

## Identifying key aspects of the communicative capabilities of children with Rett syndrome

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**Abstract:** Indications of the communicative abilities of the Rett Syndrome (RTT) are distinct with impending speech-language and communication abilities; thus, assessment is challenging. This review aims to support the clinical work of speech-language pathologists (SLPs) while assessing the communication aptitudes of children with RTT. Adequate consideration should be given to their nonverbal skills since they can demonstrate suitable forms and functions in communication development. During this outlined assessment procedure, attention is drawn to medical and developmental history, informal and formal speech-language evaluation, and analysis of aided language samples while setting up intervention therapy objectives. The assessment procedure in this review describes current principles and methods for nonbiased, appropriate evaluation while providing a beneficial and suitable protocol for the comprehensive communication assessment of RTT.

**Keywords:** Rett Syndrome (RTT); Communication Assessment; Informal Assessment; Formal Assessment

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### 1.0 INTRODUCTION

An important part of Speech Language Pathologists' work is identifying and assessing the limitations in the communication of RTT children, which require support and intervention during their early learning development (Fu *et al.*, 2020). A reliable assessment can be beneficial for children with communication deficits to achieve speech and language milestones that would not have been otherwise achieved without early intervention. SLPs can use the information obtained during a comprehensive assessment to maximise their potential for a well-established therapeutic intervention (Vignoli *et al.*, 2010).

Rett syndrome (RTT) is a rare neurodevelopmental genetic disorder that causes intellectual and physical disability (Mackay *et al.*, 2017), occurring almost exclusively in girls. The signs and symptoms of RTT typically appear in 4 stages. These four stages are separated depending on the developmental phases that characterise RTT's progression: 1. Stagnation, 2. Regression, 3. Stationary, and 4. Motor Deterioration (Smeets *et al.*, 2012). Due to these stages, it is challenging to discover the symptoms during the early developmental stages of a child. The diagnosis is established by identifying the MECP2 mutation, which is causing impairments in the cognitive field, motor control, and a substantial weakening of communication

skills ([Fabio et al., 2018](#)). Since MECP2 mutation is responsible for other neurodevelopmental disorders, it is imperative to have a thorough diagnosis of the probable presence of RTT, with genetic screening for the MECP2 gene mutation or with the diagnostic criteria, or both ([Yang et al., 2021](#)).

The principal indicative diagnostic criteria should include: partial or complete loss of acquired purposeful hand skills and attained spoken language ([Dy et al., 2017](#)), gait abnormalities (impaired or absence of the ability to walk) ([Djukic et al., 2014](#)), hand wringing, squeezing, clapping ([Smeets et al., 2011](#)), tapping ([Nativ-Zeltzer et al., 2012](#)), mouthing, washing ([Dy et al., 2017](#)) and rubbing uncontrollably ([Sitholey et al., 2005](#)). Nevertheless, suggestive exclusion criteria like brain injury, secondary neurometabolic disease, severe infections that can cause neurological problems, and grossly abnormal psychomotor development during the first six months of life should also be considered ([Marschik et al., 2014](#); [Marschik et al., 2012](#)).

The diagnostic criteria were recently revised for children with RTT, considering three variants: the early seizure variant, the congenital variant, and the preserved speech variant ([Marschik et al., 2014](#)).

## 2.0 OVERVIEW AND AIMS

This review provides further guidance for SLPs in assessing the communication abilities of children with RTT while being able to differentiate the value of communicative intent. Its principal aim is to support speech and language/communication assessment of the potential communicative deficits and the presence of verbal or nonverbal characteristics in children with RTT. SLPs have noted competency in evaluating children with RTT, which is not derived only from the standardised assessment, but also from the clinical overview considerations. The specific aims of this review are as follows:

1. To provide guidelines for the speech and language assessment of children with RTT who present communicative intent abilities, albeit not verbal.
2. To identify key aspects and resources for the speech and language assessment of children with RTT with suspected communicative capabilities.
3. To indicate probable communicative intent skills supplied by implementing an AAC device or means of communication.

This review is aspirational, grounded in both currently available evidence-based literature on assessing speech

and language skills concerning RTT children with communicative intent skills.

## 2.1 Development of this review

Several families struggle to find speech-language pathologists (SLPs) and other communication experts who are knowledgeable in RTT since traditional ways of assessing speech-language and cognition depend on oral language and motor planning ([Wandin et al., 2015](#)). Due to their loss of oral speech and purposeful hand use, adaptations to formal and informal assessment tools and technical assistance are essential to facilitate accurate speech-language and cognitive communication functions ([Townend et al., 2015](#); [Wandin et al., 2015](#)). Thus, treatment planning should be associated with assessing the individual's present levels of functioning as well as their strengths and weaknesses ([Djukic et al., 2014](#)).

In order to overcome all the impediments mentioned above, therapeutic intervention is imperative, and such interventions should be provided to individuals with RTT, diagnosed with this rare neurodevelopmental genetic disorder that causes intellectual and physical disability ([Mackay et al., 2017](#)), and their families with utmost aptitude ([Stasolla et al., 2014](#)). For reliably assessing communication abilities, a baseline of approaches regarding identification and evaluation techniques should be implemented ([Fu et al., 2020](#)).

The complexities of assessing RTT children's speech-language and cognition have been discussed previously ([Fisher et al., 2019](#); [McLeod et al., 2013](#)) and include referral, assessment, intervention, training, and collaboration with parents and other professionals. SLPs have acknowledged competence in assessing children's speech-language and cognitive abilities for RTT. However, due to their difficulties in motor movement and planning, such as dystonia and dyspraxia, which impacts communication, it is necessary to consider all those mentioned above while performing the evaluation to make an accurate assessment ([Ward et al., 2021](#)).

## 2.2 Search strategy and data sources

In the current review, relevant databases were searched to find applicable resources and studies. Research articles were searched in PubMed and Google scholar databases published from 2006 to 2020. Several pieces of information regarding the RTT were extracted from the NCBI site. A total of 85 articles were selected for this review after a rigorous search regarding RTT and their communication assessment.

The following keywords were used for the search: "Communication assessment of RTT", "Informal assessment", "Formal assessment", "Communication skills", and "speech and language skills". Among these keywords, some were used independently, and some were used by combining more than one keyword. Consequently, four independent reviewers examined all the abstracts, and 39 articles were selected and retained for screening and reviewing against the communicative capabilities in RTT. Further bilateral revision confirmed the selection of the chosen 39 articles.

