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Academic Year 2024/2025 XL Cycle

PhD Programme in **Studi Umanistici / Humanities**

CANDIDATE'S FIRST AND LAST NAME

Beatrice Scanferla

Restricted topic project

Augmentative and Alternative Communication (AAC): Research for the Development of Symbol Systems Aimed at Linguistic and Social Inclusion.

Project title

Complexity of Relevant Features in Augmentative and Alternative Communication: Experimental Study on the Use of Sinsemic Clover Complexity in the Symbols of the *PASS* System.

Project abstract

The project aims to investigate how the complexity of relevant (or constitutive) features within the design of symbols for Augmentative and Alternative Communication (AAC) influences the learning and retention of symbols in adults and children diagnosed with Autism Spectrum Disorder (ASD). Understanding the effectiveness across both groups is crucial, as families and practitioners involved in habilitative processes are end-users of the system, just as much as the individuals undergoing habilitation.

The research question is: Does representing a referent with varying levels of complexity in relevant features during symbol design affect the understanding of the referent itself? For individuals with complex communication needs (CCN), the ability to represent messages in alternative ways is central to their communication (Beukelman et al., 2014, p. 70), a fundamental right essential for overall quality of life (Drager et al., 2010).

This research includes a study involving adults without an Autism diagnosis and a study involving children (mean age 8–9 years). The experimental group consists of children diagnosed with Autism, while the control group includes children without an Autism diagnosis.

Keywords
Augmentative and Alternative Communication, Symbols, Sinsemic Clover, Feature Complexity, PASS

Disciplinary scientific fields
M–PED/01 Theories and science of education and social education
M–PED/03 Methodologies of teaching and special education
ICAR/13 Design

Proposed research project

1. Introduction of the problem in the international scientific context
1.1 Rationale for undertaking the experimental project

The typical language acquisition process requires an individual to organize their perception of the world through a system of symbols and referents. However, for children with severe intellectual and language disabilities, the ability to connect a symbol to its referent can be challenging (Barton et al., 2006), yet it is crucial for effective communication within an AAC system (Sevcik et al., 2018).

This project investigates the comprehension of AAC symbols, focusing on the ability to link each symbol to its referent. Both intrinsic and extrinsic factors are involved in the process of learning symbol–referent relationships (Sevcik et al., 2018). Intrinsic factors, which refer to the attributes the child brings to the learning task (Sevcik et al., 2018), include motivation, neurological condition, developmental age, sensory abilities, cognitive skills, communicative/linguistic competencies, and life experience (Beukelman et al., 2014, p. 71).

Extrinsic factors, on the other hand, pertain to the symbol set itself, such as the varying complexity of relevant features, a variable that has been studied sporadically in the literature.

1.2 Summary of relevant studies (state of the art)

To be defined as a "system," a symbol system must exhibit regularities; its elements are not merely a collection of images but adhere to a set of linguistic representation rules (CSCA, 2015). Otherwise, it is referred to as a symbolic set.

Picture Communication Symbols (PCS) lack graphic rules for representation (Costantino, 2011, p. 250; Bonora et al., 2019) and for further system development (Fuller & Lloyd, 1991). A symbol may appear in various versions, ranging from more transparent to stylized representations (see Figure 1.1). The set does not include rules that categorize word classes, except for some common profiles for locations, buildings, or stores (see Figure 1.2). However, there are buildings with no profile or with varying versions (see Figures 1.3 and 1.4).

