***Communication Matrix*: Description, Research Basis and Data**

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Overview

The *Communication Matrix* (Rowland, 1990, 1996, 2004, 2011; Rowland & Fried-Oken, 2010) is a communication skills assessment that was first published in 1990 and revised in 1996 and 2004. The *Matrix* accommodates *any* type of communicative behavior, including alternative forms (such as picture systems, electronic devices, voice-output systems, 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). It covers seven levels of development occurring during the earliest stages of communication in typically developing individuals.

The original version of the *Matrix* was designed primarily for use by speech-language pathologists and educators. It is sold at cost through www.designtolearn.org. A more "user friendly" version, designed especially for parents, was published in 2004 in response to requests from the field. The results of both professional and parent versions are summarized on a one-page Profile that shows what level of communicative behaviors the child uses and what kinds of messages, or communicative intents, are expressed. These profiles allow parents and professionals to directly compare the information they have from home, school or clinic to provide a comprehensive portrait of a child's communication skills.

The Communication *Matrix* was developed as an assessment tool that would operationalize a socio-pragmatic approach to early communication development that emphasizes the functional uses of communication in a social world. The *Matrix* has a strong research basis. Below the conceptual, practical and research features of the instrument are discussed.

Structure and organization of the *Matrix*

The *Communication Matrix* involves two major aspects of communication: the reasons that individuals communicate and the behaviors that they use to communicate. It is organized into four reasons to communicate that are consonant with those proposed by Light (1988): to Refuse things that we don't want; to Obtain things that we do want; to engage in Social interaction; and to provide or seek Information. Under each of these four major reasons are 24 more specific messages or communicative intents, such as Requesting More of an Action or Gaining Attention: these 24 messages correspond to the questions that users must answer to complete the *Matrix*.

The *Matrix* is further organized into seven levels of communicative behavior: I. Pre-Intentional Behavior, II. Intentional Behavior, III. Unconventional Pre-symbolic Communication, IV. Conventional Pre-symbolic Communication, V. Concrete Symbols,

VI. Abstract Symbols, and VII. Language. These levels are based on the pragmatic approach to communication development first discussed by Bates (Bates, 1979; Bates, Benigni, Bretherton, Camaioni & Volterra, 1979) that acknowledges the communicative intent of pre-linguistic behavior in young children. The seminal work of Werner and Kaplan on symbol formation (1963/1984) complements the mother-infant research on communication development. Werner and Kaplan viewed the emergence of symbols as a developmental process that is a natural outgrowth of early relationships between mothers, infants, and the objects or events in their environment.

These influences inspired my own research that informed the development of the *Matrix*. Specifically, a longitudinal study of typically developing infants who were assessed three times between the ages of 6 and 20 months (Rowland, 1990) provided the data on the sequence of acquisition of communicative intents in typically developing infants. Another line of research on the use of "tangible symbol systems " (2- and 3-dimensional symbols) by children with complex communication needs (Rowland & Schweigert, 1989 and 2000) suggested the inclusion of a separate communication stage in the *Matrix* characterized by the use of symbols bearing a concrete relationship to referents (Level V).

Transformation of the *Communication Matrix* into an Internet application

An online version of the *Matrix* was developed in 2003 for several reasons: to make the *Matrix* easier to use; to make it freely available to potential users; to encourage collaboration between professionals and parents; and to create a database of information that would advance scientific knowledge about communication development in persons with complex communication needs. The web site was designed so that parents and professionals could enter data describing a child's communication skills by answering a series of 24 questions related to the use of specific communicative behaviors and intents. Once the 24 questions have been answered, the web site automatically generates a one-page Profile (identical to the one included in the print version of the *Matrix*) that captures communication status at a glance. In addition, the web site automatically generates a Communication Skills List that shows the specific communicative behaviors that the individual uses to express each communicative intent. The web site is currently available in English, Spanish, traditional Chinese, Russian, Korean and Vietnamese to make it accessible to non-English speaking users. The database associated with the web site captures all of the data entered, including demographic information, but excluding any identifying information. A customized clinical report function that includes the potential to select educational goals based on *Matrix* assessment results is also available. This new capacity allows users to generate a completely personalized report with detailed results and explanations of current functioning and progress, as well as a brief summary report suitable for lay persons.

Psychometric properties of the *Matrix*

Validity

The 24 communicative states, functions and intents included in the *Matrix,* and their order, were derived from the longitudinal study of typically developing infants referenced earlier (Rowland, 1990). The communicative behaviors include those displayed by the same nine infants, as well as augmentative and alternative means derived from the AAC literature and clinical experience with nonspeaking children. Since no other communication skills assessments cover the range of behaviors that the *Matrix* does, it is not possible to make a meaningful comparison to other instruments: scores on instruments that emphasize speech and do not include alternatives to speech would not be expected to be similar to *Matrix* scores.