### 2.3 Study selection criteria

During the comprehensive search, research articles were screened, duplicates were disregarded, and 85 full articles were selected for review. The selection process of the research papers was based on whether the research paper offered the required information to meet the rationale of the review and how recent the publication year of the research paper was. Additionally, the inclusion criteria dealt with recognising the appropriateness of the information presented in the research. The criteria for inclusion in the study were as follows: all three keywords, thus, assessment, communication, and RTT needed to be presented in the titles of the research papers; SLPs should have administered speech-language assessment; use of standardised and non-standardised assessment tools and ACC evaluation. The exclusion criteria were also as follows: 3 articles not being in English; 21 not being relevant to the aim of the study; thus, the SLP being the evaluator in the communication assessment of RTT, three articles were not accessible in full text, and 19 articles did not report the communicative capabilities of RTT. Thirty-nine of these studies met the eligibility criteria and thus attended to Identifying key aspects of the communicative capabilities of children with RTT.

### 2.4 Data extraction and quality assessment

The narrative literature review was the most appropriate method for the study. This review article attempts to summarise a considerable volume of information in a specific field of communication and speech and language assessment by SLPs and provides a clear and explicit way to identify key aspects of communicative capabilities using both formal and informal assessment tools. The data collection method must follow a comprehensive search, and the quality assessment of articles was done methodologically by attending to the aims of the studies, title, chronological publication date and the procedure presented in the assessment guidelines.

## 3.0 DEVELOPMENT OF SPEECH-LANGUAGE ASSESSMENT

### 3.1 Communication Assessment of children with RTT

The main objective of a communication assessment is to recognise the possibility of any variance in a child's developmental growth chart by attending to the possible cognitive abilities ([Ahonniska-Assa et al., 2018](#)), learning skills, and visual-motor capabilities, along with all aspects of communication strengths ([Wandin et al., 2020](#)). Furthermore, close attention should be given to a child's medical and developmental history (case history) ([Percy, 2014](#)), along with functional assessment and review of assessment outcomes ([Byiers et al., 2014](#)), possible diagnosis, and objective settings ([Townend et al., 2020](#)). The establishment of common principles of communication assessment, as presented by the World Health Organization ([2001](#)) International Classification of Functioning, Disability, and Health, is necessary for a complete speech and language evaluation ([Westby & Washington, 2017](#)).

Evaluation of the communication skills of an individual should be done with the use of both standardised tools and non-standardised assessment tools ([Ronski et al., 2018](#)). Standardised assessments of speech, language, and cognition are likely to point to intellectual incapacity in individuals with RTT, and such assessments may not accurately reveal an individual's fundamental ability or communication and learning potential ([Bartolotta et al., 2011](#)). A dynamic assessment must be incorporated in combination with the aforementioned assessment methods, and this involves an ongoing evaluation that should not occur at a single moment in time but should be an ongoing, dynamic process ([Townend et al., 2020](#)).

Through this dynamic process, a series of prevailing behaviours are observed, such as eye gaze ([Ahonniska-Assa et al., 2018](#)), reaching, clapping ([Carter et al., 2009](#)), vocalisations ([Bartl-Pokorny et al., 2013](#)), body movements ([Marschik et al., 2012](#)), tantrums ([Percy, 2016](#)), hyperventilation ([Mackay et al., 2017](#)) and stereotyped hand mannerisms ([Stallworth et al., 2019](#)).

### 3.2 Non-Standardised assessment tools

#### 3.2.1 Medical and developmental intake

Upon completion of the input of the medical and developmental history of the RTT child, parents and caregivers should be encouraged to discuss and report on information regarding the loss of acquired skills such as verbal language, the use of hands, and gait abnormalities ([Ronski et al., 2018](#); [Percy, 2014](#)). The

RTT child's breathing form, sleeping habits, and developmental growth pattern should be considered ([Mackay et al., 2017](#)). Furthermore, information should be extracted on muscle tone, feeding and swallowing skills, stereotypical behaviours, inappropriate laughing or sound production, and how they interpret their child's eye communicative intent or eye-pointing requests take place ([Townend et al., 2020](#); [Percy, 2016](#)).

### **3.2.2 Functional assessment**

Marginally organised interviews with the child's parents and/or primary caregivers ([Byiers et al., 2014](#); [Didden et al., 2010](#)), unpremeditated observations, along with unintended interactions, will result in comparable functional analyses, which in return should be included in the well-designed speech and language assessments of children with RTT.

Since all parents habitually record family events, valid information can be collected through these audio–video recordings parents tend to keep, showing their child's growth and development while participating in everyday routines and special events ([Pokorny et al., 2016](#)). These recordings can be coded for the occurrence of potential communicative acts (e.g. body movements, turning to or moving towards a person, reaching, touching, and vocalisations, such as pleasure bursts, crying due to discomfort, babbling, proto-words, and facial expressions) ([Bartl-Pokorny et al., 2013](#)). Hence, the phases included in the coding procedure can derive from the Inventory of Potential Communicative Acts (IPCA) ([Bartl-Pokorny et al., 2013](#); [Didden et al., 2010](#)).

All potential communicative behaviours will be viewed as communication challenges and will be transcribed by two transcribers to guarantee accuracy and consistency. These transcriptions should deal with both verbal and nonverbal communicative forms and communicative functions and will be assigned based on the classification system of the IPCA ([Byiers et al., 2014](#)). These functions might include social convention, attention to self, rejection/protest, request object, request action or information, comment, choice-making, and imitation ([Marschik et al., 2014](#)). Subsequently, they can be classified into one of the two subcategories: non-linguistic and (pre-) linguistic vocalisations ([Roche et al., 2018](#)), considering that non-verbal behaviour can sometimes dominate over non-linguistic vocalisations as seen in the functional categories ([Pokorny et al., 2016](#)). The coding can be carried out using the Noldus Observer-XT device, the most complete behavioural research software ([Einspieler et al., 2013](#); [Townend et al., 2015](#)).

Given the aforementioned, the results indicate the presence of fifteen different behaviours that can be noted as communicative forms ([Neul et al., 2014](#)). These communicative forms can be divided into subcategories: body movements such as facial expression and eye gaze/movement, along with five different types of vocalisations and gestures ([Djukic et al., 2014](#)).

