other hand, had a significant statistical difference in age interval 36 months, having improved 0.34 in correlation between 2010 and 2011.

Fine Motor Coordination had significant difference in only one item. Item *"Faça uma linha dividindo ao meio uma folha de papel. Usando tesoura sem ponta, a criança corta o papel ao meio, mais ou menos em linha reta, fazendo com que as lâminas se abram e se fechem? (Observe cuidadosamente o uso da tesoura por razões de segurança.)"* improved significantly 0.05 in correlation with the total in 54 months 2010 and 2011.

In Problem Solving, 5 items showed significant differences: 2 in the 10-month interval (items *"O bebê pega dois brinquedos pequenos, um em cada mão, e os segura por algum tempo?"* and *"O bebê percebe ou tenta pegar um pedacinho de biscoito ou um brinquedo que está dentro de um recipiente transparentes (garrafa, pote ou copo fechado)?"*) had improved correlations in 0.15 and 0.26 respectively. Item *"Enquanto a criança observa, alinhe quatro objetos, como blocos ou carrinhos, em uma fileira, como se fosse um trenzinho. A criança copia ou imita você e também alinha quatro objetos em uma fileira? (Você também pode usar carretéis de linha, caixinhas ou outros brinquedos.)",* in age category 27-month, had a significant drop of 0.09 in correlation. Item *"Se a criança quer alguma coisa que não consegue alcançar, ela procura alguma coisa para subir e alcançar o objeto (por exemplo, para pegar um brinquedo sobre uma prateleira ela sobre no bloco de espuma)?"* had a 0.05 correlation drop in 33-months, but a 0.06 increase in age interval 36-month.

In Personal/Social, 15 items presented significant differences. Thirteen improved in at least one age interval. Despite that, 3 items had significant drops in at least one age category, though one of those also improved in other age intervals. Items of 10-month intervals *"O bebê toma água, suco ou leite em uma caneca enquanto você segura a caneca? (Marque "sim" se a criança já faz um movimento diferente do de sucção)."* and *"O bebê come sozinho um biscoito ou uma fruta?"* improved their correlation significantly in 0.37 and 0.47 respectively. In age category 14 months, item *"Quando você está jogando bola com o bebê, ele joga a bola de volta para você?"* decreased correlation significantly in 0.15. In age category 16 months, item *"Quando você tira a roupa da criança, ela ajuda você tirando peças como meias, boné ou sapatos? (Se ela já tira as peças sozinho, marque "sim")"* and *"A criança tenta comer sozinha com uma colher, ainda que derrame a comida."* improved correlation significantly in 0.10 and 0.14, though the latter item also improved 0.10 in the 20-month interval. There was improvement of 0.13 in the 18 month interval in item *"A criança bebe no copo ou caneca e coloca de volta na mesa sem derramar muito?"*. The item also improved in 20 and 22 months, respectively in 0.09 and 0.08.

Still in the Personal/Social domain, item *"A criança escova os dentes"*, in age interval 20 months, improved significantly 0.26. That also happened with the same item in age interval 27 months with correlation having significantly gone up 0.12. In 30 months, item *"Se você faz algum dos seguintes gestos, a criança imita pelo menos um deles?"* improved significantly 0.08, what also happened in 27 months (a 0.17 delta). On the other hand, item *"A criança usa colher para se alimentar sem derramar muito?"* got 0.08 worse, which happened in 33 months too (a 0.04 decrease).

In 36 months, item *"A criança veste casaco ou camisa sozinha?"* improved 0.08 significantly. The same happened in the following age interval, 42 months, in 0.05. Item *"A criança sabe utilizar o potinho de sobremesa, jogando fora aquilo que não quer ou não deve comer, como caroço, casca ou bagaço."* improved significantly in age categories 42 and 54 months respectively in 0.06 and 0.12, but got worse significantly 0.21 in 60 months. Item *"A criança informa pelo menos quatro dos seguintes dados pessoais? Marque os itens que ela sabe."* improved significantly in 48 and 54 months, 0.06 and 0.04 respectively. The same happened with item *"A criança põe e tira a roupa sem ajuda? Ela pode pedir sua*

ajuda no caso de colchetes, botões e zíperes.": it improved 0.07 in 48 months. Item *"A criança lava as mãos com água e sabão e depois se seca com uma toalha, sem ajuda? (Você pode mandá-la lavar as mãos e secar)."* improved in age intervals 42, 48 and 54 months in 0.07, 0.06 and 0.03 respectively.

Despite a large number of items have improved significantly in comparison with items that got worse, we compared the averages of the positive deltas (difference of improved items) with the averages of the negative deltas (difference of worsened items). For that, deltas were divided into positive and negative deltas and a t-student test for independent samples was performed in order to verify the average delta of correlations. The average of the positive deltas was 0.17 (SD=0.08), while the average of the negative deltas was 0.06 (SD=0.20). There was significant difference for $t(38) = 3.90$; $p<0.05$, which attests higher gains than losses in correlation in general relatively to modified items.

One could question if such improvement only happened with the modified items or if there was a significant improvement in ASQ-BR-2011's items. To answer that, the average of the deltas of all modified items was compared with the deltas of the items that were not modified for ASQ-BR-2011. The average of deltas of unchanged items ($N = 69$) – including decreases – was $\Delta'_{not-modified} = 0.03$ (SD=0.13) while the average of deltas of modified items was $\Delta'_{modified} = -0.01$ (SD=0.11). That shows a significant difference between the two indexes for $t(478)=-2.458$; $p<0.05$. Such results will be discussed on the next section of this dissertation.

8
Discussion

The objective of this study was determining if the modifications made upon ASQ-BR (2010) in order to provide adjustments for the following application in 2011 improved its psychometrics characteristics. Aside from deepening psychometric theory, this dissertation aimed at discussing how modifying selected items could empirically change data collection. For that, a few psychological theories will be discussed as well as ASQ-BR's social and cultural adequacy to its real context of application (Borsa, Damásio, & Bandeira, 2012) and how both aspects could be the basis for the actual results.

Despite our discussion was organized in the following order: (1) descriptive statistics of the score, (2) inferential statistics of both application years, (3) dimensionality, (4) reliability analysis and (5) item analysis, we believe that the discussion would be clearer if scales were divided by domain. Scales should be understood as a whole and not for each result since inferential results can be influenced by data reliability and dimensionality. Besides, a modified item may start to contribute more – or less – to the total of the scale causing a change to the whole structure of the scale, *e.g.*, increasing or decreasing the scores of the children. We believe in this case it is better to discuss the results by domain, respecting age intervals. Despite doing that, this study does not try to answer why Personal/Social domain still presents two dimensions nor worries about items that have not been modified though showed significant differences along the two application years – what might have influenced the measure consistency (Cohen & Swerdlik, 2009). The limitations of the study and future directions for ASQ-BR will be presented at the end of this dissertation and will entail new suggestions for further research.

8.1
Communication

A baby's ability to communicate appears with its first unintended sounds and movements (Wagner, 2006). Babies' behaviors are unintentional in the beginning of life since infants do not expect any particular outcome from their behavior. Intentional communication is only established much later, when behavior becomes responses to particular stimuli or situations. Piaget (1953) suggests that in the first year of life babies tend to have basic emotional behaviors – crying, laughing and active looking – and its communications skills are associated to an attempt to imitate the world around him, copying adults' behaviors, joining and sharing attention with adults and peers and anticipating his/her own behaviors (engaging in games such as *where's mommy?*). After 9 months, other behaviors – babbling, vocalizing, hearing and one-word speech – lead to the development of a limited type of speech language. It is expected that children complexify their semantic and pragmatic understanding after 12 months of age until reaching adult-like speech at the age of five (Bialystok, 1986; Kidd & Bavin, 2002). The definition of communication behaviors in the ASQ-3-BR goes as follow:

> "Ability of babble, vocalize, speak, hear and understand. Structure and express some though so that his/her interlocutor understands it. Simple verbal structures, some speech complexity and correct use of plurals, complex and conditional verbal tenses."

> (Squires et al., 2009)

Several assumptions are possible regarding ASQ-3-BR items if the above mentioned assumptions by Squires et al. (2009) are considered. The first is that ASQ's questions consider more than language as communication, including any features of social interaction in any way other person understands. Engaging in joint attention behaviors and concerning about others perspective are important parts of communication skills (Wagner, 2006). Nevertheless, not only domain

Communication deals with the latter skills in ASQ. Domain Personal/Social also measures that. This dissertation is going to discuss the implications of having social skills measured in two different scales. Perhaps this is one of the possible explanations for consistent psychometric problems in the Personal/Social scale—both in 2010 and 2011 results.