*Construct Validity Study (2011).*Ten national experts in the field of communication disorders in severe/multiple disabilities were identified and requested to complete a construct validity survey anonymously online. All agreed to participate. Primary professional employment categories of the respondents were: clinical service provider (4), university teacher (4), and researcher (2). Six had doctoral degrees and the remaining four had Master's degrees. Five were speech-language pathologists. Six respondents were very familiar with the *Matrix* and four were quite familiar with it. The survey contained the 24 questions from the *Matrix*. Participants were asked to rate the clarity and relevance of each of the 24 items/questions on a 3-point scale (0 = not at all clear/relevant; 1 = somewhat clear/relevant; 2 = relevant/clear; 3 = very relevant/clear). The mean relevance score across items was 2.8; the mean clarity score across items was 2.7. An open ended question solicited suggestions for additional items (communicative states, functions or intents) that should be included. This option yielded only more general comments with no specific suggestions.

Reliability

Since the *Matrix* is not a test, but a direct observational tool/behavioral inventory, it does not lend itself to traditional estimates of inter-rater reliability. Indeed, reliability lies in the relative observational skills of the administrators and their familiarity with the child assessed. A teacher who does not see the child in the cafeteria at lunchtime may score items related to obtaining items very differently from the classroom aide who accompanies the child to lunch and who observes food-related requesting/choosing/refusing behaviors not seen in other classroom activities. Of course, familiarity with the instrument and understanding of how to administer it would also affect reliability. The online *Matrix* includes a 26-page downloadable handbook that describes in great detail how to use the instrument. Additionally, three instructional videos may be viewed from the web site.

Iner-rater reliability between parents and professionals. Since the development of the parent version of the *Matrix*, data have been collected from both parents and educators of individuals participating in our projects. The Pearson's product-moment

correlation between parent and professional scores on the *Matrix* for a sample of 19 children with a variety of severe and multiple disabilities was .926 (p<. 01, 2-tailed), an extremely high rate of concordance between two independent assessments of the same individual.

Inter-rater reliability between professionals. Parker (2009) evaluated inter-observer reliability on *Matrix* scores based on viewing videotapes and written data on three children with vision impairment and developmental disabilities; she reports a mean of 90% agreement. A local study of inter-rater reliability was conducted in 2011. A convenience sample of ten pairs of professionals (either special educators or speech-language pathologists) were recruited from local school districts and clinics. Each pair of professionals considered themselves equally familiar with the same child, whose communication skills fell within those of the typical 0-24 month old (the range addressed by the *Matrix)*. The children assessed ranged in age from 1 to 18 years; half were males and half were females. Their disabilities varied widely and included Angelman syndrome, cerebral palsy, Cohen syndrome, autism, deafblindness with cortical vision impairment, an unspecified metabolic disorder, and developmental disability. Each participant pair completed the *Matrix* on the same child at the same time in the presence of research staff, so that it was clear that they were not comparing their impressions as they completed the *Matrix*. There was an average 83% agreement on mastered skills between pairs of participants, based on their scores for each of the 80 cells of the *Matrix* profile. Most respondents were not experienced with the *Matrix*. As such, this represents a conservative test of inter-observer reliability. We would expect even higher agreement among trained users whose experience with a student could be somehow equalized.

Test-retest reliability. Between 2 and 5 weeks after the local inter-observer reliability sessions reported above, the same participants independently administered the *Matrix* a second time for the purpose of evaluating test-retest reliability. One participant failed to participate in this second stage, yielding 19 test-retest scores. The assumption was that the communication skills of the students assessed were unlikely to have changed during that time, given the severity of their disabilities. There was an average 89% agreement on mastered skills within participants, based on their scores for each of the 80 cells of the *Matrix* profile.

Sensitivity to change

The *Matrix* has proven sensitive to development over time in children with severe communication disorders, as has been demonstrated by a long series of research and demonstration projects that have used the *Matrix* to document gains in the communication skills of children with severe and multiple disabilities (Rowland & Schweigert, 1989, 2000, 2005a and b). For instance, a study involving nonspeaking children with pervasive developmental disorders showed a mean gain of 13% in scores from the start to the finish of a school year (Rowland & Schweigert, 2002). Gains in a larger group of 51 children that included youngsters with a variety of severe and multiple disabilities showed a mean gain of 10% over the same time

period (Rowland & Schweigert, 2005b). Other authors also have used the *Matrix* to track progress in AAC users (e.g., Bruce, Mann, Jones & Gavin, 2007; McEwen, in press). Other instruments, because they focus strictly on spoken language, or because they fail to address incremental steps in pre-symbolic and symbolic communication development, are not able to document the gains of children who begin at the earliest stages of communication and develop very slowly.