During the communication assessment, SLPs will precisely analyse the significance and the rate of the existence of certain age-specific vocalisations as described by proto-phones, proto-words, and first words ([Sigafos et al., 2011](#)). The frequency of their presence will be indicated by the calculation of the number of utterances that are produced per minute in either typical or atypical age-related vocalisations ([Roche et al., 2018](#)). Furthermore, during the evaluation procedure, the development, recognition, and use of single words and word combinations should be considered during the communication assessment, as seen in a child's second year of development ([Marschik et al., 2014](#)).

Researchers often describe their difficulty in assessing certain proto vowels (V) and proto consonants (C) in terms of CV-, CVC- or CCVC clusters ([Marschik et al., 2012](#)). Additionally, the intricacy in identifying the ratio denoted by the number of single (proto-first sounds to indicate verbal production) vowels and (proto) consonants or the number of compound clusters divided by the total number of vocalisations presented ([Einspieler et al., 2016](#)). Furthermore, the psychological lexicon can be evaluated via the use of spontaneous speech and parental input accounts, which can be inscribed in diaries and can be requested in discussions with parents ([Wandin et al., 2014](#)).

Any vegetative sounds such as sneezing and coughing are not necessarily included in the transcription: stable vocal signals such as crying and laughing can be mentioned only if they present an atypical high-pitched quality or laughing unsuitably, however, vegetative sounds such as sneezing and coughing should be given further consideration before being included ([Fu et al., 2020](#)). Moreover, divergent vocalisations, hand stereotypes, and share vocalisations can also be noted for potential inclusion in the assessment transcription ([Sigafos et al., 2011](#)).

Analysis should focus on spontaneous speech trials, vocalisations, and verbal utterances, which can be phonetically transcribed concerning the chronological

age of an RTT child ([Marschik et al., 2012](#)). The transcriptions can be analysed using the International Phonetic Alphabet (IPA) as phonetic approximations of a given utterance. However, if they are presented as unintelligible utterances, attention should be given to the reliability of use to confirm resolution ([De Felice et al., 2014](#)). An utterance is defined as a unit of speech specified by intonation or pause, but to maintain accuracy and consistency, a second transcriber can double-check the transcription ([Lotan & Ben-Zeev, 2006](#)). Lastly, the development of phonological clustering, lexical grouping, and breathy voice characteristics can be grouped using the final transcriptions and complete analyses ([Marschik et al., 2014](#)).

### 3.3 Standardised assessment tools

#### 3.3.1 Mullen scales

These early learning scales can be used effectively for assessment since they capture a wide age range (birth–68 months) and can evaluate skills across numerous domains of development while also facilitating the mapping of skill loss connected with RTT: for instance, Visual Reception (VR), Fine Motor (FM), Receptive Language (RL), and Expressive Language (EL) ([Bishop et al., 2011](#)). The Mullen Scales offer a different developmental age for each domain, letting clinicians track progress in exact areas. Adaptations will be implemented to reduce inter-domain misperceptions due to a child's impairments, thus receiving more accurate results. These can include allowing more time for responses, enlarging testing items, or even using motivational objects while accepting eye gaze as a valid response method, resulting in two versions: with (MSEL-ET) and without (MSEL-A). These adaptations can be made following the Standards for Psychological and Educational Testing accommodations ([Clarkson et al., 2017](#)).

#### 3.3.2 Inventory of Potential Communicative Acts (IPCA)

In an effort to assess the potential communicative forms and functions of existing pre-linguistic behaviours in individuals with severe disabilities, including individuals with RTT, ([Sigafos et al., 2011](#)) developed the Inventory of Potential Communicative Acts (IPCA). The IPCA is an instrument that can be administered to assess the forms and functions of communicative behaviour in RTT. It aims to recognise potential communicative acts or forms the RTT child may use for any of the ten communicative functions. These potential communicative acts are defined as any behaviours the informant has identified as being used by the RTT child for communicative purposes. The given categories, as described by the IPCA,

attend to social convention (e.g. 'How does your child greet you?'), attention to self (e.g. 'How does your child request your attention?'), reject/protest (e.g. 'What does your child do if a routine is disrupted?'), request an object (e.g. 'How does your child let you know that s/he wants something?'), request an action (e.g. 'How does your child let you know that s/he wants help with dressing?'), request information (e.g. 'How does your child let you know that s/he needs clarification if s/he does not understand?'), comment (e.g. 'How does your child let you know that s/he is happy?'), choice making (e.g. 'How does your child choose between two objects?'), answer (e.g., 'How does your child react when someone talks to him/her?'), and imitation (e.g. 'How does your child imitate something that you say or do?').

It should be noted that this inventory gives clinicians the ability to evaluate children who present extremely limited communicative and behavioural repertoires, such as eye gazing and/or body movements, but who may, on the other hand, retain some pre-linguistic acts that parents and teachers interpret as communicative ([Marschik et al., 2012](#); [Townend et al., 2015](#)). Therefore, these retained pre-linguistic acts could be viewed as having some communicative functions, which result in helping the RTT child become involved in greeting, conversing, requesting an object, protesting, and rejecting ([Lotan & Ben-Zeev, 2006](#)).

Didden et al. ([2009](#)) evaluated the communicative functions present in eight young women with RTT. Of these, six demonstrated some type of social interaction capability, while eye pointing was observed in only a few individuals, and expressions of communicative intent such as function were rare. Analyses revealed that communication abilities were not related to age, presence of epilepsy, and breathing difficulties; however, there was a significant positive correlation between communication ability, mobility, self-help skill, and a negative association between communication ability and oral motor dysfunction ([Bartl-Pokorny et al., 2013](#); [Sigafos et al., 2011](#)).

#### 3.3.3 The Peabody Picture Vocabulary Test (PPVT)

This standardised tool evaluates receptive language abilities, also known as receptive language acquisition skills. In each question, which comprises four pictures, the participant is asked to point to the target picture while adapting to the "My Tobii PC Eye tracking device", which is found to be a compatible grid for RTT children ([Ahonniska-Assa et al., 2018](#)). Picture plates remain identical to the original task and include four

separate pictures presented on a computer screen. The correct picture is placed in an unexpected position while the target word is verbally offered, and participants are asked to look at the corresponding picture ([Key et al., 2019](#)).

