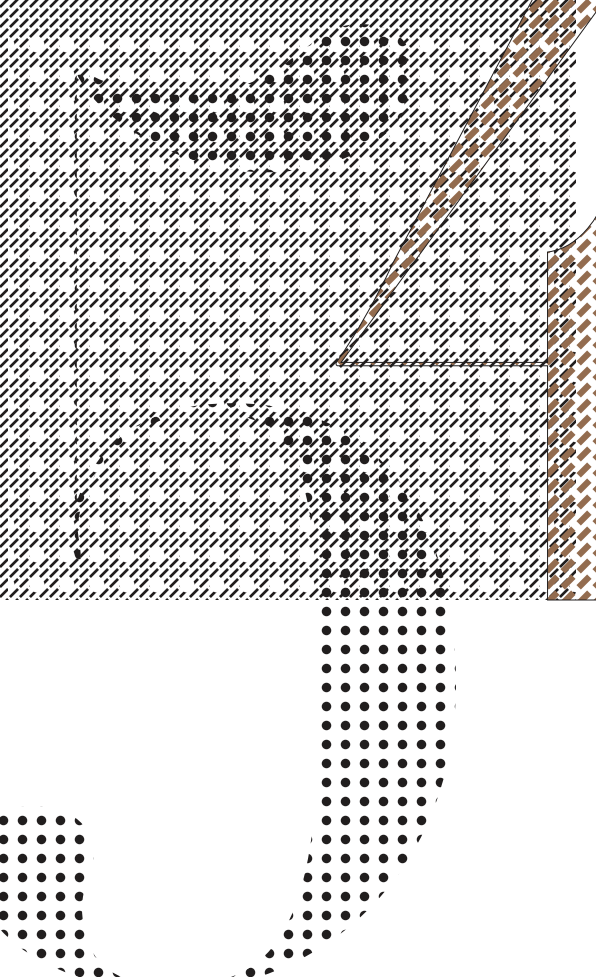




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A Latin-script typeface for education of individuals with Autism

Surveys of educators of Autistic children supported by literature review guided the design of a typeface to support teaching Autistic individuals to read.

implications for typeface design and user-centered/inclusive design methods

Before there was reading there was seeing.

People navigate the world and probe life's meaning through visible language. *Visible Language* has been concerned with ideas that help define the unique role and properties of visual communication. A basic premise of the journal has been that visual design is a means of communication that must be defined and explored on its own terms. This journal is devoted to enhancing people's experience through the advancement of research and practice of visual communication.

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**Visible
Language**

the journal of
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s p e c i a l i s s u e

Inclusive Design

April + August 2020

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Special Issue: Introduction

Jeanne-Louise Moys

We often hear design researchers say about inclusive design research “a lot has been done” and it is certainly an established, multidisciplinary area of research with many examples of distinct and impactful research and practice. However, we’re still a long way off from an inclusive world and accessibility is of increasing priority for twenty-first century societies with aging populations. There also seem to be many more studies of inclusive design for the built environment and product design than there are for visual communication.

When Mike Zender and I wrote the Visible Language call for papers that might broaden discussions of inclusive design in visual communication and explore the complexities and subtleties of designing for diverse user needs, I did not anticipate how varied the responses would be. In hindsight, the diversity of the literature, methods and approaches in the received responses highlights how much scope there is for visual communication research to contribute to inclusive design practice and research. Within this issue, we are publishing a few of the submissions we received and hope a few more will be shared with Visible Language readers in forthcoming issues.

The first three articles presented in this issue respectively explore the role of braille and digital technologies for people who are blind and/or have visual impairments, the evolution of manual syllabaries in Japan for the deaf community, and how drawing on teachers’ experiences informed the design of a typeface intended to make learning resources more accessible for learners with Autism. These studies help provide insight into the reading needs, preferences and experiences of individuals with particular disabilities and the associated implications for visual communication. Together, they also highlight how people’s lived experiences of traditional and emerging media can be profoundly shaped by education, policy and other historical and contextual factors.

Publishing these articles alongside other studies of information design, reading, technology and typography, and the commentary on the intersection of culture and technology for the Persian script, is a considered editorial decision. Inclusive design is not about designing for disabilities but about supporting people’s independence through respectfully anticipating and considering a range of possible user needs and contexts. We hope that the juxtaposition of ‘inclusive’ and ‘regular’ articles encourages reflection about two themes. First, how our everyday design decisions and exploration of new genres and technological affordances might have implications for different individuals and contexts of use. Second, how the kinds of methods and materials we use in research might shape what we find out and how these findings can be translated to practice.

Research into reading and visual and material communication variables occurs across many disciplines. Studies that demonstrate generalizability and robust controls to isolate effects are more likely to be published across a range of disciplinary journals. Yet, for communication design research to effectively inform inclusive practices, it seems that more awareness of the range of readers rather than ‘the average reader’ experiences and projects might be helpful in our discipline.