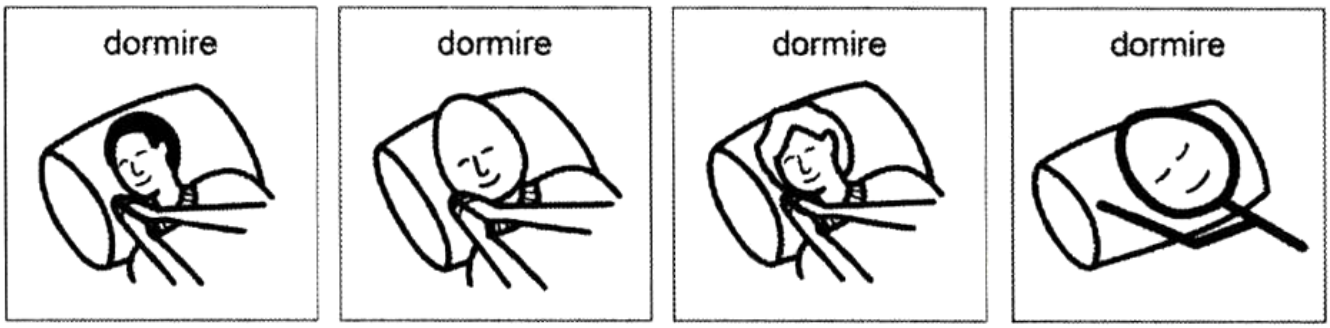


Figure 1.1 Lack of regularity in the PCS system; a single symbol appears in various versions. Reprinted from *Costruire libri e storie con la CAA: Gli IN-Books per l'intervento precoce e l'inclusione* (p. 250), by M. A. Costantino, 2011, Trento: Erickson. Copyright 2011 by Maria Antonella Costantino.

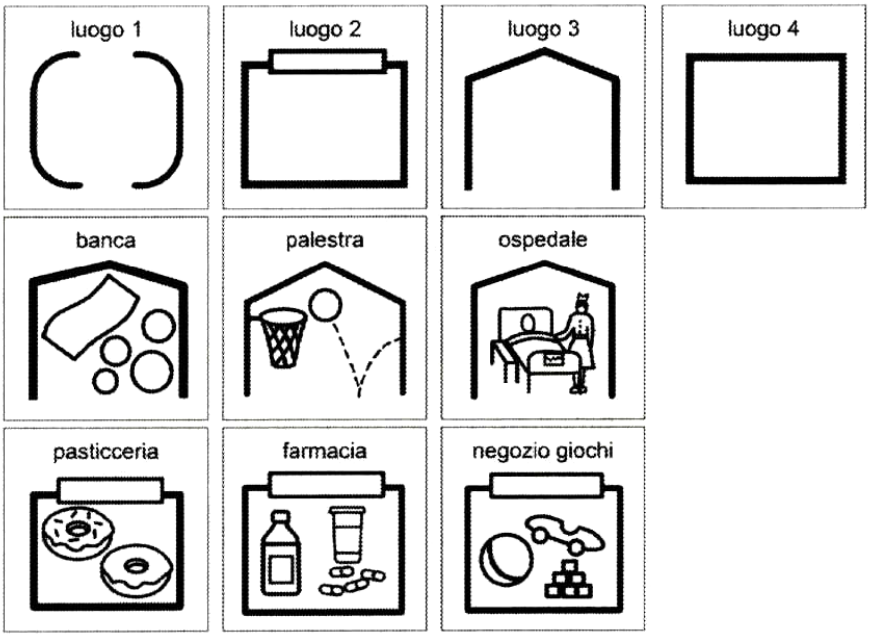


Figure 1.2 Some common profiles that can be used for certain locations. Reprinted from *Costruire libri e storie con la CAA: Gli IN-Books per l'intervento precoce e l'inclusione* (p. 251), by M. A. Costantino, 2011, Trento: Erickson. Copyright 2011 by Maria Antonella Costantino.

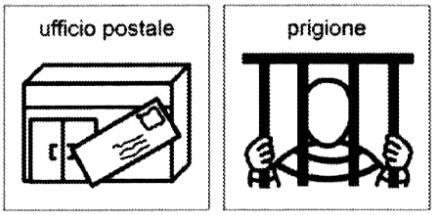


Figure 1.3 Some buildings are also represented without the surrounding house profile. Reprinted from *Costruire libri e storie con la CAA: Gli IN-Books per l'intervento precoce e l'inclusione* (p. 251), by M. A. Costantino, 2011, Trento: Erickson. Copyright 2011 by Maria Antonella Costantino.

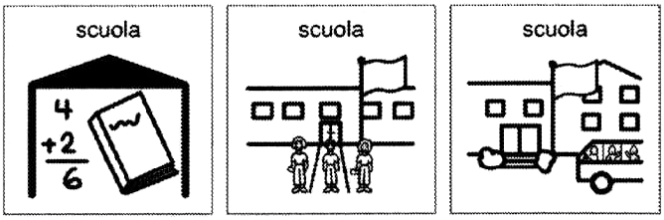


Figure 1.4 Some buildings are represented in different versions. Reprinted from *Costruire libri e storie con la CAA: Gli IN-Books per l'intervento precoce e l'inclusione* (p. 251), by M. A. Costantino, 2011, Trento: Erickson. Copyright 2011 by Maria Antonella Costantino.