In the beginning, the child with RTT will be asked to look at each picture. Scanning of the pictures is confirmed by a visual cue and a red frame will appear around each of the four pictures, thus ensuring that the child has scanned all the pictures. The clinician will call out the target word, and the child will turn towards the matching picture and attend to it carefully while fixating their eyes ([Ahonniska-Assa et al., 2018](#)). The screen is divided into four quarters so that each option is located in the centre of the quarter, as originally designed. The options are widely spaced to allow sufficient fixation, but if the fixation duration surpasses the individual baseline fixation time, a green frame will appear, representing a completed choice ([Key et al., 2019](#)). The clinician will then point at the framed picture and ask the child whether the target word is appropriate for this picture. This will be done to verify the intentionality of choice, and the child will provide an answer indicating a comprehensible "yes" or "no". If the child gives an affirmative answer, the next question will be presented, but if the response is "no", a second trial for the same picture will be offered ([Sysoeva et al., 2020](#)). Since children with RTT can become overwhelmed by continuous eye gaze responses, the evaluation can often entail several assessment sessions ([Ahonniska-Assa et al., 2018](#)).

Since there are adequate calibration administration and validation processes, the chance of error due to visual impairment is low; however, the differences between performance levels of children with RTT seem to be mainly related to their cognitive ability. A potential cognitive assessment should be suggested only after proficient eye-tracking technology (ETT) is used in everyday communication. Such a procedure is suggested by Warschausky et al. ([2011](#)) in their study involving the measurement stability between the standard and modified versions of quadrant forced-choice format tests (i.e., PPVT), and it was reasoned suitable among children with severe motor and communication limitations. Although this research demonstrated a wider variance in the communicative ability of RTT children, it should be noted that these children must continually deal with several medical conditions that cause numerous functional restrictions, hence imposing on their emotional and cognitive status ([Ahonniska-Assa et al., 2018](#)).

### **3.3.4 Vineland adaptive behaviour scales**

The Vineland Adaptive Behaviour Scales are designed to assist in the diagnosis of intellectual and developmental disabilities in a semi-structured parent interview with the clinician while providing an overall assessment regarding the developmentally adaptive behaviours across various domains, even in children with RTT of all ages ([Einspieler et al., 2013](#)). These Scales cover the domains of receptive, expressive, and written communication, personal, domestic, and community daily living, interpersonal relationships, play skills, coping and social skills, and gross and fine motor skills ([Vignoli et al., 2010](#)). Due to the appearance of moderate to severe motor impairment seen in children with RTT, along with the wide age range of learning and attaining daily routine skills, this domain of daily living can be excluded from the assessment, although it has been suggested that communication and socialisation skills should be evaluated individually, calculating a composite score as an aptitude of the average score between communication and socialisation skills ([Kaufmann et al., 2011](#)).

### **3.3.5 Communication Matrix**

While the Communication Matrix database was initially designed and created to assess early communication development, it can be used to diagnose the communication abilities of children with RTT, as long as this diagnosis is subsequently confirmed ([Brady et al., 2016](#)). The Communication Matrix communication skills assessment entails any type of communicative behaviour. These include alternative forms such as picture systems, electronic devices, voice-output methods, Braille, sign language and 3-dimensional symbols, pre-symbolic communication such as gestures, body movements, sounds, eye gaze, and facial expressions, as well as typical forms of communication, such as speech and writing ([Rowland & Fried-Oken, 2010](#)). It covers seven levels of development taking place during the earliest stages of communication in typically emerging individuals. These profiles allow the comparison of the information obtained from home, school, or clinic settings while providing a comprehensive portrait of a child's communication skills. This evaluation tool would also operationalise a socio-pragmatic approach to early communication development that underlines the functional uses of communication in a social world ([De Felice et al., 2014](#)).

### 3.4 AAC assessment

Further assistance in developing communication assessment guidelines for individuals diagnosed with RTT should be considered regarding the use of different components found and used by the child in terms of either their aided or unaided Alternative or Augmentative Communication system (AAC) ([Creer et al., 2016](#)). Using the guidelines recognised by the AAC, its implementation and practices can be crucial for developing verbal and nonverbal communication abilities. Components of AAC assessment can be described and necessary implementation models for best practice can be offered: for example, the six-step process ([Dietz et al., 2012](#)), the participation model ([Mirenda, 2014](#)), and the communicative competence model ([Light & McNaughton, 2014](#); [Townend et al., 2020](#)).

Subsequently, using AAC strategies is a probable solution providing more conventional communication forms needed for assessment purposes while compensating for the weakened motor function seen in children with RTT ([Djukic et al., 2014](#)). Thus, nonverbal communication forms can include unaided responses such as gestures, signs, and vocalisations; technology-aided responses, such as using pictures, 2D symbols, and 3D objects; and the use of speech-generating devices (SGD) and computer-based interfaces ([Mirenda, 2014](#)). Unassisted communication forms are often too difficult for many individuals with RTT due to the concomitant severe motor deterioration and the high motor effort needed in the engagement of gestures or signs. An imperative feature of intervention scheduling with aided communication systems could comprise selecting a viable response form for the child with RTT to have adequate motor control ([Mirenda, 2014](#)). Communication forms that have been examined experimentally range from low technology, thus, including (a) eye-gaze with a choice board, which may be limited due to its context-dependence and must be interpreted by the caregiver ([Townend et al., 2015](#)), (b) picture exchange communication systems (PECS) ([Stasolla et al., 2014](#)), and (c) micro switches ([Byiers et al., 2014](#)), to high technology, including (a) computer touch-screen and (b) voice output device ([Stasolla et al., 2014](#)). Hence, using this communicative strategy is vital since symbols must be relatively far apart to guarantee an accurate interpretation by the listener.

One rather recent advance concerning aided AAC options involves using a high-technology eye-gaze interface with (SGDs) (Higginbotham et al., 2007). An SGD utilising an eye-gaze interface measures the

duration of an individual's fixed gaze on a symbol ([Simacek et al., 2015](#)).