In Communication, only two changes were empirically examined. In item "*O bebê fala três palavras como, por exemplo, "Mamã", "Papá" e "Dá" (Uma "palavra" é um som que o bebê fala regularmente referindo-se a alguém ou a alguma coisa)*" changes were basically two: the inclusion of the word "*Dá*" (give) and the explanation of the item in parenthesis. The item clearly addresses the issue of one-word speech in the correct period of childhood development. These changes did not help empirically improve the item itself nor the scale, however it made the item more adequate to the evaluation setting, *i.e.*, child daycare centers. We thus considered those modifications to be more suitable to the environment where the assessment takes place, according to Borsa (2012).

The other modified item was "*Se você aponta para figuras e pergunta à criança "O que é isso?", ela nomeia corretamente pelo menos uma figura? (Exemplos de figuras: bola, gato, carro, casa, etc.)*", modified by including only the explanatory parenthesis. It addresses the child's ability to name an object, in other words, the child's semantic knowledge. The item was altered in three different age intervals – 20, 22 and 30 months – but only the last age interval showed statistical difference between years of assessment ($\Delta=-0.02$). However, since an item contributes to the scale's total score (Cohen & Swerdlik, 2009), when an item is changed, it is expected that its relation to the other items and to the scale as a whole is also empirically modified. Indeed, all Crobach's alphas of scales in age intervals 20, 22 and 30 months showed statistical difference, showing that the item modification, even when the item-total correlation was not significant, probably contributed somehow to alteration in the scale's internal consistency. Empirically speaking, though, item modification was unsuccessful in two scales – 22 and 30 months – but successful in the 20-month communication scale. Despite that, item modification seems to not have influenced children's performance in those scales, once no statistical difference was found between averages comparing years of assessment.

Semantic knowledge is expected to increase in different rates, developing in logistic progression (Kidd & Bavin, 2002), that is, there is rapid acquisition of meaning in early stages and progressive changing from quantity to quality as years go by. Probably, teachers' expectations for 20-month old children are different from expectations for older toddlers, which could lead to the difference in their evaluation.

In order to decide if those modifications should be incorporated to the ASQ-BR, four results were considered: (1) adequacy of the adaptation to child daycare centers, (2) Cronbach's alpha, (3) item-to-total correlation and (4) stability or improvement of children's performance in a given scale. In Communication scales, items were more adequate to its assessment context, no Cronbach's alpha was found below the established criteria ($\alpha < 0.65$) and stability of children's performance was achieved in all communication scales. So, we recommend that the modifications implemented for ASQ-BR-2011 remain for further research with the ASQ-BR.

8.2
Gross Motor Domain

Among ASQ-BR scales the Gross Motor domain was the most reliable according to Filgueiras (2011). Gross Motor abilities are those defined by controling and coordenating movements in space with upper and lower parts of the body (J. Squires, Bricker, Twonbly, & Potter, 2009). They are indeed the first ones to develop in the human baby. Rapidly, baby suction reflex is followed by moving arms and holding the mother's breast to provide more security during breast feeding; movements of arms and legs get quickly under control to stiffen the body when the baby is picked up, culminating in walking before one year of age (Piaget, 1953).

> "Broad bodily movements. Move arms to complete simple tasks as throwing an object or leaning against walls or handrails. Leg and feet coordination for balance and moving."
>
> (Squires et al., 2009)

Gross motor control, in terms of assessment, is a very straightforward construct in ASQ. Locomotion and coordination between legs and arms are basically the essence of the questions in this domain. Probably the simplicity of the construct is is the reason for the better assessment: "(...) assessing a simple psychological construct is perhaps the best way to assure its validity and consistency." (Clark & Watson, 1995). Because of its simplicity, modifications of items focused solely in adding a small assertion in parenthesis to the items. The three modified items had the same explanatory parenthesis: "(*Você pode observar isso na creche, no parquinho, em casa ou numa loja.*)" – the added term in bold. Few or no statistical differences between years of assessment were expected. However, one item showed significant decrease of item-total correlation leading to decrease in internal consistency measured by Cronbach's alpha, while another item had the opposite behavior, improving both item-total correlation and the alpha of the scale. Other than that, several scales, regardless of the modifications, also showed Cronbach's alpha increase or decrease.

Using the criteria above-mentioned to decide if the changes should remain, item-total correlation and Cronbach's alpha did not changed enough to consider further modifications in those items. Adequacy was also better because the scale considers gross motor related behaviors at the very child daycare centers. Finally, significant differences between score averages between 2010 and 2011 occurred only in the 10-month age interval, thus the modifications seem to have not influenced children's performance in the scale: a point in favor of the scale's stability. Therefore, we recommend that changes in items in Gross Motor Domain remain. Among all the scales, only the 22-month age interval presented alpha below 0.65 and we suggest further studies to improve the scale's reliability.

8.3
Fine Motor Domain

Fine motor skills are fundamental to children development. Countless evidences in different areas of cognitive sciences show that fine motor skills such as pointing, grasping and clinging can actually predict the emergence and development of other cognitive domains (James, 2010; Nieder & Dehaene, 2009; Pulvermüller, Shtyrov, & Hauk, 2009; Wilson, 2002). For example, Nieder and Dehaene (2009) suggest that pointing using the index finger is one of the first movements towards voluntary joint attention between baby and mother. This behavior is ultimately leading to communication. In ASQ fine motor scales, several aspects are measured from fine control of the finger movements to enough control to use scissors or a pencil adequately. The definition of fine motor control can be seen below:

> "Movement and coordination of fingers and fingertips ability to use tools like knobs, scissors, taps, pencils and pens".
>
> (Squires et al., 2009)

Basically, items require children to execute a task, which can be problematic in child daycare centers because it may mean getting out of the normal path of daily activities. One of the main concerns of teachers during the pilot study was exactly the ability and the adequate training of professionals involved in the assessment to understand the correct way to ask children to do any of those tasks and respond to them in a homogeneous way.

Among Fine Motor items, three were altered. Two of those items clearly improved the scale. Item "*A criança liga e desliga interruptores de luz? Abre a maçaneta ou trinco da porta? Abre e fecha torneiras? Caso a criança faça uma dessas atividades marque sim.*" initially only required the children to show if they knew how to switch the lights on or off. By adding other fine motor behaviors, the scale improved homogeneity in the 27-months scale. This probably happened because the modification allowed teachers and caregivers to observe other behaviors leading to more consistent responses.

The other improved item in Fine Motor scales was "Faça uma linha dividindo ao meio uma folha de papel. Usando tesoura sem ponta, a criança corta o papel ao meio, mais ou menos em linha reta, fazendo com que as lâminas se

abram e se fechem? *(Observe cuidadosamente o uso da tesoura por razões de segurança.)"*. The item was changed to include a parenthesis guiding teachers and caregivers to be careful watching the children when using scissors. The message served for two purposes: (1) for safety reasons, and (2) to make clear that the child had to be tested to answer this item. During the pilot study, teachers reported that several caregivers were answering the ASQ-BR without testing children in all the required behaviors, but only in a few. This could be misleading and jeopardize statistical results. Analyzing item statistics and internal consistency, we strongly recommend that those changes remain in the ASQ-BR.

Regardless of that, an unexpected phenomenon was observed: seven age intervals showed improvement in children's performance in fine motor skills. There are several possible hypotheses to explain and they will be addressed ahead in this study.

8.4
Problem Solving Domain

Problem solving is a controversial construct because it is focused on the outcome – the behavior itself, *i.e.*, if the child solves a problem – and not on the process. Cognitive science is more concerned, nowadays, with the processes leading to an answer than with the answer itself (Munakata, Casey, & Diamond, 2004). Nevertheless, research on information processing in babies and toddlers is still very incipient (Hackman & Farah, 2009). Thus, instrumentalizing the construct would be more coherent with the literature than assessing just the outcome. Problem solving can be defined in several different ways, thus we are going to stick to Squires' et al. (2009) definition:

> "Respond appropriately to external and internal demands of the environment, such as: taking an object from inside another, handling two pieces of information at the same time, imitating or copying adults, attributing meaning, recognizing and categorizing objects and people."
>
> (Squires et al., 2009)

Among the seven modified items, four showed actual statistical differences between years of assessment. Two of those items were in the 10-month scale.

Both item-total correlation and Cronbach's alpha improved significantly, what confirmed the implementation of changes.

One item had low item-total correlation and its change led to a decrease of internal consistency. Item "*Enquanto a criança observa, alinhe quatro objetos, como blocos ou carrinhos, em uma fileira, como se fosse um trenzinho. A criança copia ou imita você e também alinha quatro objetos em uma fileira? (Você também pode usar carretéis de linha, caixinhas ou outros brinquedos.)*" had parentheses included so teachers and caregivers had more tools to observe the behavior. However, observing more children behaviors in this case was misleading at least for children in the 27-month interval. Average scores of the scale were statistically higher in 2011 than in 2010. That can suggest that the modification actually made the scale easier, probably with an important contribution of the item. A specific study of item difficulty would probably help understand what happened with the item. So, regarding this item, we recommend to change it back to its previous form until changes are reengineered for further studies.