Aragonés Sistemas Aumentativos y Alternativos de Comunicación (ARASAAC) lack composition rules, leading to potentially inconsistent glyphs (Bonora et al., 2019), with multiple symbols representing the same concept (see Figures 1.5 and 1.6). However, this flexibility allows for the activation of natural language mechanisms, such as adaptability and flexibility (Bonora et al., 2019).

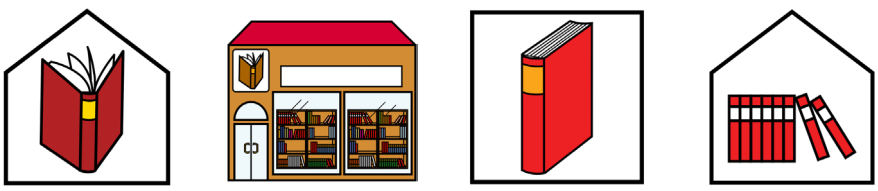


Figure 1.5 Various glyphs from the ARASAAC library expressing the same concept. Retrieved from https://arasaac.org/pictograms/search/biblioteca. Copyright 2023 by Aragonés Sistemas Aumentativos y Alternativos de Comunicación (ARASAAC).

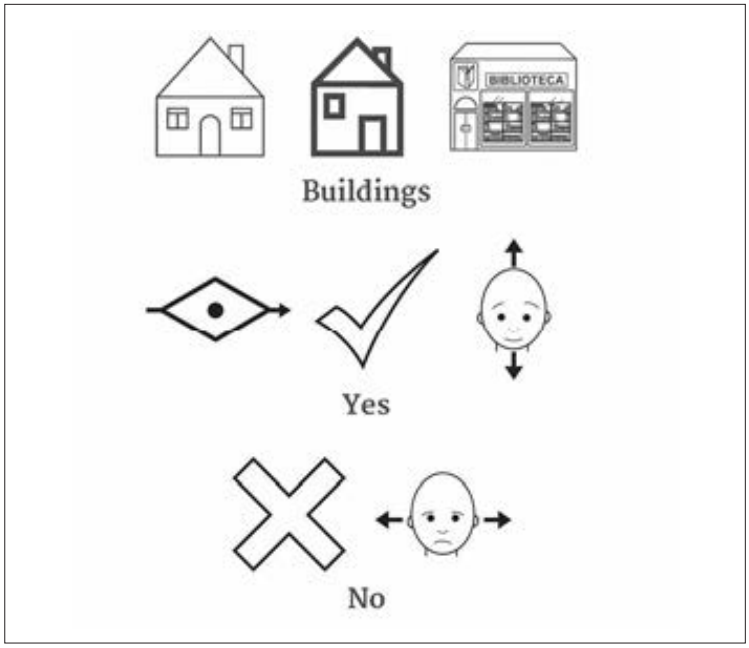


Figure 1.6 Various glyphs from the ARASAAC library expressing the same concept. Reprinted from "PASS: Picture Augmentative Synsemic System. Un nuevo sistema para las prácticas habilitativas en la CA (comunicación aumentativa): marco teórico", by G. Bonora, G. Dalai, D. De Rosa, M. Panunzi, L. Perondi, & C. Rubertelli, 2019, *INMATERIAL. Diseño, Arte y Sociedad*, *4*(8), p. 49. Copyright 2019 by Giulia Bonora, Giampiero Dalai, Daniele De Rosa, Marta Panunzi, Luciano Perondi, and Cecilia Rubertelli.

Widgit Literacy Symbols (WLS) have rules that identify homogeneous linguistic categories: the house profile for buildings, the elongated profile for complex structures, the square for rooms, the "cashier" symbol for stores, and the square and circle for spatial concepts (see Figure 1.7).