Numerous techniques assisted by individualised strategies should be encouraged, although the use of identifying eye gaze is likely to be the most reliable source of access to communication forms by either using low- or high-tech AAC with RTT children ([Bartolotta et al., 2011](#)). The already-known AAC system will allow children with RTT to indicate their autonomous capabilities. These consensus-based guidelines are a valuable way to evaluate the communication capabilities of these individuals further while underpinning the need for the inclusion of AAC systems in assessment ([Townend et al., 2015](#)).

### 3.5 Formal & informal assessment tools combined

Eye gaze, and eye tracking technology, provide an access method that can facilitate the delivery of both formal and informal assessment tasks and offer opportunities to engage in learning and communication. As Ward et al. ([2021](#)) demonstrated in their study trying to investigate and compare the performance of children with RTT on formal and informal assessments of visual reception, receptive and expressive language assessments can be adapted for eye gaze access. The assessments delivered using eye gaze and eye tracking technology can reveal a broad range of cognitive abilities within a small test sample. It was also revealed that bringing together low-tech augmentative and alternative communication, eye gaze technology, informal activities, and formal assessment generates greater insight into children's abilities than employing formal assessments alone. Some individuals had a better response to informal assessments, others on formal, and combined, a better picture of an individual was formed. This study validates the imperative for assessments to be adapted to meet an individual's physical and verbal limitations; thus, hidden cognitive abilities can be revealed, and an individual can be supported most appropriately and efficiently to supplement their learning and communication ([Armstrong et al., 2020](#)).

### 3.6 Strategies to optimise assessment

The information gained from the consensus-based guidelines for managing the communication of individuals with RTT is generally accepted and evidence-based. However, the matter on hand is the disadvantages of such implementations, such as funds, location, and training ([Wandin et al., 2020](#)). This review is proposed to address the following areas explored by Townend et al. ([2020](#)), eliminating the need to seek

knowledge from only a few RTT expert professionals. It is also suggested that training based on this review should be mandatory for all SLPs before initiating the assessment procedure for RTT individuals ([Sysoeva et al., 2020](#)).

Townend et al. ([2015](#)) developed international consensus-based guidelines for managing the communication of individuals with RTT by combining available evidence, lived experience, and expert opinion. Many phases and sections are referred to in the original study up to an extent. One of those sections is "Professional practice" ([Bartolotta et al., 2011](#)). This section explores the responsibilities obligatory on professionals and their employers to cultivate awareness and competency, stating that professionals who are not experienced in working with individuals with RTT must pursue training in associated matters and seek guidance and support from colleagues with more focused knowledge and expertise in the field ([Wandin et al., 2020](#)). It also states that to get a diagnosis, a referral to an RTT specialist is highly advisable (for a specialised assessment) ([Percy, 2016](#)).

#### 4.0 CONCLUSION AND IMPLICATIONS

Considering the necessity to create a reliable and accurate assessment of communicative intent, potential sources of information such as medical records, parent reports, and video recordings noting RTT child development and clinical observations should be used together with developmental history, along with their current functioning. Alongside clinical assessment and observation, standardised methods and specific assessment tools will add information to the unique RTT profile ([Barnes et al., 2015](#)).

The motivation for this review article was to support the assessing and managing for the assessment and management of communication impairments in children with RTT. Although we have provided a clinical description, it is evident from the literature that there are areas requiring further research to establish evidence-based management for children with RTT.

This review gives an overview of methods and techniques to assess communication with an RTT child. Communication assessment tools are suggested based on the current literature. However, no assessment protocol is specifically designed to monitor the progression of communication impairments in children with RTT.

In order to facilitate both formal and informal assessment tasks and open up opportunities to engage in learning and communication, a standardised assessment protocol is necessarily and reasonably challenging, particularly for establishing receptive and expressive language performance, especially when RTT children have little or no oral speech. However, different children respond to different assessment styles, suggesting we cannot generalise optimal methods for assessing all children with RTT ([Ward et al., 2021](#)). Awareness of the communicative abilities of RTT children is imminent and plays a significant role in the ability to assess the communicative intent of the child with RTT accurately, but subsequently, so are assessment tools. This study validates the imperative for assessments to be adapted to meet an individual's physical and verbal limitations.

The significance of this review for SLPs and caregivers of individuals with RTT is to employ an assessment-guided protocol to identify each child's knowledge and potential as accurately as possible and further use this information to provide learning at a level and pace that is correct for that child. Consequently, the assessment of communicative forms and functions can be carried out using both standardised and formal assessment tools necessary for each child with RTT to obtain a better picture of their communication capabilities. Bearing this in mind, clinicians can assess social convention skills, self-attention, rejection of unwanted items and situations, and the ability to request an object, an action, or even information, alongside commenting abilities, choice-making, and responding to everyday requests. Subsequently, knowledge of the individual's communication style, ample assessment time, and technological tools are needed to generate reliable communication evaluation results. Furthermore, verbal children's vocalisations and nonverbal communicative behaviours can be transcribed using their chronological age ([Fabio et al., 2019](#); [Marschik et al., 2014](#)). Given the important role, SLPs undertake in managing people with progressive neurological conditions, such as RTT, it is worth considering the development of an assessment tool sufficiently sensitive to detect mild language impairment at an early stage and to measure change over time. The ultimate goal is to facilitate all those with RTT to become more autonomous in communication ([Van Acker, 1991](#)).

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genetic disorder. AP collected the literature and set up the development and overview of the aims of this review while identifying necessary information regarding the speech-language assessment procedures. RG contributed to understanding the essential assessment tools and identifying the means of verbal and nonverbal skills of RTT children. AP did the final revisions of this review and wrote the paper.