The last modified item, "*Se a criança quer alguma coisa que não consegue alcançar, ela procura alguma coisa para subir e alcançar o objeto (por exemplo, para pegar um brinquedo sobre uma prateleira ela sobre no bloco de espuma)?*" had an interesting behavior regarding its item-total correlation. In the 30-month scale, no statistical difference was found. In the 33-month interval a significant decrease was observed while the complete opposite happened with the 36-month interval, which showed significant improvement. One can hypothesize that there is some age effect in the item. But, after evaluating children's performance on the three scales, no significant difference was found. We thus believe that the modifications only helped adapt the item in the assessment context. Based on that, we recommend that six of the seven items remain altered. Five scales, though, should be studied in future research because of impaired internal consistency ($\alpha < 0.65$) in intervals 20, 22, 24, 27 and 54-month.

8.5
Personal/Social Domain

This domain is indeed controversial. Filgueiras (2011) and Filgueiras et al. (2013) argue that the low homogeneity in this scale, measured by Cronbach's alpha, is due to the scale's attempt to measure two different constructs at the same time. Indeed, the description of the domain according to Squires is:

> "Ability to be independent and relate to other children and adults. Verify if: the child looks for help when needs something, is able to engage in relationships with other people, can identify with elements socially established for his/her individuation, is independent in daily tasks like eating, getting dressed, and clean him/herself."

(Squires et al., 2009)

The ability of being independent in a child – personal skills – is associated with behaviors of autonomy, *e.g.*, not paying attention to others, but at his/her own will (Kochanska, Murray, & Harlan, 2000). In contrast, social skills are the ability to interact appropriately, concerning with others and engaging in pleasant interactions for both parts (Jane Squires, Bricker, & Twombly, 2004). Thus, modifications in this scale should benefit from concern in measuring both constructs in a unidimensional fashion. The authors of the scale have actually attested that it lacked some precision statistically and, for that, created ASQ: Social Emotional (ASQ:SE) for dealing with the issue (J Squires, Bricker, Heo, & Twombly, 2010).

Regarding dimensionality, based on the latter argument, two dimensions would be expected. However, according to Filgueiras et al. (2013), personal and social skills could be "two faces of the same coin". Their study conducted several factor analysis using different techniques and only three among the twenty analyzed scales presented bidimensionality. In the present study, only one of the scales shows such results, the 60-months scale. Thus, scales can be considered unidimensional.

With respect to internal consistency, the present study gave one step towards a better scale. In 2011, only seven scales had alphas below the established criteria, against twelve in 2010. However, it seems that even with the impressive

improvement of the scales – both in internal consistency and item-to-total correlation – problems with Personal/Social scales still remain. Future studies are therefore needed to carefully analyze Personal/Social scales.

8.6
Limitations of the study

The results found in the present study are not entirely comparable to the ASQ-BR used in 2010. Several variables were altered between years of assessment, when conclusions derived from the present study were not available. The first variable changed between 2010 and 2011 was the inclusion of preschool children in the sample, which remarkably increased the sample size of the 60-month age interval.

The second variable that probably influenced results were questionnaire completion by teachers recently hired (in 2011) who had not been trained on ASQ-BR. Actually, the Secretary of Education of Rio de Janeiro hired 1.500 teachers for child daycare centers through a public selection (Rio de Janeiro, 2010) at the beginning of 2011. That meant an increase of over 10% of professionals using ASQ-BR-2011. Despite the efforts for adequate training given to the directors of municipal schools and daycare centers it is not possible to entirely guarantee the quality of the training passed on to the teachers by the directors. The novelty of the profession for the recently hired teachers as well as possible inconsistencies on directors' training may be reason for the average difference.

The third possible explanation for significant differences between scales is the development of new activities in child daycare centers in Rio de Janeiro in virtue of the 2010's assessment. The Secretary of Education had developed a free adaptation of the ASQ-3's book of learning activities (Rio de Janeiro, 2011). The book gives teachers and caregivers guidelines of how to improve children performance in classroom with respect to each ASQ domain. There are no official reports or information about the effects of those activities in municipal children enrolled in daycare centers in Rio de Janeiro but the initiative might be an explanation to the difference of averages between 2010 and 2011.

9
Conclusion

The present study seems to have partially achieved its objectives. Several scales were improved due to item modification and presented a higher reliability index – Cronbach's alpha – as compared to the first year of assessment. ASQ-BR-2011 showed better psychometric properties when compared to the 2010 version, ASQ-BR.

Regardless of that, a few limitations in this study could be addressed as future research in the area. The study of item difficulty and item information is absent is this study and interesting statistics could arise from it. For example, if an item is too difficult for a group of children, it might not help the scale. The same reasoning is valid for when an item is too easy: it would not discriminate children accurately. Either situation is a possible cause for the lack of balance in a few scales in ASQ-BR-2011.

10
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8
Annex

10-month scale									
2010				2011					Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.76	1	0.58	Communication	0.81	1	0.61	0.77	No
		2	0.58			2	0.66	0.76	No
		3	0.57			3	0.68	0.76	No
		4	0.49			4	0.53	0.79	No
		5	0.34			5	0.52	0.80	No
		6	0.36			6	0.45	0.81	Yes
Gross Motor	0.79	1	0.44	Gross Motor	0.79	1	0.26	0.80	No
		2	0.32			2	0.25	0.80	No
		3	0.58			3	0.64	0.73	No
		4	0.68			4	0.70	0.71	No
		5	0.73			5	0.76	0.69	No
		6	0.53			6	0.61	0.74	No
Fine Motor	0.78	1	0.32	Fine Motor	0.81	1	0.46	0.80	No
		2	0.44			2	0.47	0.80	No
		3	0.53			3	0.72	0.74	No
		4	0.57			4	0.58	0.78	No
		5	0.71			5	0.63	0.76	No
		6	0.54			6	0.57	0.78	No
Problem Solving	0.72	1	0.31	Problem Solving	0.89	1	0.79	0.86	No
		2	0.40			2	0.73	0.87	No
		3	0.53			3	0.67	0.88	No
		4	0.62			4	0.77	0.86	Yes
		5	0.36			5	0.62	0.89	Yes
		6	0.41			6	0.71	0.87	No
Personal/Social	0.58	1	0.28	Personal/Social	0.80	1	0.16	0.84	No
		2	0.21			2	0.58	0.77	Yes
		3	0.13			3	0.60	0.77	Yes
		4	0.55			4	0.68	0.74	No
		5	0.37			5	0.64	0.75	No
		6	0.50			6	0.70	0.73	No

12-month scale								
2010				2011				Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.75	1	0.47	Communication	0.78	1	0.43	0.77	No
		2	0.47			2	0.51	0.76	No
		3	0.42			3	0.57	0.74	No
		4	0.54			4	0.54	0.75	Yes
		5	0.53			5	0.63	0.72	No
		6	0.47			6	0.54	0.75	No
Gross Motor	0.85	1	0.60	Gross Motor	0.83	1	0.63	0.80	No
		2	0.61			2	0.63	0.80	No
		3	0.64			3	0.68	0.79	No
		4	0.67			4	0.52	0.82	No
		5	0.72			5	0.70	0.78	No
		6	0.62			6	0.53	0.83	No
Fine Motor	0.77	1	0.46	Fine Motor	0.84	1	0.67	0.80	No
		2	0.52			2	0.60	0.82	No
		3	0.62			3	0.59	0.82	No
		4	0.52			4	0.61	0.81	No
		5	0.49			5	0.58	0.82	No
		6	0.50			6	0.65	0.80	No
Problem Solving	0.77	1	0.32	Problem Solving	0.83	1	0.60	0.80	No
		2	0.51			2	0.60	0.80	No
		3	0.46			3	0.57	0.81	No
		4	0.64			4	0.70	0.78	No
		5	0.63			5	0.61	0.80	No
		6	0.48			6	0.54	0.82	No
Personal/Social	0.76	1	0.54	Personal/Social	0.79	1	0.57	0.76	No
		2	0.48			2	0.48	0.77	No
		3	0.53			3	0.60	0.75	No
		4	0.57			4	0.63	0.74	No
		5	0.50			5	0.51	0.77	No
		6	0.38			6	0.49	0.77	No