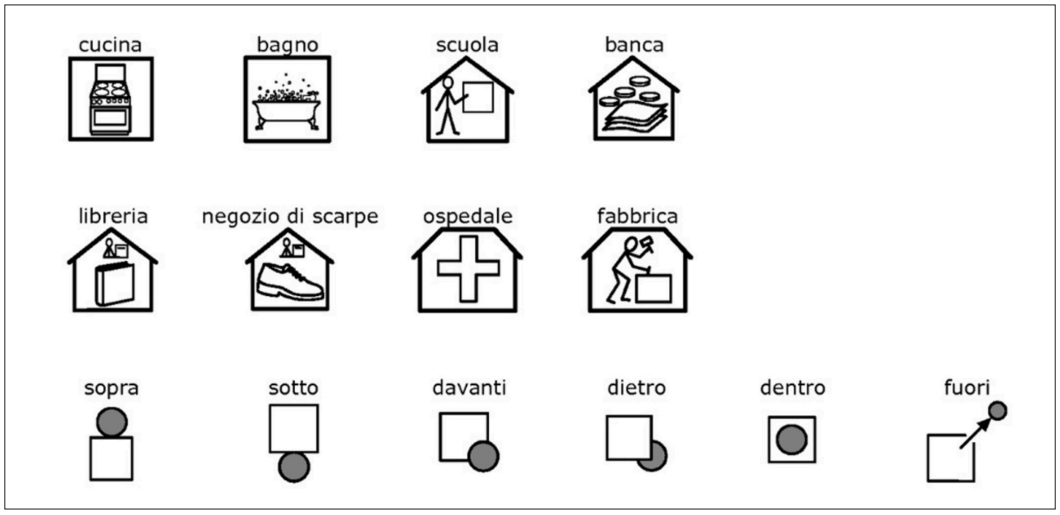


Figure 1.7 The WLS system has internal rules that aid in identifying homogeneous linguistic categories. Reprinted from *Costruire libri e storie con la CAA: Gli IN-Books per l'intervento precoce e l'inclusione* (p. 253), by M. A. Costantino, 2011, Trento: Erickson. Copyright 2011 by Maria Antonella Costantino.

Blissymbolics (Bliss) features formal linguistic rules and structure (Emms & Gardner, 2010); it is described as "a non-alphabetic graphic communication system" (McNaughton & Kates, 1980). It utilizes simple geometric primitive elements that can be combined into a generative system (Alant et al., 2005). This allows for the expression of grammatical and morphosyntactic elements (Costantino, 2011, p. 256) (see Figure 1.8).

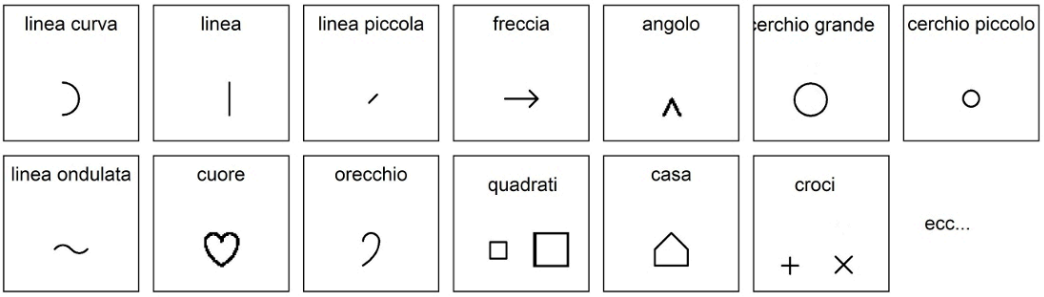


Figure 1.8 Bliss symbols, characterized by relatively simple geometric components. Reprinted from *Costruire libri e storie con la CAA: Gli IN-Books per l'intervento precoce e l'inclusione* (p. 256), by M. A. Costantino, 2011, Trento: Erickson. Copyright 2011 by Maria Antonella Costantino.

Picture Augmentative Synsemic System (PASS) is a set of black-and-white glyphs introduced in 2019 under a free software and open source license. The PASS system is based on principles of internal consistency, with its design focusing on sustainability, regularity, and independence from any specific language, drawing on both linguistic and visual properties (Bonora et al., 2019). A limited number of constitutive features (see Figure 1.9) prevent glyphs from being too thick or thin, avoiding undesirable visual hierarchies and ensuring consistent reproducibility of small graphic details. Thus, a person should remain recognizable even if depicted with different positions and characteristics, without altering the visual weight of the features.