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## References

- Ahonniska-Assa, J., Polack, O., Saraf, E., Wine, J., Silberg, T., Nissenkorn, A., & Ben-Zeev, B. (2018). Assessing cognitive functioning in females with Rett syndrome by eye-tracking methodology. *European Journal of Paediatric Neurology*, 22(1), 39–45. <https://doi.org/10.1016/j.ejpn.2017.09.010>
- Barnes, K. V., Coughlin, F. R., O'Leary, H. M., Bruck, N., Bazin, G. A., Beinecke, E. B., Kaufmann, W. E. (2015). Anxiety-like behavior in Rett syndrome: Characteristics and assessment by anxiety scales. *Journal of Neurodevelopmental Disorders*, 7(1), 30. <https://doi.org/10.1186/s11689-015-9127-4>
- Bartl-Pokorny, K. D., Marschik, P. B., Sigafos, J., Tager-Flusberg, H., Kaufmann, W. E., Grossmann, T., & Einspieler, C. (2013). Early socio-communicative forms and functions in typical Rett syndrome. *Research in Developmental Disabilities*, 34(10), 3133–3138. <https://doi.org/10.1016/j.ridd.2013.06.040>
- Bartolotta, T. E., Zipp, G. P., Simpkins, S. D., & Glazewski, B. (2011). Communication Skills in Girls With Rett Syndrome. *Focus on Autism and Other Developmental Disabilities*, 26(1), 15–24. <https://doi.org/10.1177/1088357610380042>
- Bishop, S. L., Guthrie, W., Coffing, M., & Lord, C. (2011). Convergent validity of the Mullen Scales of Early Learning and the Differential Ability Scales in children with autism spectrum disorders. *American Journal on Intellectual and Developmental Disabilities*, 116(5), 331–343. <https://doi.org/10.1352/1944-7558-116.5.331>
- Brady, N. C., Bruce, S., Goldman, A., Erickson, K., Mineo, B., Ogletree, B. T., Wilkinson, K. (2016). Communication services and supports for individuals with severe disabilities: Guidance for assessment and intervention. *American Journal on Intellectual and Developmental Disabilities*, 121(2), 121–138. <https://doi.org/10.1352/1944-7558-121.2.121>
- Byiers, B. J., Dimian, A., & Symons, F. J. (2014). Functional communication training in rett syndrome: A preliminary study. *American Journal on Intellectual and Developmental Disabilities*, 119(4), 340–350. <https://doi.org/10.1352/1944-7558-119.4.340>
- Caesar, L. G., & Kohler, P. D. (2007). The State of School-Based Bilingual Assessment: Actual Practice Versus Recommended Guidelines. *Language, Speech, and Hearing Services in Schools*, 38(3), 190–200. [https://doi.org/10.1044/0161-1461\(2007/020\)](https://doi.org/10.1044/0161-1461(2007/020))
- Carter, P., Downs, J., Bebbington, A., Williams, S., Jacoby, P., Kaufmann, W. E., & Leonard, H. (2010). Stereotypical hand movements in 144 subjects with Rett syndrome from the population-based Australian database. *Movement Disorders*, 25(3), 282–288. <https://doi.org/10.1002/mds.22851>
- Clarkson, T., LeBlanc, J., DeGregorio, G., Vogel-Farley, V., Barnes, K., Kaufmann, W. E., & Nelson, C. A. (2017). Adapting the mullen scales of early learning for a standardised measure of development in children with rett syndrome. *Intellectual and Developmental Disabilities*, 55(6), 419–431. <https://doi.org/10.1352/1934-9556-55.6.419>
- Creer, S., Enderby, P., Judge, S., & John, A. (2016). Prevalence of people who could benefit from augmentative and alternative communication (AAC) in the UK: determining the need. *International Journal of Language & Communication Disorders*, 51(6), 639–653. <https://doi.org/10.1111/1460-6984.12235>
- De Felice, C., Della Ragione, F., Signorini, C., Leoncini, S., Pecorelli, A., Ciccoli, L., D'Esposito, M. (2014). Oxidative brain damage in Mecp2-mutant murine models of Rett syndrome. *Neurobiology of Disease*, 68(100), 66–77. <https://doi.org/10.1016/j.nbd.2014.04.006>
- Didden, R., Korzilius, H., Smeets, E., Green, V. A., Lang, R., Lancioni, G. E., & Curfs, L. M. (2010). Communication in individuals with Rett syndrome: An assessment of forms and functions. *Journal of Developmental and Physical Disabilities*, 22(2), 105–118. <https://doi.org/10.1007/s10882-009-9168-2>
- Dietz, A., Quach, W., Lund, S. K., & McKelvey, M. (2012). AAC assessment and clinical-decision Making: The impact of experience. *AAC: Augmentative and Alternative Communication*, 28(3), 148–159. <https://doi.org/10.3109/07434618.2012.704521>
- Djukic, A., Rose, S. A., Jankowski, J. J., & Feldman, J. F. (2014). Rett syndrome: Recognition of facial expression and its relation