Thank you to Mike Zender and all guest reviewers who contributed to the editorial process and provided invaluable feedback on the inclusive design articles included in this issue (and those which we hope to publish in forthcoming issues).

Jeanne-Louise Moys
March 2020

**A Latin-script
typeface,
based on
special
education
teachers'
opinions,
to use in
literacy
education of
individuals
with autism.**

Efecan Serin

Aprigio Luis Moreira
Morgado

Ricardo Santos

The present study is based on an investigation in the areas of psychology, pedagogy, and design. It investigated the reading process and reading education strategies of individuals with autism spectrum disorders (ASD) in order to develop a typographic system to assist pedagogues as they develop educational aids appropriate for a child's reading problems. The study used an interdisciplinary research methodology including a literature study, empirical knowledge, and a survey study. The survey was based on the opinions and experiences of special education teachers. The survey study showed that individuals with autism could have difficulties learning similar letterforms. According to the combined results of special education teachers' common opinions, legibility studies, and literature study, the prototype of a typeface for individuals with autism and learning disabilities was developed. The Accessible Typeface v.1, v.2, v.3, v.4 v.5 family has been developed with the intention to facilitate learning-to-read and to minimize reading mistakes for individuals with autism and learning disabilities. However, before being implemented, this font family should be tested to conclude whether it is beneficial or not to teach an individual who has autism or learning disabilities in reading.

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Keywords

typeface design
inclusive design
earning to read
education strategies
Autism
learning difficulties

1. Introduction

Autism is a severely disabling life-long developmental disability that typically appears during the first three years of life. No factor has been shown to cause autism in the child’s psychological environment (Woods, Davis, & Scharff, 2005). Individuals with autism are known as good decoders, and they have a reading comprehension problem, which can be characterized with hyperlexia¹ (Newman et al. 2007). For this reason, the literature is generally focused on reading comprehension problem of individuals with autism (Fernandes, Amato, Cardoso, Navas, & Molini-Avejonas, 2015). However, in a study that examines the reading ability of individuals with autism, it is stated that there is a poor word reading subgroup in the population of autism (Nation, Clarke, Wright & Williams, 2006). This subgroup was not able to decode nonwords and show poor decoding performance. Nevertheless, Åsberg & Sandberg (2012) cited that this poor reading profile does not match with a dyslexic² profile nor autistic symptoms, it characterizes “delayed or impaired reading pattern” (Åsberg & Sandberg, 2012). Besides, studies conducted in the field of education reported that individuals with autism might have difficulties in learning to read (Laz, 2009). These contradictory results have led us to conduct our research and to investigate the problems of poor word reading group in the autism population.

The research question of the study is; Does it make sense to design a typeface to use in educational strategies in individuals with autism?

For this purpose, some of the contradictory information found in the literature was examined and a new typeface was designed according to the investigation results, legibility studies, and typeface design empirical knowledge. The research hopes to contribute to the literature and encourage future research.

2. Theoretical framework

2.1 Reading pattern of individuals with autism

Reading is a complex skill, and even reading a simple sentence requires a set of skills that can distinguish each word from the concept of the intended meaning of a text. Reading is one of the most important skills learned in school (National Early Literacy Panel, 2008). Emerging research has shown

1. Hyperlexia is a syndrome characterized by an intense fascination with letters or numbers and an advanced reading ability. Hyperlexic children read at levels far beyond those of their age mates and often begin reading at very young ages, sometimes at age two (Center for Speech and Language Disorders).

2. Dyslexia is a common learning difficulty that can cause problems with reading, writing, and spelling. It is a specific learning difficulty, which means it causes problems with certain abilities used for learning, such as reading and writing (National Health Service, 2018).

that the reading assessment and reading pattern of individuals with autism are independent and variable (Whalon & Barnett, 2010). IQ, age, and symptoms are factors that differentiate the needs of these groups from one another (Kelly J. Whalon, 2009). Studies prove that individuals with autism have hyperlexia reading profiles, but at the same time, they cannot extract information from within the text (reading comprehension) (Newman, et al. 2007). Despite this, Nation (2006) has shown that there is poor word reading subgroup in individuals with autism’s population. This poor word reading sub-group show poor performance to decode the word and they were not able to decode non-words (Nation, 2006). Based on these investigations, it appears that reading ability differs amongst the children with ASD. Also, literature study conducted by examining 58 articles showed that the reading and literacy ability of children with ASD varied from each other, (Fernandes, de La Higuera Amato, Cardoso, Navas, & Molini-Avejonas, 2015). According to this information, it is a significant mistake to have just one perspective; therefore, the reading process should be investigated with multiple perspectives in individuals with autism.

Nally, Healy, Holloway, and Lydon (2018) concluded that children with ASD have the most severe deficits in phonemic awareness, and language skills, which was consistent with other research (Dynia, Brock, Justice, & Kaderavek, 2017; Gabig, 2010; Whalon & Hart, 2011), and suggested more intensive reading instruction for more severe ASD symptoms.