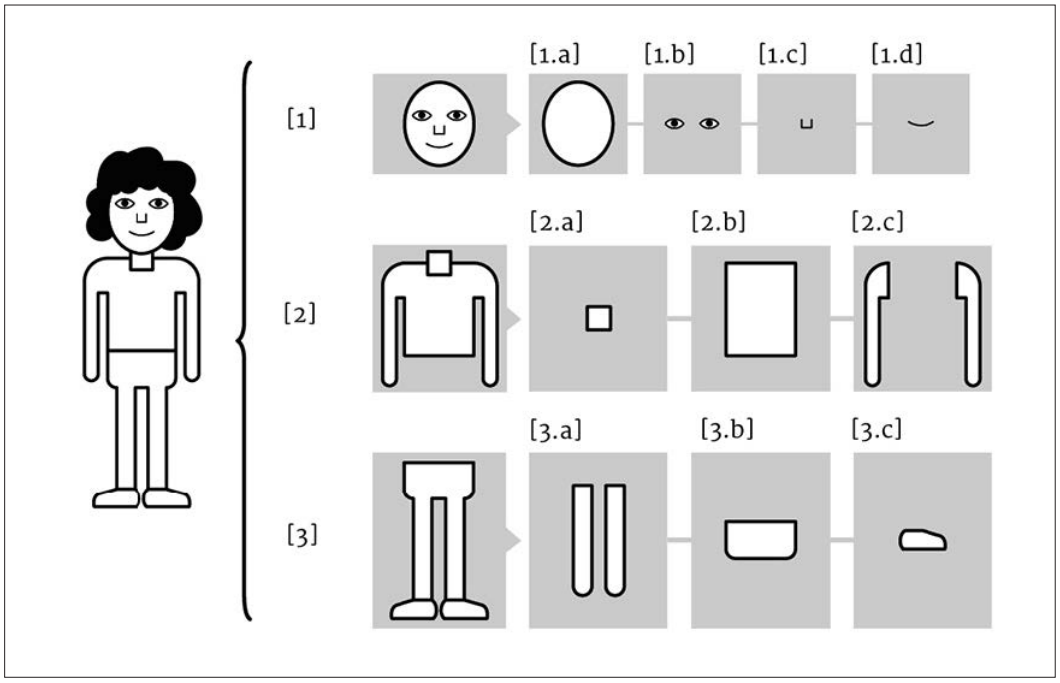
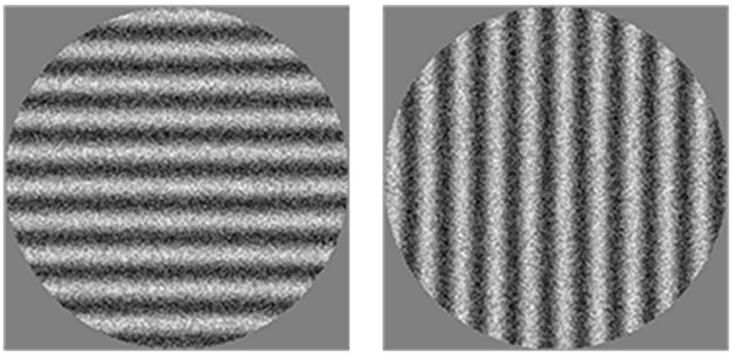


Figure 1.9 Constitutive features of the PASS system. Reprinted from "PASS: Picture Augmentative Synsemic System. Un nuevo sistema para las prácticas habilitativas en la CA (comunicación aumentativa): marco teórico", by G. Bonora, G. Dalai, D. De Rosa, M. Panunzi, L. Perondi, & C. Rubertelli, 2019, *INMATERIAL. Diseño, Arte y Sociedad*, 4(8), p. 64. Copyright 2019 by Giulia Bonora, Giampiero Dalai, Daniele De Rosa, Marta Panunzi, Luciano Perondi, and Cecilia Rubertelli.

The set of criteria used is the sinsemic clover, which defines specific visual variables such as orientation, value, texture, size, and color (Bertin, 2010). **The variable texture falls within the complexity of features, a key theme**

of the project. In the PASS system, the repetition of similar modules is minimized, and dense textures are avoided to address perception issues and information overload in individuals with complex communication needs (CCN) (Bogdashina, 2011). In autism, areas involved in texture perception are not as sensitive compared to neurotypical children (Rivest et al., 2013) (see Figure 1.10). Some variants developed by the author, where texture is minimized, are shown (see Figures 1.11 and 1.12).