- to scanning patterns. *Pediatric Neurology*, 51(5), 650–656. <https://doi.org/10.1016/j.pediatrneurol.2014.07.022>
- Dy, M. E., Waugh, J. L., Sharma, N., O'Leary, H., Kapur, K., D'Gama, A. M., Kaufmann, W. E. (2017). Defining Hand Stereotypies in Rett Syndrome: A Movement Disorders Perspective. *Pediatric Neurology*, 75, 91–95. <https://doi.org/10.1016/j.pediatrneurol.2017.05.025>
- Einspieler, C., Bos, A. F., Libertus, M. E., & Marschik, P. B. (2016). The general movement assessment helps us to identify preterm infants at risk for cognitive dysfunction. *Frontiers in Psychology*, 7, 406. <https://doi.org/10.3389/FPSYG.2016.00406/BIBTEX>
- Einspieler, C., Marschik, P. B., Domingues, W., Talisa, V. B., Bartl-Pokorny, K. D., Wolin, T., & Sigafoos, J. (2014). Monozygotic Twins with Rett Syndrome: Phenotyping the First Two Years of Life. *Journal of Developmental and Physical Disabilities*, 26(2), 171–182. <https://doi.org/10.1007/s10882-013-9351-3>
- Fabio, R. A., Gangemi, A., Capri, T., Budden, S., & Falzone, A. (2018). Neurophysiological and cognitive effects of Transcranial Direct Current Stimulation in three girls with Rett Syndrome with chronic language impairments. *Research in Developmental Disabilities*, 76, 76–87. <https://doi.org/10.1016/j.ridd.2018.03.008>
- Fabio, R. A., Giannatiempo, S., & Capri, T. (2019). Attention and identification of the same and the similar visual stimuli in Rett Syndrome. *Life Span and Disability*, 1, 113–127.
- Fisher, E. L., Barton-Hulsey, A., Walters, C., Sevcik, R. A., & Morris, R. (2019). Executive Functioning and Narrative Language in Children With Dyslexia. *American Journal of Speech-Language Pathology*, 28(3), 1127. [https://doi.org/10.1044/2019\\_AJSLP-18-0106](https://doi.org/10.1044/2019_AJSLP-18-0106)
- Fu, C., Armstrong, D., Marsh, E., Lieberman, D., Motil, K., Witt, R., Benke, T. (2020). Consensus guidelines on managing Rett syndrome across the lifespan. *BMJ Paediatrics Open*, 4(1), e000717. <https://doi.org/10.1136/BMJPO-2020-000717>
- Higginbotham, D. J., Shane, H., Russell, S., & Caves, K. (2007). Access to AAC: Present, past, and future. *AAC: Augmentative and Alternative Communication*, 23(3), 243–257. <https://doi.org/10.1080/07434610701571058>
- Kaufmann, W. E., Tierney, E., Rohde, C. A., Suarez-Pedraza, M. C., Clarke, M. A., Salorio, C. F., Naidu, S. (2012). Social impairments in Rett syndrome: Characteristics and relationship with clinical severity. *Journal of Intellectual Disability Research*, 56(3), 233–247. <https://doi.org/10.1111/j.1365-2788.2011.01404.x>
- Key, A. P., Jones, D., & Peters, S. (2019). Spoken Word Processing in Rett Syndrome: Evidence from Event-Related Potentials. *International Journal of Developmental Neuroscience : The Official Journal of the International Society for Developmental Neuroscience*, 73, 26. <https://doi.org/10.1016/J.IJDEVNEU.2019.01.001>
- Light, J., & McNaughton, D. (2014). Communicative Competence for Individuals who require Augmentative and Alternative Communication: A New Definition for a New Era of Communication? *Augmentative and Alternative Communication*, 30(1), 1–18. <https://doi.org/10.3109/07434618.2014.885080>
- Lotan, M., & Ben-Zeev, B. (2006). Rett syndrome. A review with emphasis on clinical characteristics and intervention. *The Scientific World Journal*, 6, 1517–1541. <https://doi.org/10.1100/tsw.2006.249>
- MacKay, J., Downs, J., Wong, K., Heyworth, J., Epstein, A., & Leonard, H. (2017). Autonomic breathing abnormalities in Rett syndrome: Caregiver perspectives in an international database study. *Journal of Neurodevelopmental Disorders*, 9(1). <https://doi.org/10.1186/s11689-017-9196-7>
- Marschik, P. B., Pini, G., Bartl-Pokorny, K. D., Duckworth, M., Gugatschka, M., Vollmann, R., Einspieler, C. (2012). Early speech-language development in females with Rett syndrome: Focusing on the preserved speech variant. *Developmental Medicine and Child Neurology*, 54(5), 451–456. <https://doi.org/10.1111/j.1469-8749.2012.04123.x>
- Marschik, P. B., Sigafoos, J., Kaufmann, W. E., Wolin, T., Talisa, V. B., Bartl-Pokorny, K. D., Einspieler, C. (2012). Peculiarities in the gestural repertoire: An early marker for Rett syndrome? *Research in Developmental Disabilities*, 33(6), 1715–1721. <https://doi.org/10.1016/j.ridd.2012.05.014>
- Marschik, P. B., Vollmann, R., Bartl-Pokorny, K. D., Green, V. A., Van Der Meer, L., Wolin, T., & Einspieler, C. (2014). Developmental profile of speech-language and communicative functions in an individual with the Preserved Speech Variant of Rett syndrome. *Developmental Neurorehabilitation*, 17(4), 284–290. <https://doi.org/10.3109/17518423.2013.783139>
- McLeod, F., Ganley, R., Williams, L., Selfridge, J., Bird, A., & Cobb, S. R. (2013). Reduced seizure threshold and altered network oscillatory properties in a mouse model of Rett syndrome. *Neuroscience*, 231, 195–205. <https://doi.org/10.1016/J.NEUROSCIENCE.2012.11.058>
- Mirenda, P. (2014). Revisiting the mosaic of supports required for including people with severe intellectual or developmental disabilities in their communities. *AAC: Augmentative and Alternative Communication*, 30(1), 19–27. <https://doi.org/10.3109/07434618.2013.875590>
- Nativ-Zeltzer, N., Kahrilas, P. J., & Logemann, J. A. (2012). Manofluorography in the Evaluation of Oropharyngeal Dysphagia. *Dysphagia*, 27(2), 151–161. <https://doi.org/10.1007/s00455-012-9405-1>
- Neul, J. L., Lane, J. B., Lee, H. S., Geerts, S., Barrish, J. O., Annese, F., Percy, A. K. (2014). Developmental delay in Rett syndrome: Data from the natural history study. *Journal of Neurodevelopmental Disorders*, 6(1), 1–9. <https://doi.org/10.1186/1866-1955-6-20>