	14-month scale								
	2010				2011				Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.75	1	0.52	Communication	0.81	1	0.57	0.78	No
		2	0.58			2	0.64	0.76	No
		3	0.51			3	0.58	0.77	No
		4	0.35			4	0.54	0.78	No
		5	0.50			5	0.53	0.79	No
		6	0.45			6	0.56	0.78	No
Gross Motor	0.85	1	0.66	Gross Motor	0.90	1	0.58	0.90	No
		2	0.68			2	0.71	0.89	No
		3	0.86			3	0.87	0.86	No
		4	0.47			4	0.61	0.91	No
		5	0.81			5	0.83	0.87	No
		6	0.84			6	0.88	0.86	No
Fine Motor	0.77	1	0.39	Fine Motor	0.83	1	0.50	0.82	No
		2	0.44			2	0.66	0.78	No
		3	0.53			3	0.68	0.78	No
		4	0.64			4	0.67	0.78	No
		5	0.42			5	0.49	0.82	No
		6	0.54			6	0.59	0.80	No
Problem Solving	0.77	1	0.64	Problem Solving	0.85	1	0.62	0.82	No
		2	0.72			2	0.68	0.81	No
		3	0.49			3	0.60	0.82	No
		4	0.51			4	0.63	0.82	No
		5	0.68			5	0.72	0.80	No
		6	0.38			6	0.54	0.84	No
Personal/Social	0.76	1	0.64	Personal/Social	0.79	1	0.64	0.73	No
		2	0.72			2	0.57	0.75	Yes
		3	0.47			3	0.52	0.76	Yes
		4	0.51			4	0.44	0.78	Yes
		5	0.68			5	0.66	0.72	No
		6	0.38			6	0.43	0.78	No

16-month scale									
2010				2011					Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.75	1	0.26	Communication	0.79	1	0.39	0.78	No
		2	0.60			2	0.67	0.71	No
		3	0.41			3	0.45	0.77	No
		4	0.43			4	0.55	0.75	No
		5	0.54			5	0.59	0.74	No
		6	0.54			6	0.55	0.75	No
Gross Motor	0.89	1	0.72	Gross Motor	0.83	1	0.64	0.80	No
		2	0.60			2	0.64	0.80	No
		3	0.74			3	0.69	0.79	No
		4	0.71			4	0.62	0.81	No
		5	0.67			5	0.64	0.79	No
		6	0.56			6	0.59	0.82	No
Fine Motor	0.75	1	0.61	Fine Motor	0.82	1	0.66	0.78	No
		2	0.42			2	0.48	0.81	No
		3	0.65			3	0.70	0.76	No
		4	0.55			4	0.60	0.79	No
		5	0.49			5	0.48	0.81	Yes
		6	0.57			6	0.65	0.78	No
Problem Solving	0.80	1	0.56	Problem Solving	0.77	1	0.52	0.73	No
		2	0.60			2	0.63	0.70	No
		3	0.49			3	0.35	0.79	No
		4	0.45			4	0.48	0.74	No
		5	0.61			5	0.55	0.73	No
		6	0.56			6	0.61	0.71	No
Personal/Social	0.71	1	0.21	Personal/Social	0.74	1	0.41	0.72	No
		2	0.38			2	0.48	0.70	Yes
		3	0.34			3	0.48	0.70	Yes
		4	0.32			4	0.39	0.72	No
		5	0.48			5	0.56	0.68	No
		6	0.52			6	0.55	0.68	No

				18-month scale					
	2010				2011				Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.73	1	0.35	Communication	0.79	1	0.40	0.78	No
		2	0.39			2	0.43	0.78	No
		3	0.62			3	0.60	0.74	No
		4	0.64			4	0.66	0.72	No
		5	0.47			5	0.52	0.76	No
		6	0.61			6	0.62	0.73	No
Gross Motor	0.85	1	0.44	Gross Motor	0.82	1	0.67	0.78	No
		2	0.31			2	0.58	0.80	No
		3	0.46			3	0.66	0.78	No
		4	0.37			4	0.54	0.81	No
		5	0.39			5	0.60	0.79	No
		6	0.46			6	0.65	0.77	No
Fine Motor	0.79	1	0.44	Fine Motor	0.76	1	0.42	0.74	No
		2	0.62			2	0.67	0.67	No
		3	0.44			3	0.51	0.72	No
		4	0.59			4	0.60	0.69	No
		5	0.41			5	0.45	0.73	No
		6	0.31			6	0.39	0.76	No
Problem Solving	0.79	1	0.35	Problem Solving	0.74	1	0.40	0.72	No
		2	0.43			2	0.52	0.69	No
		3	0.60			3	0.57	0.67	No
		4	0.48			4	0.44	0.71	No
		5	0.26			5	0.31	0.75	Yes
		6	0.61			6	0.63	0.65	No
Personal/Social	0.64	1	0.31	Personal/Social	0.75	1	0.40	0.74	Yes
		2	0.32			2	0.40	0.73	No
		3	0.44			3	0.59	0.68	No
		4	0.47			4	0.57	0.68	No
		5	0.26			5	0.39	0.73	Yes
		6	0.46			6	0.57	0.68	No

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| 20 -month scale | | | | | | | | | |
| 2010 | | | | 2011 | | | | | Item has been changed between years of assessment? |
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.77	1	0.71	Communication	0.83	1	0.72	0.78	No
		2	0.63			2	0.73	0.77	No
		3	0.52			3	0.50	0.82	No
		4	0.68			4	0.71	0.78	Yes
		5	0.38			5	0.25	0.86	No
		6	0.60			6	0.68	0.79	No
Gross Motor	0.64	1	0.42	Gross Motor	0.72	1	0.41	0.70	No
		2	0.55			2	0.47	0.69	No
		3	0.50			3	0.48	0.68	No
		4	0.43			4	0.50	0.68	No
		5	0.52			5	0.53	0.66	No
		6	0.51			6	0.46	0.70	No
Fine Motor	0.72	1	0.36	Fine Motor	0.71	1	0.35	0.69	No
		2	0.53			2	0.55	0.63	No
		3	0.42			3	0.37	0.69	No
		4	0.32			4	0.44	0.67	No
		5	0.47			5	0.49	0.65	No
		6	0.35			6	0.47	0.65	No
Problem Solving	0.72	1	0.40	Problem Solving	0.59	1	0.35	0.54	No
		2	0.26			2	0.27	0.58	Yes
		3	0.25			3	0.20	0.59	Yes
		4	0.43			4	0.40	0.51	No
		5	0.47			5	0.39	0.52	No
		6	0.37			6	0.39	0.52	No
Personal/Social	0.64	1	0.23	Personal/Social	0.70	1	0.49	0.63	Yes
		2	0.32			2	0.38	0.67	No
		3	0.36			3	0.46	0.65	Yes
		4	0.41			4	0.50	0.63	Yes
		5	0.37			5	0.45	0.65	Yes
		6	0.15			6	0.33	0.69	Yes

22 -month scale									
2010				2011					Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.82	1	0.61	Communication	0.68	1	0.58	0.58	Yes
		2	0.37			2	0.15	0.71	No
		3	0.54			3	0.47	0.63	No
		4	0.58			4	0.15	0.73	No
		5	0.62			5	0.57	0.58	No
		6	0.68			6	0.59	0.57	No
Gross Motor	0.74	1	0.52	Gross Motor	0.64	1	0.24	0.64	No
		2	0.51			2	0.44	0.59	No
		3	0.37			3	0.44	0.60	No
		4	0.44			4	0.40	0.58	No
		5	0.45			5	0.39	0.61	No
		6	0.51			6	0.49	0.54	No
Fine Motor	0.67	1	0.33	Fine Motor	0.64	1	0.38	0.59	No
		2	0.39			2	0.43	0.57	No
		3	0.48			3	0.45	0.56	No
		4	0.41			4	0.38	0.62	No
		5	0.36			5	0.37	0.60	No
		6	0.26			6	0.34	0.62	No
Problem Solving	0.63	1	0.40	Problem Solving	0.63	1	0.35	0.60	No
		2	0.42			2	0.45	0.55	No
		3	0.35			3	0.35	0.59	No
		4	0.22			4	0.27	0.64	Yes
		5	0.45			5	0.41	0.57	No
		6	0.43			6	0.44	0.56	No
Personal/Social	0.57	1	0.42	Personal/Social	0.63	1	0.50	0.53	Yes
		2	0.24			2	0.24	0.63	Yes
		3	0.15			3	0.30	0.64	Yes
		4	0.27			4	0.32	0.60	Yes
		5	0.46			5	0.46	0.55	No
		6	0.39			6	0.42	0.57	Yes

				24-month scale					
	2010				2011				Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.81	1	0.57	Communication	0.82	1	0.54	0.80	No
		2	0.74			2	0.71	0.76	No
		3	0.36			3	0.27	0.84	No
		4	0.72			4	0.72	0.76	No
		5	0.68			5	0.69	0.77	No
		6	0.62			6	0.61	0.79	No
Gross Motor	0.71	1	0.35	Gross Motor	0.65	1	0.36	0.63	Yes
		2	0.47			2	0.27	0.65	No
		3	0.39			3	0.45	0.59	Yes
		4	0.42			4	0.43	0.61	No
		5	0.40			5	0.44	0.60	No
		6	0.48			6	0.52	0.55	No
Fine Motor	0.64	1	0.28	Fine Motor	0.67	1	0.36	0.64	No
		2	0.39			2	0.42	0.64	No
		3	0.44			3	0.47	0.60	No
		4	0.30			4	0.40	0.63	Yes
		5	0.42			5	0.49	0.59	No
		6	0.33			6	0.40	0.65	No
Problem Solving	0.65	1	0.28	Problem Solving	0.63	1	0.30	0.63	No
		2	0.43			2	0.46	0.54	No
		3	0.33			3	0.35	0.59	No
		4	0.34			4	0.33	0.60	No
		5	0.37			5	0.35	0.59	Yes
		6	0.47			6	0.45	0.54	No
Personal/Social	0.59	1	0.28	Personal/Social	0.65	1	0.28	0.64	Yes
		2	0.49			2	0.50	0.57	No
		3	0.14			3	0.36	0.63	No
		4	0.46			4	0.43	0.59	No
		5	0.38			5	0.42	0.59	Yes
		6	0.41			6	0.38	0.61	No