A



B

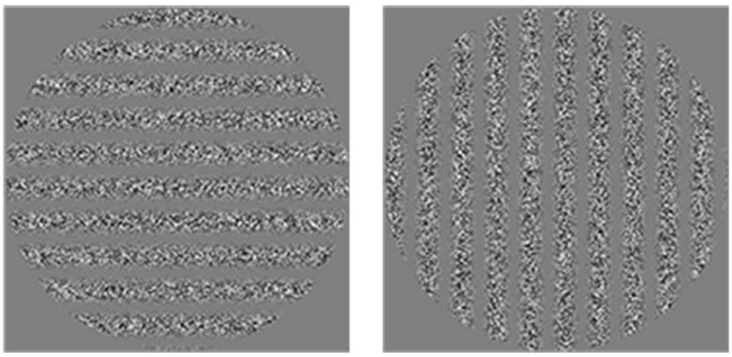


Figure 1.10 Examples of visual stimuli. A) First-order condition: grids defined by luminance oriented horizontally or vertically; B) Second-order condition: grids defined by texture oriented horizontally or vertically. Reprinted from "Luminance- and Texture-Defined Information Processing in School-Aged Children with Autism" by J. B. Rivest, B. Jemel, A. Bertone, M. McKerral, L. Mottron, & A. Key, 2013, *PLoS ONE, 8*(10), p. 4. Copyright 2013 by Jessica B. Rivest, Armando Bertone, Michelle McKerral, Laurent Mottron, and Alexandra Key.

Figure 1.11 Internal consistency rule for the controlled use of texture in symbols. Image by the author.

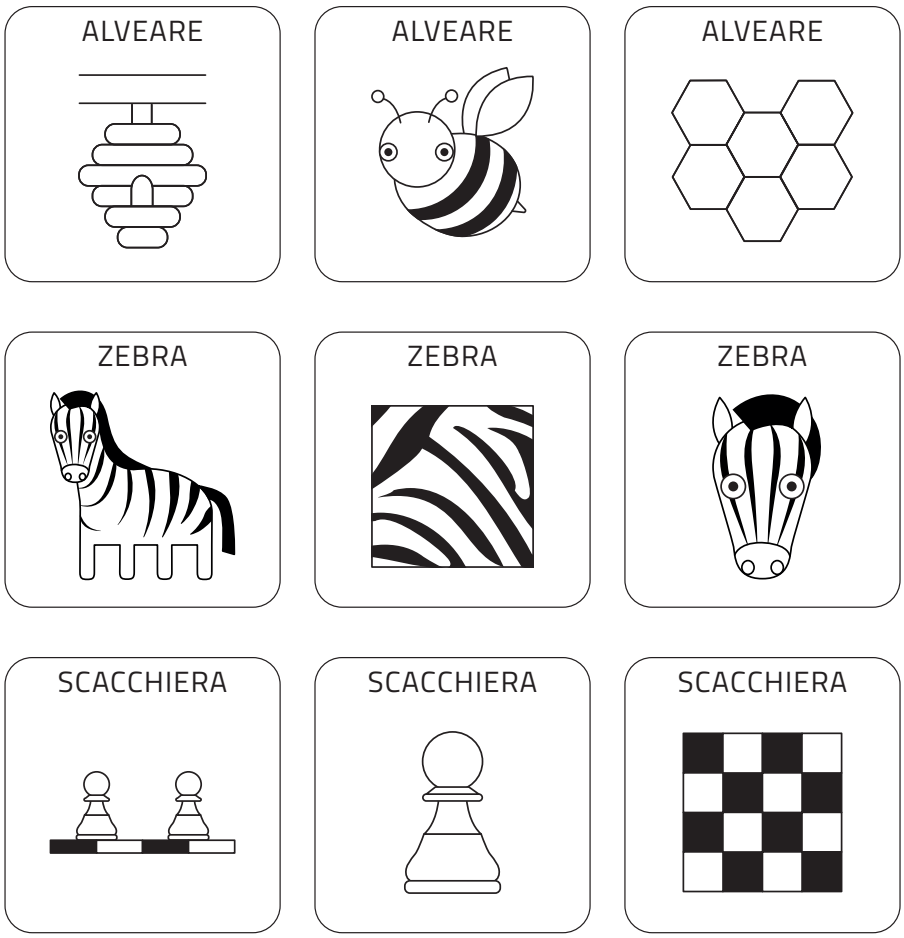


Figure 1.12 **Examples of symbols with texture minimized as much as possible. Image by the author.**

In a study by McDougall et al. (2000) (see Figure 1.13), it is demonstrated that the characteristics of concreteness (i.e., those that allow users to apply everyday knowledge about objects) and icon complexity have independent effects on user performance. There are significant effects associated with icon complexity (simpler icons are easier to use) and experience. These effects are not related; therefore, experience does not mitigate the effect of icon complexity on the speed of identification.