- Percy, A. (2014). The American history of rett syndrome. *Pediatric Neurology*, 50(1), 1–3. <https://doi.org/10.1016/j.pediatrneurol.2013.08.018>
- Percy, A. K. (2016). Progress in Rett Syndrome: from discovery to clinical trials. *Wiener Medizinische Wochenschrift*, 166(11–12), 325–332. <https://doi.org/10.1007/s10354-016-0491-9>
- Pokorny, F. B., Marschik, P. B., Einspieler, C., & Schuller, B. W. (2016). Does She Speak RTT? Towards an Earlier Identification of Rett Syndrome Through Intelligent. *Interspeech*, 1953–1957. <https://doi.org/10.21437/Interspeech.2016-520>
- Roche, L., Zhang, D., Bartl-Pokorny, K. D., Pokorny, F. B., Schuller, B. W., Esposito, G., Marschik, P. B. (2018). Early Vocal Development in Autism Spectrum Disorder, Rett Syndrome, and Fragile X Syndrome: Insights from Studies Using Retrospective Video Analysis. *Advances in Neurodevelopmental Disorders*, 2(1), 49–61. <https://doi.org/10.1007/s41252-017-0051-3>
- Romski, M. A., Bornman, J., Sevcik, R. A., Tönsing, K., Barton-Hulsey, A., Morwane, R., White, R. (2018). Language assessment for children with a range of neurodevelopmental disorders across four languages in South Africa. *American Journal of Speech-Language Pathology*, 27(2), 602–615. [https://doi.org/10.1044/2017\\_AJSLP-17-0035](https://doi.org/10.1044/2017_AJSLP-17-0035)
- Rowland, C., & Fried-Oken, M. (2010). Communication Matrix: A clinical and research assessment tool targeting children with severe communication disorders. *Journal of Pediatric Rehabilitation Medicine*, 3(4), 319–329. <https://doi.org/10.3233/PRM-2010-0144>
- Sandberg, A. D., Ehlers, S., Hagberg, B., & Gillberg, C. (2000). The Rett Syndrome Complex. *Autism*, 4(3), 249–267. <https://doi.org/10.1177/1362361300004003003>
- Sigafoos, J., Kagohara, D., Van Der Meer, L., Green, V. A., O'Reilly, M. F., Lancioni, G. E., Zisimopoulos, D. (2011). Communication assessment for individuals with Rett syndrome: A systematic review. *Research in Autism Spectrum Disorders*, 5(2), 692–700. <https://doi.org/10.1016/j.rasd.2010.10.006>
- Simacek, J., Reichle, J., & McComas, J. J. (2016). Communication Intervention to Teach Requesting Through Aided AAC for Two Learners With Rett Syndrome. *Journal of Developmental and Physical Disabilities*, 28(1), 59–81. <https://doi.org/10.1007/s10882-015-9423-7>
- Sitholey, P., Agarwal, V., & Srivastava, R. (2005). Rett syndrome. *Indian Journal of Psychiatry*, 47(2), 116. <https://doi.org/10.4103/0019-5545.55959>
- Smeets, E. E. J., Pelc, K., & Dan, B. (2012). Rett syndrome. *Molecular Syndromology*, 2(3–5), 113–127. <https://doi.org/10.1159/000337637>
- Stallworth, J. L., Dy, M. E., Buchanan, C. B., Chen, C. F., Scott, A. E., Glaze, D. G., Kaufmann, W. E. (2019). Hand stereotypies: Lessons from the Rett Syndrome Natural History Study. *Neurology*, 92(22), E2594–E2603. <https://doi.org/10.1212/WNL.0000000000007560>
- Stasolla, F., De Pace, C., Damiani, R., Di Leone, A., Albano, V., & Perilli, V. (2014). Comparing PECS and VOCA to promote communication opportunities and to reduce stereotyped behaviors by three girls with Rett syndrome. *Research in Autism Spectrum Disorders*, 8(10), 1269–1278. <https://doi.org/10.1016/j.rasd.2014.06.009>
- Sysoeva, O. V., Molholm, S., Djukic, A., Frey, H. P., & Foxe, J. J. (2020). Atypical processing of tones and phonemes in Rett Syndrome as biomarkers of disease progression. *Translational Psychiatry*, 10(1). <https://doi.org/10.1038/S41398-020-00877-4>
- Townend, G. S., Bartl-Pokorny, K. D., Sigafoos, J., Curfs, L. M. G., Bölte, S., Poustka, L., Marschik, P. B. (2015). Comparing social reciprocity in preserved speech variant and typical Rett syndrome during the early years of life. *Research in Developmental Disabilities*, 43–44, 80–86. <https://doi.org/10.1016/J.RIDD.2015.06.008>
- Townend, G. S., Bartolotta, T. E., Urbanowicz, A., Wandin, H., & Curfs, L. M. G. (2020). Development of consensus-based guidelines for managing communication of individuals with Rett syndrome. *AAC: Augmentative and Alternative Communication*, 36(2), 71–81. <https://doi.org/10.1080/07434618.2020.1785009>
- Townend, G. S., Marschik, P. B., Smeets, E., van de Berg, R., van den Berg, M., & Curfs, L. M. G. (2016). Eye Gaze Technology as a Form of Augmentative and Alternative Communication for Individuals with Rett Syndrome: Experiences of Families in The Netherlands. *Journal of Developmental and Physical Disabilities*, 28(1), 101–112. <https://doi.org/10.1007/s10882-015-9455-z>
- Van Acker, R. (1991). Rett syndrome: A review of current knowledge. *Journal of Autism and Developmental Disorders*, 21(4), 381–406. <https://doi.org/10.1007/BF02206866>
- Vignoli, A., Fabio, R. A., La Briola, F., Giannatiempo, S., Antonietti, A., Maggiolini, S., & Canevini, M. P. (2010). Correlations between neurophysiological, behavioral, and cognitive function in Rett syndrome. *Epilepsy and Behavior*, 17(4), 489–496. <https://doi.org/10.1016/j.yebeh.2010.01.024>
- Wandin, H., Lindberg, P., & Sonnander, K. (2015). Communication intervention in Rett syndrome: a survey of speech language pathologists in Swedish health services. *Disability and Rehabilitation*, 37(15), 1324–1333. <https://doi.org/10.3109/09638288.2014.962109>
- Wandin, H., Lindberg, P., & Sonnander, K. (2020). Development of a tool to assess visual attention in Rett syndrome: a pilot study. *Augmentative and Alternative Communication*, 36(2), 118–127. <https://doi.org/10.1080/07434618.2020.1798507>

- Ward, C., Chiat, S., & Townend, G. S. (2021). A comparison of formal and informal methods for assessing language and cognition in children with Rett syndrome. *Research in Developmental Disabilities, 114*, 103961. <https://doi.org/10.1016/J.RIDD.2021.103961>
- Warschausky, S., van Tubbergen, M., Asbell, S., Kaufman, J., Ayyangar, R., & Donders, J. (2012). Modified Test Administration Using Assistive Technology: Preliminary Psychometric Findings. *Assessment, 19*(4), 472–479. <https://doi.org/10.1177/1073191111402458>
- Westby, C., & Washington, K. N. (2017). Using the International Classification of Functioning, Disability and Health in Assessment and Intervention of School-Aged Children With Language Impairments. *Language, Speech, and Hearing Services in Schools, 48*(3), 137–152. [https://doi.org/10.1044/2017\\_LSHSS-16-0037](https://doi.org/10.1044/2017_LSHSS-16-0037)
- Yang, D., Robertson, H. L., Condliffe, E. G., Carter, M. T., Dewan, T., & Gnanakumar, V. (2020). Rehabilitation therapies in Rett syndrome across the lifespan: A scoping review of human and animal studies. *Journal of Pediatric Rehabilitation Medicine, 14*(1), 69-96. <https://doi.org/10.3233/prm-200683>