27-month scale									
2010				2011					Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.84	1	0.38	Communication	0.75	1	0.33	0.76	No
		2	0.64			2	0.62	0.69	No
		3	0.54			3	0.49	0.72	No
		4	0.62			4	0.59	0.69	No
		5	0.57			5	0.56	0.71	No
		6	0.44			6	0.47	0.72	No
Gross Motor	0.67	1	0.42	Gross Motor	0.65	1	0.14	0.69	Yes
		2	0.46			2	0.39	0.62	No
		3	0.59			3	0.58	0.52	No
		4	0.44			4	0.39	0.60	No
		5	0.55			5	0.51	0.55	No
		6	0.32			6	0.38	0.60	Yes
Fine Motor	0.62	1	0.36	Fine Motor	0.71	1	0.31	0.71	No
		2	0.21			2	0.21	0.73	Yes
		3	0.58			3	0.64	0.60	No
		4	0.39			4	0.40	0.69	No
		5	0.47			5	0.48	0.66	No
		6	0.57			6	0.64	0.60	No
Problem Solving	0.63	1	0.36	Problem Solving	0.62	1	0.40	0.56	No
		2	0.35			2	0.32	0.60	No
		3	0.40			3	0.43	0.54	No
		4	0.40			4	0.31	0.59	Yes
		5	0.35			5	0.41	0.55	No
		6	0.37			6	0.38	0.59	No
Personal/Social	0.63	1	0.28	Personal/Social	0.62	1	0.40	0.56	Yes
		2	0.15			2	0.32	0.60	Yes
		3	0.29			3	0.43	0.54	No
		4	0.29			4	0.31	0.59	Yes
		5	0.38			5	0.41	0.55	No
		6	0.31			6	0.38	0.59	No

30-month scale								
2010				2011				Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.77	1	0.58	Communication	0.74	1	0.56	0.68	Yes
		2	0.37			2	0.29	0.75	No
		3	0.52			3	0.50	0.70	No
		4	0.58			4	0.58	0.67	No
		5	0.44			5	0.39	0.72	No
		6	0.57			6	0.60	0.66	No
Gross Motor	0.71	1	0.40	Gross Motor	0.67	1	0.49	0.61	No
		2	0.39			2	0.23	0.68	No
		3	0.39			3	0.41	0.63	No
		4	0.53			4	0.51	0.59	No
		5	0.40			5	0.39	0.63	Yes
		6	0.44			6	0.45	0.61	No
Fine Motor	0.70	1	0.32	Fine Motor	0.80	1	0.39	0.80	No
		2	0.70			2	0.70	0.72	No
		3	0.43			3	0.51	0.77	No
		4	0.70			4	0.72	0.72	No
		5	0.63			5	0.61	0.75	No
		6	0.29			6	0.37	0.80	No
Problem Solving	0.62	1	0.35	Problem Solving	0.71	1	0.41	0.67	No
		2	0.29			2	0.28	0.71	No
		3	0.37			3	0.37	0.69	Yes
		4	0.48			4	0.47	0.66	Yes
		5	0.56			5	0.54	0.63	No
		6	0.53			6	0.55	0.62	No
Personal/Social	0.53	1	0.30	Personal/Social	0.65	1	0.22	0.65	Yes
		2	0.33			2	0.30	0.63	No
		3	0.34			3	0.42	0.60	Yes
		4	0.32			4	0.48	0.56	No
		5	0.46			5	0.55	0.53	No
		6	0.36			6	0.33	0.62	No

| 33-month scale | | | | | | | | |
| 2010 | | | | 2011 | | | | Item has been changed between years of assessment? |
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.75	1	0.46	Communication	0.70	1	0.44	0.66	No
		2	0.55			2	0.53	0.62	No
		3	0.44			3	0.21	0.72	No
		4	0.58			4	0.59	0.59	No
		5	0.42			5	0.39	0.67	No
		6	0.46			6	0.44	0.65	No
Gross Motor	0.67	1	0.41	Gross Motor	0.77	1	0.46	0.76	No
		2	0.41			2	0.71	0.68	No
		3	0.53			3	0.63	0.71	No
		4	0.37			4	0.32	0.78	Yes
		5	0.45			5	0.62	0.71	No
		6	0.42			6	0.41	0.77	No
Fine Motor	0.78	1	0.64	Fine Motor	0.83	1	0.72	0.77	No
		2	0.47			2	0.42	0.83	No
		3	0.68			3	0.58	0.80	No
		4	0.60			4	0.70	0.77	No
		5	0.37			5	0.44	0.82	No
		6	0.40			6	0.70	0.77	No
Problem Solving	0.69	1	0.37	Problem Solving	0.76	1	0.43	0.74	No
		2	0.37			2	0.34	0.76	Yes
		3	0.29			3	0.65	0.68	No
		4	0.42			4	0.42	0.75	Yes
		5	0.44			5	0.64	0.68	No
		6	0.51			6	0.55	0.71	No
Personal/Social	0.61	1	0.34	Personal/Social	0.66	1	0.35	0.63	No
		2	0.37			2	0.33	0.63	Yes
		3	0.36			3	0.40	0.63	No
		4	0.43			4	0.43	0.60	No
		5	0.44			5	0.43	0.60	No
		6	0.44			6	0.45	0.59	No

36-month scale								
2010				2011				Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.74	1	0.42	Communication	0.65	1	0.41	0.62	No
		2	0.45			2	0.44	0.58	No
		3	0.39			3	0.40	0.60	No
		4	0.52			4	0.53	0.55	No
		5	0.42			5	0.40	0.60	No
		6	0.28			6	0.29	0.69	No
Gross Motor	0.69	1	0.37	Gross Motor	0.77	1	0.45	0.76	No
		2	0.57			2	0.54	0.74	No
		3	0.30			3	0.64	0.71	Yes
		4	0.50			4	0.46	0.76	No
		5	0.43			5	0.51	0.74	No
		6	0.54			6	0.55	0.73	No
Fine Motor	0.79	1	0.65	Fine Motor	0.79	1	0.67	0.73	No
		2	0.48			2	0.45	0.78	No
		3	0.63			3	0.54	0.76	No
		4	0.68			4	0.63	0.74	No
		5	0.44			5	0.46	0.78	No
		6	0.39			6	0.51	0.76	No
Problem Solving	0.67	1	0.41	Problem Solving	0.68	1	0.39	0.65	No
		2	0.25			2	0.29	0.68	No
		3	0.29			3	0.35	0.67	Yes
		4	0.56			4	0.57	0.59	Yes
		5	0.43			5	0.43	0.64	No
		6	0.52			6	0.51	0.61	No
Personal/Social	0.66	1	0.34	Personal/Social	0.59	1	0.29	0.57	No
		2	0.32			2	0.30	0.56	No
		3	0.36			3	0.41	0.51	No
		4	0.27			4	0.35	0.55	Yes
		5	0.38			5	0.44	0.49	No
		6	0.24			6	0.26	0.58	No

42-month scale									
2010				2011					Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.66	1	0.40	Communication	0.69	1	0.42	0.65	No
		2	0.46			2	0.51	0.63	No
		3	0.38			3	0.39	0.66	No
		4	0.32			4	0.34	0.70	No
		5	0.43			5	0.44	0.64	No
		6	0.47			6	0.52	0.61	No
Gross Motor	0.71	1	0.29	Gross Motor	0.67	1	0.40	0.64	No
		2	0.42			2	0.46	0.61	No
		3	0.38			3	0.42	0.63	No
		4	0.48			4	0.48	0.60	No
		5	0.41			5	0.43	0.63	No
		6	0.31			6	0.29	0.67	No
Fine Motor	0.79	1	0.55	Fine Motor	0.71	1	0.51	0.66	No
		2	0.56			2	0.53	0.65	No
		3	0.41			3	0.44	0.67	No
		4	0.41			4	0.41	0.68	No
		5	0.33			5	0.39	0.70	No
		6	0.45			6	0.45	0.68	No
Problem Solving	0.67	1	0.31	Problem Solving	0.67	1	0.33	0.65	Yes
		2	0.51			2	0.50	0.60	No
		3	0.40			3	0.42	0.63	No
		4	0.51			4	0.50	0.59	No
		5	0.35			5	0.35	0.66	No
		6	0.35			6	0.35	0.64	No
Personal/Social	0.57	1	0.26	Personal/Social	0.57	1	0.34	0.53	No
		2	0.30			2	0.36	0.50	Yes
		3	0.32			3	0.37	0.52	No
		4	0.25			4	0.25	0.56	No
		5	0.26			5	0.31	0.56	Yes
		6	0.33			6	0.40	0.52	Yes