2. Relevance of the problem

Therefore, complexity and novelty have a significant impact on symbol identification. The effect of complexity does not decrease with experience. Even when complex symbols are learned, discrimination remains more difficult. Thus, complexity and concreteness are independent factors.

Excessive complexity in features can result from a lack of regularity and may present an insurmountable barrier to reading for individuals with Autism Spectrum Disorder (ASD) (Menyuk & Quill, 1985).

3. Objectives and expected results

Data will be collected to determine the threshold of complexity in features necessary for symbol comprehension: which rules of feature complexity facilitate a more effective understanding of the symbol's meaning? The

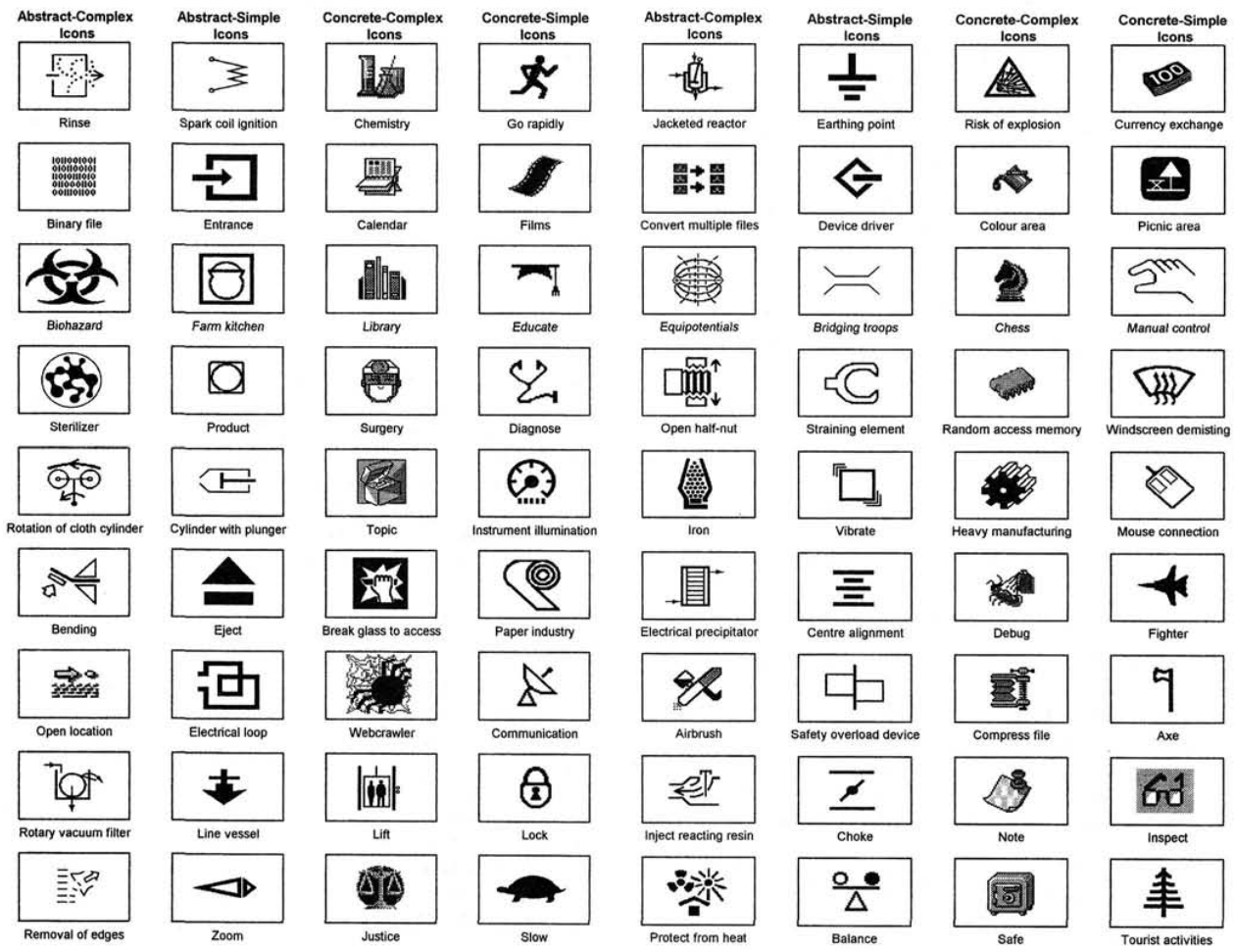


Figura 1.13 Le icone usate nello studio di McDougall et al. (2000). Le icone sono state scelte da un'ampia varietà di fonti per garantire che fossero rappresentative dell'ampio spettro di applicazioni in cui i simboli sono utilizzati. Tra questi, simboli per l'uso su apparecchiature elettriche, sistemi di informazione pubblica, simbologia militare, siti web, comandi e display di veicoli e aerei e interfacce di computer.Ristampato da "Exploring the Effects of Icon Characteristicson User Performance: The Role of Icon Concreteness, Complexity, and Distinctiveness" di S. J. P. McDougall, M. B. Curry e O. de Bruijn, 2000, *Journal of Experimental Psychology: Applied*, 6(4), 291–306. Copyright 2000 di Sine J. P. McDougall, Martin B. Curry e Oscar de Bruijn.

clinical relevance of this outcome is to provide guidelines to symbol designers in AAC regarding these rules.

3.1 Search question 1

The first research question investigates whether there is a difference in preference for three different levels of complexity, regardless of whether they are presented in a matrix, a sentence, or a narrative text.

3.2 Search question 2

The second research question examines whether preferences for complexity are related to the grammatical category to which the term belongs.

4. Research method used and any facilities and equipment needed to carry out the research

4.1 Participants, inclusion and exclusion criteria, exit criteria, recruitment

The scientific-experimental method will be employed with two types of participants: adults without an Autism diagnosis for **study 1**, and children (a clinical group with Autism diagnoses and a control group without Autism diagnoses) for **study 2**.

Study 1

Participants without disabilities

Inclusion criteria:

a) Age: 18–65 years;

b) No disabilities.

Study 2

Experimental Group: Individuals with Autism Spectrum Disorder (ASD) (with and without cognitive delay).

Inclusion criteria:

a) Age range: 8–9 years (the age at which children have basic literacy skills but do not yet fully master them);

b) Diagnosis of Autism Spectrum Disorder;