Consumer satisfaction

Professional ratings. Experts agree that the instrument is of high value. A research project investigating appropriate ways to assess communication and cognitive skills in young children who are deafblind and who have severe cognitive and communicative disorders (Rowland, Stillman & Mar, 2010) collected evidence in this regard. The first activity of this project was to survey professionals across the country to find out what instruments they recommend to accomplish such evaluations, using a completely open-ended questionnaire (Rowland, 2009c). Respondents were requested to rate any instruments they recommended: thus each instrument was rated completely independently. Of all the communication skill assessments recommended and rated, the *Communication Matrix* was rated highest for assessing communication skills (mean rating = 4.9 on a 1-5 scale), highest for assessing skills in children with severe cognitive impairment (mean = 4.8 on a 1-5 scale), highest for assessing children without language (mean = 4.8 on a 1-5 scale) and highest for reflecting educational progress (mean = 4.6 on a 1-5 scale). A similar open-ended survey was completed by parents through the same project. The *Communication Matrix* was the only assessment of communication skills recommended by parent respondents, and as such received the highest ratings on all five evaluation questions. Interestingly, it was rated 5 (on a scale of 1-5) in terms of being "Useful for describing my child's progress over time." Professional respect for the instrument is also evidenced in the pre-eminent textbook on AAC by Beukelman and Mirenda (2005) that highlights the *Communication Matrix* in its chapter on principles of assessment (p. 145).

Consumer Satisfaction with the online version. An evaluation study was conducted in 2009 to assess consumer satisfaction with the online *Matrix* as an assessment tool. Participants were 237 professionals and 33 parents. Individuals who completed the evaluation survey were given a choice of $25.00 gift certificates. Identifying information provided to mail the gift certificates was separated from survey results to maintain the anonymity of respondents. The survey included 28 statements about the organization/clarity and ease of use of specific features of the online assessment. Statements were rated on a 1 (completely disagree) to 5 (completely agree) Likert scale, with agreement always representing a positive judgment. Responses were overwhelmingly positive, averaging 4.51 across the 10 questions about organization/clarity and 4.53 on the 18 questions about ease of use. Four additional statements addressing the degree to which evaluators thought the online *Matrix* would be useful yielded a mean score of 4.63 on the same scale.

Usage Statistics on the online version (updated June 2011)

The online version of the *Matrix* (like the print version) is becoming widely used. At this writing, over 41,000 *Matrix* profiles have been completed on over 23,000 individuals, many of whom have been assessed multiple times. New assessments are being entered at a rate of approximately 300 per week. Demographic information collected through the online version shows that 8% of users are family members, 44% are speech-language pathologists, 43% are teachers, other educators or therapists, and 5% are "other." The relatively large number of family members using the service suggests that it is encouraging parents to participate in the assessment process, as hoped. Although people of all ages are represented in the database, most of the individuals assessed are young children, including 22% between the ages of 0 and 5 years, 24% between 6 and 10 years, 43% between 11 and 15 years and the remaining 11% above 15 years of age. Users come from 124 different countries, with 65% of users from the U.S.

Individuals assessed using the online *Matrix* represent many different etiologies, diagnoses and health conditions. Those that constitute 5% or more of the database are: primary diagnosis of autism (25%), cerebral palsy (18%), developmental disability/delay (16%), primary diagnosis of deafblindness (10%) and Down syndrome (8%). (Since users may check more than one category for the same individual, there is overlap among the individuals represented by these categories.) One of the hopes in developing the online version was that data could be collected on the communication skills of children with low-incidence disabilities on whom little data can be aggregated in any one geographical location. This expectation is being realized. For instance, the database currently includes profiles on 338 individuals with Angelman syndrome (incidence, 1:15,000), 252 with CHARGE syndrome (incidence, 1:11,000), 80 with Cornelia de Lange syndrome (incidence, 1:20,000), 260 with Rett syndrome (incidence, 1:16,000) and 25 with Aicardi syndrome (incidence, 1:1000,000). Deafblindness is a label that is associated with few individuals but many different etiologies and there are no official incidence figures. The database includes 1,554 0-21 year old individuals with a primary diagnosis of deafblindness residing in the U.S., which is approximately 17% of the 9,320 children ages 0-21 identified in the 2010 U.S. child count (National Consortium on Deafblindness, 2011).

Future Efforts

Funds are currently being sought to underwrite further research and development activities related to the online *Communication Matrix.* In the meantime, we are soliciting donations to the Friends of the Communication *Matrix*, a 501(c)(3) organization dedicated to supporting the online *Matrix*. It is our goal to continue to provide this assessment service at little or no cost to users.

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