48-month scale									
2010				2011					Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.66	1	0.55	Communication	0.77	1	0.53	0.74	No
		2	0.52			2	0.46	0.75	No
		3	0.57			3	0.60	0.72	No
		4	0.56			4	0.53	0.74	No
		5	0.44			5	0.42	0.76	No
		6	0.60			6	0.58	0.72	No
Gross Motor	0.64	1	0.45	Gross Motor	0.71	1	0.51	0.65	No
		2	0.30			2	0.26	0.72	No
		3	0.38			3	0.31	0.72	No
		4	0.53			4	0.59	0.62	No
		5	0.48			5	0.57	0.63	No
		6	0.53			6	0.46	0.67	No
Fine Motor	0.71	1	0.40	Fine Motor	0.75	1	0.45	0.72	No
		2	0.40			2	0.44	0.72	No
		3	0.54			3	0.54	0.70	No
		4	0.38			4	0.42	0.73	No
		5	0.51			5	0.53	0.70	No
		6	0.51			6	0.55	0.69	No
Problem Solving	0.67	1	0.38	Problem Solving	0.70	1	0.38	0.67	No
		2	0.42			2	0.45	0.65	No
		3	0.41			3	0.44	0.65	No
		4	0.46			4	0.49	0.64	No
		5	0.33			5	0.28	0.70	No
		6	0.49			6	0.52	0.63	No
Personal/Social	0.52	1	0.27	Personal/Social	0.57	1	0.30	0.55	No
		2	0.27			2	0.28	0.56	Yes
		3	0.31			3	0.37	0.54	Yes
		4	0.30			4	0.32	0.54	No
		5	0.38			5	0.45	0.47	Yes
		6	0.31			6	0.37	0.50	Yes

54-month scale									
2010				2011					Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.78	1	0.54	Communication	0.80	1	0.58	0.77	No
		2	0.63			2	0.66	0.75	No
		3	0.56			3	0.61	0.76	No
		4	0.36			4	0.42	0.80	No
		5	0.58			5	0.56	0.77	No
		6	0.56			6	0.54	0.77	No
Gross Motor	0.70	1	0.48	Gross Motor	0.78	1	0.56	0.74	No
		2	0.36			2	0.45	0.77	No
		3	0.48			3	0.55	0.74	No
		4	0.47			4	0.52	0.75	No
		5	0.51			5	0.58	0.73	No
		6	0.45			6	0.52	0.75	No
Fine Motor	0.72	1	0.52	Fine Motor	0.75	1	0.53	0.70	No
		2	0.34			2	0.40	0.73	No
		3	0.51			3	0.56	0.69	Yes
		4	0.45			4	0.44	0.72	No
		5	0.48			5	0.48	0.71	No
		6	0.40			6	0.50	0.70	No
Problem Solving	0.68	1	0.52	Problem Solving	0.59	1	0.35	0.26	No
		2	0.26			2	0.40	0.54	No
		3	0.50			3	0.38	0.53	No
		4	0.35			4	0.49	0.52	No
		5	0.47			5	0.51	0.46	No
		6	0.50			6	0.49	0.52	No
Personal/Social	0.53	1	0.24	Personal/Social	0.58	1	0.17	0.74	Yes
		2	0.28			2	0.30	0.56	No
		3	0.38			3	0.42	0.50	Yes
		4	0.28			4	0.33	0.55	No
		5	0.25			5	0.28	0.57	Yes
		6	0.31			6	0.39	0.51	No

60-month scale								
2010				2011				Item has been changed between years of assessment?
Subscale	Cronbach's α	Item	Item-to-total Correlation	Subscale	Cronbach's α	Item	Item-to-total Correlation	Cronbach's α if item deleted	
Communication	0.78	1	0.41	Communication	0.66	1	.273	.654	No
		2	0.32			2	.153	.683	No
		3	0.33			3	.735	.437	No
		4	0.39			4	.670	.480	No
		5	0.29			5	.242	.662	No
		6	0.36			6	.351	.632	No
Gross Motor	0.71	1	0.48	Gross Motor	0.78	1	.603	.724	No
		2	0.46			2	.478	.757	No
		3	0.53			3	.613	.721	No
		4	0.46			4	.475	.756	No
		5	0.50			5	.535	.742	No
		6	0.30			6	.457	.763	No
Fine Motor	0.72	1	0.34	Fine Motor	0.77	1	0.37	0.77	No
		2	0.35			2	0.49	0.74	No
		3	0.36			3	0.47	0.75	No
		4	0.32			4	0.57	0.72	No
		5	0.41			5	0.63	0.71	No
		6	0.46			6	0.59	0.72	No
Problem Solving	0.70	1	0.34	Problem Solving	0.76	1	0.35	0.76	No
		2	0.40			2	0.56	0.71	No
		3	0.38			3	0.54	0.71	No
		4	0.25			4	0.39	0.75	No
		5	0.44			5	0.62	0.69	No
		6	0.35			6	0.56	0.71	No
Personal/Social	0.52	1	0.18	Personal/Social	0.50	1	0.28	0.44	No
		2	0.37			2	0.11	0.62	No
		3	0.43			3	0.21	0.47	Yes
		4	0.29			4	0.51	0.36	No
		5	0.19			5	0.49	0.37	No
		6	0.29			6	0.22	0.47	No

Age Interval (in months)	Domain	Number of items modified between 2010-2011	Number of items with r < 0.30	
			N of items modified	N of items not modified
	Communication	1	-	-
	Gross Motor	-	-	-
10	Fine Motor	-	-	-
	Problem Solving	2	-	-
	Personal/Social	2	-	-
	Communication	1	-	-
	Gross Motor	-	-	-
12	Fine Motor	-	-	-
	Problem Solving	-	-	-
	Personal/Social	-	-	-
	Communication	-	-	-
	Gross Motor	-	-	-
14	Fine Motor	-	-	-
	Problem Solving	-	-	-
	Personal/Social	3	-	-
	Communication	-	-	-
	Gross Motor	-	-	-
16	Fine Motor	1	-	-
	Problem Solving	-	-	-
	Personal/Social	2	-	-
	Communication	-	-	-
	Gross Motor	-	-	-
18	Fine Motor	-	-	-
	Problem Solving	1	-	-
	Personal/Social	2	-	-
	Communication	1	-	1
	Gross Motor	-	-	-
20	Fine Motor	-	-	-
	Problem Solving	2	2	-
	Personal/Social	4	-	-
	Communication	1	-	2
	Gross Motor	-	-	1
22	Fine Motor	-	-	-
	Problem Solving	2	1	-
	Personal/Social	5	1	-
	Communication	-	-	1
	Gross Motor	2	-	1
24	Fine Motor	1	-	-
	Problem Solving	2	-	-
	Personal/Social	2	1	-
	Communication	-	-	-
	Gross Motor	2	1	-
27	Fine Motor	1	1	-
	Problem Solving	1	-	-
	Personal/Social	3	3	3
	Communication	1	-	1
	Gross Motor	1	-	1
30	Fine Motor	-	-	-
	Problem Solving	2	-	1
	Personal/Social	2	2	4
	Communication	-	-	1
	Gross Motor	1	1	5
33	Fine Motor	-	-	6
	Problem Solving	2	2	4
	Personal/Social	1	-	-
	Communication	-	-	1
36	Gross Motor	1	1	5
	Fine Motor	1	1	1

	Problem Solving	2	-	1
	Personal/Social	1	-	2
	Communication	-	-	-
	Gross Motor	-	-	1
42	Fine Motor	-	-	-
	Problem Solving	1	-	-
	Personal/Social	3	-	1
	Communication	-	-	-
	Gross Motor	-	-	1
48	Fine Motor	-	-	-
	Problem Solving	-	-	1
	Personal/Social	4	1	-
	Communication	-	-	-
	Gross Motor	-	-	-
54	Fine Motor	-	-	-
	Problem Solving	-	-	3
	Personal/Social	3	1	-
	Communication	-	-	6
	Gross Motor	-	-	2
60	Fine Motor	-	-	-
	Problem Solving	-	-	-
	Personal/Social	1	1	5
Total		71	20	62