c) Adequate score on the *Peabody Picture Vocabulary Test* (PPVT-R), a test measuring receptive vocabulary. This test is useful for selecting words to be translated into symbols.

Control Group: Individuals without disabilities.

Inclusion criteria:

a) Age: Younger than 8–9 years (must have cognitive skills comparable to those of the ASD group);

b) No disabilities.

The independent variable is the complexity of relevant features in the symbols. The system used is the *PASS*.

4.2 Procedure, study duration, tools used and replicability support

Study 1: The study will involve a single experimental session. Participants will be presented with questions featuring three symbols representing the same word. These symbols will be designed in three variants of feature complexity.

Study 2: The study will include a pre-test and three experimental sessions.

Pre-Test: Participants will take the *Peabody Picture Vocabulary Test* (PPVT-R).

Session 1: Participants will be shown sets of three sentences, each featuring a target symbol in three variants of feature complexity. A questionnaire will assess the comprehension of the symbol (dependent variable).

Session 2: A questionnaire with matrices containing three symbols each, in the three complexity variants, will be administered. Participants will select their preferred symbol within each matrix.

Session 3: Participants will engage with an illustrated activity book, where they choose the missing symbol from the three variants on each page. The dependent variable is the participant's preference of symbol.

4.3 Research description for the three-year period (feasibility)

Development in the three-year period:

Year 1: Conduct a literature review, design, and catalog the symbol system, ensuring it is balanced by grammatical categories and complexity.

Year 2: Select the sample, conduct the first three experimental sessions (both in Italy and internationally), and perform statistical analysis of the results.

Year 3: Continue statistical analysis of the results and apply findings in a potential fourth experimental session.

5. Acquired skills in experimental research

During the Master's degree and thesis work, proficiency in statistical analysis was demonstrated. *Proportion tests* were conducted (for both experimental and control groups as well as the entire sample) to assess whether the distribution of responses was random. The results consistently showed statistical significance, indicating that the responses were not random.

Additionally, through the thesis work and as a substitute teacher in primary education, experience with children (both with and without disabilities) was gained. The author exhibited strong experimental, educational, and teaching skills. This experience was characterized by motivation, passion, and curiosity. The ability to connect with students and families with empathy and friendliness was evident, and a commitment to enhancing students' learning was central to the teaching approach.

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