Domain	Item	ASQ-BR 10 month	ASQ-BR 12 month	ASQ-BR 14 month	ASQ-BR 16 month	ASQ-BR 18 month	ASQ-BR 20 month	ASQ-BR 22 month	ASQ-BR 24 month	ASQ-BR 27 month	ASQ-BR 30 month	ASQ-BR 33 month	ASQ-BR 36 month	ASQ-BR 42 month	ASQ-BR 48 month	ASQ-BR 54 month	ASQ-BR 60 month	
		Factor 1	*Factor 1*	*Factor 1*	*Factor 1*	*Factor 1*	*Factor 1*	*Factor 1*	*Factor 1*	*Factor 1*	*Factor 1*	*Factor 1*	*Factor 1*	*Factor 1*	*Factor 1*	*Factor 1*	*Factor 1*	*Factor 2*
Communication	1	0.67	0.65	0.59	0.59	0.58	0.52	0.61	0.55	0.53	0.49	0.41	0.45	0.51	0.48	0.42	0.55	-
	2	0.74	0.75	0.81	0.70	0.71	0.77	0.59	0.64	0.59	0.64	0.70	0.62	0.59	0.62	0.69	0.61	-
	3	0.45	0.44	0.41	0.49	0.48	0.45	0.49	0.46	0.57	0.55	0.52	0.46	0.59	0.57	0.48	0.47	-
	4	0.33	0.33	0.29	0.30	0.49	0.36	0.55	0.41	0.39	0.36	0.30	0.34	0.46	0.43	0.38	0.40	-
	5	0.46	0.47	0.50	0.43	0.44	0.48	0.47	0.50	0.46	0.50	0.55	0.61	0.46	0.49	0.54	0.38	-
	6	0.46	0.45	0.42	0.51	0.49	0.46	0.41	0.38	0.47	0.46	0.43	0.38	0.49	0.47	0.40	0.48	-
Gross Motor Coordination	1	0.48	0.47	0.42	0.42	0.42	0.37	0.43	0.39	0.37	0.34	0.50	0.44	0.36	0.33	0.30	0.39	-
	2	0.34	0.35	0.38	0.32	0.33	0.36	0.37	0.40	0.37	0.40	0.44	0.50	0.37	0.39	0.44	0.67	-
	3	0.35	0.34	0.32	0.39	0.37	0.35	0.39	0.37	0.45	0.44	0.42	0.46	0.47	0.45	0.39	0.37	-
	4	0.48	0.47	0.43	0.43	0.42	0.38	0.35	0.32	0.30	0.28	0.31	0.28	0.39	0.37	0.33	0.40	-
	5	0.56	0.57	0.62	0.53	0.54	0.59	0.56	0.61	0.56	0.60	0.66	0.58	0.55	0.59	0.65	0.46	-
	6	0.90	0.88	0.82	0.98	0.95	0.90	0.78	0.31	0.38	0.38	0.37	0.46	0.43	0.41	0.35	0.93	-
Fine Motor Coordination	1	0.62	0.61	0.55	0.56	0.54	0.49	0.57	0.52	0.49	0.46	0.41	0.45	0.47	0.45	0.40	0.51	-
	2	0.73	0.75	0.81	0.70	0.71	0.77	0.59	0.64	0.59	0.63	0.73	0.65	0.58	0.62	0.69	0.60	-
	3	0.32	0.31	0.30	0.35	0.34	0.32	0.35	0.33	0.41	0.40	0.31	0.27	0.42	0.41	0.35	0.34	-
	4	0.65	0.64	0.57	0.58	0.57	0.51	0.64	0.58	0.56	0.52	0.65	0.74	0.53	0.50	0.45	0.53	-
	5	0.68	0.69	0.75	0.64	0.66	0.71	0.69	0.75	0.69	0.74	0.47	0.71	0.68	0.72	0.80	0.56	-
	6	0.70	0.68	0.64	0.76	0.74	0.70	0.61	0.58	0.71	0.69	0.53	0.47	0.73	0.71	0.60	0.73	-
Problem Solving	1	0.43	0.42	0.38	0.38	0.38	0.34	0.39	0.35	0.34	0.31	0.70	0.62	0.32	0.30	0.36	0.35	-
	2	0.81	0.82	0.89	0.77	0.78	0.85	0.88	0.96	0.51	0.55	0.31	0.35	0.88	0.53	0.81	0.67	-
	3	0.75	0.73	0.69	0.82	0.80	0.75	0.84	0.79	0.46	0.45	0.51	0.57	0.60	0.58	0.31	0.78	-
	4	0.70	0.69	0.62	0.63	0.61	0.55	0.51	0.46	0.44	0.41	0.40	0.36	0.42	0.40	0.79	0.58	-
	5	0.41	0.41	0.45	0.39	0.39	0.43	0.41	0.44	0.40	0.44	0.42	0.37	0.40	0.43	0.47	0.34	-
	6	0.76	0.73	0.69	0.82	0.80	0.75	0.90	0.85	0.43	0.42	0.40	0.45	0.37	0.36	0.53	0.78	-
Personal/Social	1	0.82	0.80	0.72	0.73	0.71	0.64	0.75	0.67	0.65	0.45	0.33	0.37	0.62	0.58	0.52	**0.57**	0.07
	2	0.40	0.40	0.44	0.38	0.38	0.41	0.32	0.34	0.32	0.72	0.59	0.53	0.32	0.33	0.37	**0.33**	0.02
	3	0.65	0.63	0.59	0.71	0.68	0.64	0.70	0.66	0.47	0.37	0.48	0.42	0.84	0.61	0.52	**0.67**	0.16
	4	0.34	0.33	0.30	0.30	0.31	0.46	0.35	0.53	0.41	0.71	0.44	0.50	0.30	0.38	0.34	0.28	**0.57**
	5	0.86	0.87	0.94	0.65	0.66	0.72	0.70	0.75	0.69	0.43	0.47	0.52	0.69	0.73	0.81	**0.52**	0.17
	6	0.92	0.89	0.84	0.66	0.64	0.60	0.53	0.50	0.61	0.79	0.45	0.40	0.63	0.61	0.52	0.03	**0.71**

Factorial

MINIMUM AVERAGE PARTIAL TEST (MAP)
Velicer (1976)

Communication

8 months

Dimensions	Averaged Partial
1	0.12563*
2	0.21405
3	0.99999

* Advised number of dimensions:　1

10 months

Dimensions	Averaged Partial
1	0.10508*
2	0.20734
3	0.99999

* Advised number of dimensions:　1

12 months

Dimensions	Averaged Partial
1	0.07464*
2	0.21265
3	0.99999

* Advised number of dimensions:　1

14 months

Dimensions	Averaged Partial
1	0.08029*
2	0.21323
3	0.99999

* Advised number of dimensions:　1

16 motnhs

Dimensions	Averaged Partial
1	0.22211*
2	0.25726
3	0.99999

* Advised number of dimensions: 1

18 months

Dimensions	Averaged Partial
1	0.22041*
2	0.23609
3	0.99999

* Advised number of dimensions: 1

20 months

Dimensions	Averaged Partial
1	0.06256*
2	0.23245
3	0.99999

* Advised number of dimensions: 1

22 months

Dimensions	Averaged Partial
1	0.06256*
2	0.23245
3	0.99999

* Advised number of dimensions: 1

24 months

Dimensions	Averaged Partial
1	0.07132*
2	0.30491
3	0.99999

* Advised number of dimensions: 1

27 months

Dimensions	Averaged Partial
1	0.07526*
2	0.24177
3	0.99999

* Advised number of dimensions: 1

30 months

Dimensions	Averaged Partial
1	0.05717*
2	0.23971
3	0.99999

* Advised number of dimensions: 1

33 months

Dimensions	Averaged Partial
1	0.04625*
2	0.27596
3	0.99999

* Advised number of dimensions: 1

36 months

Dimensions	Averaged Partial
1	0.05559*
2	0.24346
3	0.99999

* Advised number of dimensions: 1

42 months

Dimensions	Averaged Partial
1	0.05053*
2	0.24430
3	0.99999

* Advised number of dimensions: 1

48 months

Dimensions	Averaged Partial
1	0.05870*
2	0.25604
3	0.99999

* Advised number of dimensions: 1

54 months

Dimensions	Averaged Partial
1	0.06053*
2	0.24348
3	0.99999

* Advised number of dimensions: 1

60 months

Dimensions	Averaged Partial
1	0.18895*
2	0.46241
3	0.99999

* Advised number of dimensions: 1

MINIMUM AVERAGE PARTIAL TEST (MAP)
Velicer (1976)

Gross Motor

8 months

Dimensions	Averaged Partial
1	0.22939*
2	0.47987
3	2.19365
4	0.99999

* Advised number of dimensions: 1

10 months

Dimensions	Averaged Partial
1	0.11046*
2	0.22181
3	0.99999

* Advised number of dimensions: 1

12 months

Dimensions	Averaged Partial
1	0.10068*
2	0.24263
3	0.41138
4	0.99999

* Advised number of dimensions: 1

14 months

Dimensions	Averaged Partial
1	0.11879*
2	0.23322
3	0.99999

* Advised number of dimensions: 1

16 months

Dimensions	Averaged Partial
1	0.13804*
2	0.22894
3	0.99999

* Advised number of dimensions: 1

18 months

Dimensions	Averaged Partial
1	0.06575*
2	0.24135
3	0.93867
4	0.99999

* Advised number of dimensions: 1

20 months

Dimensions	Averaged Partial
1	0.06219*
2	0.23015
3	1.60308
4	0.99999

* Advised number of dimensions: 1

22 months

Dimensions	Averaged Partial
1	0.06456*
2	0.25812
3	0.99999

* Advised number of dimensions: 1

24 months

Dimensions	Averaged Partial
1	0.09639*
2	0.25101
3	0.99999

* Advised number of dimensions: 1

27 months

Dimensions	Averaged Partial
1	0.06449*
2	0.22566
3	0.99999

* Advised number of dimensions: 1

30 months

Dimensions	Averaged Partial
1	0.05033*
2	0.25913
3	0.83810
4	0.99999

* Advised number of dimensions: 1

33 months

Dimensions	Averaged Partial
1	0.13498*
2	0.25600
3	1.03778
4	0.99999

* Advised number of dimensions: 1

36 months

Dimensions	Averaged Partial
1	0.15858*
2	0.29831
3	0.84175
4	0.99999

* Advised number of dimensions: 1

42 months

Dimensions	Averaged Partial
1	0.06348*
2	0.20297
3	0.99999

* Advised number of dimensions: 1

48 months

Dimensions	Averaged Partial
1	0.07043*
2	0.22493
3	0.99999

* Advised number of dimensions: 1

54 months

Dimensions	Averaged Partial
1	0.05764*
2	0.22318
3	0.99999

* Advised number of dimensions: 1

60 months

Dimensions	Averaged Partial
1	0.06532*
2	0.24819
3	0.99999

* Advised number of dimensions: 1

MINIMUM AVERAGE PARTIAL TEST (MAP)
Velicer (1976)

Fine Motor

8 months

Dimensions	Averaged Partial
1	0.11703*
2	0.25087
3	0.99999

* Advised number of dimensions: 1

10 months

Dimensions	Averaged Partial
1	0.06276*
2	0.21458
3	0.99999

* Advised number of dimensions: 1

12 months

Dimensions	Averaged Partial
1	0.05653*
2	0.23178
3	0.99999

* Advised number of dimensions: 1

14 months

Dimensions	Averaged Partial
1	0.09794*
2	0.24456
3	0.99999

* Advised number of dimensions: 1

16 months

Dimensions	Averaged Partial
1	0.10950*
2	0.29648
3	0.99999

* Advised number of dimensions: 1

18 months

Dimensions	Averaged Partial
1	0.07780*
2	0.22199
3	0.99999

* Advised number of dimensions: 1

20 months

Dimensions	Averaged Partial
1	0.07974*
2	0.21132
3	0.40993
4	0.99999

* Advised number of dimensions: 1

22 months

Dimensions	Averaged Partial
1	0.06528*
2	0.22027
3	0.50879
4	0.99999

* Advised number of dimensions: 1

24 months

Dimensions	Averaged Partial
1	0.07861*
2	0.21589
3	0.99999

* Advised number of dimensions: 1

27 months

Dimensions	Averaged Partial
1	0.16635*
2	0.20941
3	0.99999

* Advised number of dimensions: 1

30 months

Dimensions	Averaged Partial
1	0.09757*
2	0.25924
3	1.#INF0
4	0.99999

* Advised number of dimensions: 1

33 months

Dimensions	Averaged Partial
1	0.16467*
2	0.44538
3	0.99999

* Advised number of dimensions: 1

36 months

Dimensions	Averaged Partial
1	0.15318*
2	0.34671
3	0.99999

* Advised number of dimensions: 1

42 months

Dimensions	Averaged Partial
1	0.07328*
2	0.22035
3	2.88648
4	0.99999

* Advised number of dimensions: 1

48 months

Dimensions	Averaged Partial
1	0.04335*
2	0.28169
3	0.49573
4	0.99999

* Advised number of dimensions: 1

54 months

Dimensions   Averaged Partial
  1   0.04596*
  2   0.21470
  3   0.99999

* Advised number of dimensions: 1

60 months

Dimensions   Averaged Partial
  1   0.05424*
  2   0.22141
  3   0.99999

* Advised number of dimensions: 1

MINIMUM AVERAGE PARTIAL TEST (MAP)
Velicer (1976)

Problem Solving

8 months

Dimensions	Averaged Partial
1	0.12563*
2	0.21405
3	0.99999

* Advised number of dimensions: 1

10 months

Dimensions	Averaged Partial
1	0.10508*
2	0.20734
3	0.99999

* Advised number of dimensions: 1

12 months

Dimensions	Averaged Partial
1	0.07464*
2	0.21265
3	0.99999

* Advised number of dimensions: 1

14 months

Dimensions	Averaged Partial
1	0.08029*
2	0.21323
3	0.99999

* Advised number of dimensions: 1

16 months

Dimensions	Averaged Partial
1	0.22211*
2	0.25726
3	0.99999

* Advised number of dimensions: 1

18 months

Dimensions	Averaged Partial
1	0.22041*
2	0.23609
3	0.99999

* Advised number of dimensions: 1

20 months

Dimensions	Averaged Partial
1	0.06256*
2	0.23245
3	0.99999

* Advised number of dimensions: 1

22 months

Dimensions	Averaged Partial
1	0.06256*
2	0.23245
3	0.99999

* Advised number of dimensions: 1

24 months

Dimensions	Averaged Partial
1	0.07132*
2	0.30491
3	0.99999

* Advised number of dimensions: 1

27 months

Dimensions	Averaged Partial
1	0.07526*
2	0.24177
3	0.99999

* Advised number of dimensions: 1

30 months

Dimensions	Averaged Partial
1	0.05717*
2	0.23971
3	0.99999

* Advised number of dimensions: 1

33 months

Dimensions	Averaged Partial
1	0.04625*
2	0.27596
3	0.99999

* Advised number of dimensions: 1

36 months

Dimensions	Averaged Partial
1	0.05559*
2	0.24346
3	0.99999

* Advised number of dimensions: 1

42 months

Dimensions	Averaged Partial
1	0.05053*
2	0.24430
3	0.99999

* Advised number of dimensions: 1

48 months

Dimensions	Averaged Partial
1	0.05870*
2	0.25604
3	0.99999

* Advised number of dimensions: 1

54 months

Dimensions	Averaged Partial
1	0.06053*
2	0.24348
3	0.99999

* Advised number of dimensions: 1

60 months

Dimensions	Averaged Partial
1	0.18895*
2	0.46241
3	0.99999

* Advised number of dimensions: 1

MINIMUM AVERAGE PARTIAL TEST (MAP)
Velicer (1976)

Personal/Social

8 months

Dimensions	Averaged Partial
1	0.22694*
2	0.43523
3	0.23455
4	0.99999

* Advised number of dimensions: 1

10 months

Dimensions	Averaged Partial
1	0.10441*
2	0.21426
3	0.99999

* Advised number of dimensions: 1

12 months

Dimensions	Averaged Partial
1	0.06890*
2	0.20505
3	0.99999

* Advised number of dimensions: 1

14 months

Dimensions	Averaged Partial
1	0.06570*
2	0.22763
3	0.39065
4	0.99999

* Advised number of dimensions: 1

16 months

Dimensions	Averaged Partial
1	0.06171*
2	0.22167
3	0.99999

* Advised number of dimensions: 1

18 months

Dimensions	Averaged Partial
1	0.06495*
2	0.22873
3	4.66617
4	0.99999

* Advised number of dimensions: 1

20 months

Dimensions	Averaged Partial
1	0.07423*
2	0.21822
3	0.99999

* Advised number of dimensions: 1

22 months

Dimensions	Averaged Partial
1	0.05402*
2	0.22039
3	0.99999

* Advised number of dimensions: 1

24 months

Dimensions	Averaged Partial
1	0.05090*
2	0.23412
3	0.99999

* Advised number of dimensions: 1

27 months

Dimensions	Averaged Partial
1	0.06380*
2	0.21402
3	0.99999

* Advised number of dimensions:　1

30 months

Dimensions	Averaged Partial
1	0.12261*
2	0.31100
3	0.26179
4	0.99999

* Advised number of dimensions:　1

33 months

Dimensions	Averaged Partial
1	0.07266*
2	0.21144
3	0.99999

* Advised number of dimensions:　1

36 months

Dimensions	Averaged Partial
1	0.06311*
2	0.21990
3	0.99999

* Advised number of dimensions:　1

42 months

Dimensions	Averaged Partial
1	0.07727*
2	0.24991
3	0.99999

* Advised number of dimensions:　1

48 months

Dimensions	Averaged Partial
1	0.05995*
2	0.25088
3	0.99999

* Advised number of dimensions: 1

54 months

Dimensions	Averaged Partial
1	0.06465*
2	0.23983
3	0.99999

* Advised number of dimensions: 1

60 months

Dimensions	Averaged Partial
1	0.23648
2	0.23554*
3	0.86362
4	0.99999

* Advised number of dimensions: 2