Åsberg and Sandberg examined word reading skills and reading-related language and cognitive correlates in Swedish 10–15 years old with ASD (2012). The full group with ASD did not differ statistically from an age-matched comparison group in word reading, but a poor-readers subgroup was identified who displayed severe difficulties. Normal readers with ASD did not differ from the comparison group in nonverbal ability (see Wechsler, 1999), phonological processing, rapid naming, or receptive vocabulary. The poor subgroup performed below on all measures except nonverbal ability. When poor readers with ASD were matched for reading level with younger readers, no difference was found on any reading-related skill. Furthermore, no significant correlation was found between autistic symptomatology and word reading within the ASD group. It is concluded that the pattern of individual differences in word reading among children with ASD conforms well to that seen in children without ASD of normal or delayed reading abilities, and the profile of the poor reader’s group with ASD conformed to a ‘normally impaired’ reading pattern (Åsberg & Sandberg, 2012).

2.2 Learning Disabilities

Autism is more prevalent among individuals with learning disabilities. Many of the autistic behaviours coincide with behaviours common to learning disabilities. Fombonne (1999) found that 19.4% of people with autism functioned within the normal range of intelligence, 29.4% of people with autism had moderate and moderate learning disabilities, and 41.9% were severely learning disabled in a comprehensive compilation of 23 studies on autism epidemiology. These results should be carefully examined, due to differences in methodology, assessments, and IQ bands, but this is a good indicator of the level of learning disability in the autism population (O'Brien & Pearson, 2004).

These results suggest there is a relationship between learning disabilities and autism. However, the difficulty in reading in individuals with autism does not overlap with the dyslexic profile (Åsberg & Sandberg, 2012). For this reason, addressing the difficulties of dyslexia while creating a new typeface will not help or solve the problems of individuals with autism.

2.3 Reading Education of individuals with autism

Reading education is necessary for all students (Kliewer & Landis, 1999; Laz, 2009). In modern education, the expectation is that all students can gain some reading skills. Children with autism defect in the mental capacity and focus necessary to learn how to read and develop reading comprehension may take longer than normal children do. Although some students with autism cannot achieve full academic literacy, functional literacy is essential for them to live and work (Alberto, Fredrick, Hughes, McIntosh, & Cihak, 2007).

According to Koegel (2006), only about half of students diagnosed with autism can acquire strong communication. Language intervention strategies are time and labor-intensive for both students and teachers. Teachers use different methods and approaches according to symptoms (IQ, age, several and learning disabilities) of individuals with autism (Kelly J. Whalon, 2009).

Linda Laz (2009) has explained the challenges of teaching reading to students with autism in the six titles; language deficits, behavioral challenges, cognitive ability lack of early reading opportunities, the school experience, and literate communities. These challenges ensure that learning-to-read is delayed and transformed into a long process specific to children with autism. Using a typical reading readiness model may not be effective for students with autism (Lanter & Watson, 2008). National Research Council (NRC) suggested that educational interventions must be highly individualized and capitalize on the student's specific skill strengths (National Research Council, 2001). Therefore, many students with autism require personalized education (Laz, 2009). It is clear that to teach literacy skills to students with autism takes a long time, and requires effective education creativity by the special educator. The emerging literature shows that

many programs, strategies, and interventions have been created to teach reading to students with autism efficiently, although the current research is still limited (Kelly J. Whalon, 2009).

2.4 Typography for Children

Typography for students is an area that attracts the interests of legibility researchers, educators, and designers. However, designers, educators, and legibility researchers have not reached any joint conclusion on a typeface for children (Bessemans, 2016). The views of the teachers are usually based on prejudice and habit (Raban, 1984). Designers generally intend to follow the views of customers, and scientific readability researchers often do not have a professional approach to building valid test material (Bessemans, 2016). Teachers usually suggested sans-serif typefaces rather than serif typefaces. According to the teachers, sans-serif character forms are easier for children to read than a serif letterforms. Teachers have preferred sans-serif typefaces in reading books due to this simplicity, and they presumed that sans-serif was more closely related to the letterforms which children learn to write with than were serif typefaces (Walker, 2005). These teacher's views are based on tradition and on the force of habit (Garfield, 2010; McLean, 1980; Raban, 1984). Teachers and educationalists concluded that using infant characters in early reading books is beneficial due to similar handwritten characters (Pohlen, 2010; Walker, 2005). In addition, Sassoon (1993) cited that the infant characters are critical to the beginning readers. Assumptions about typefaces for children were translated into the design of letterforms by introducing rounded terminal strokes, the addition of flicks (the upwards exit strokes on the baseline), long ascenders and descenders, which are believed to aid the identification of word images (Bessemans, 2016).

The emerging literature shows research often intuitively supports the views of the teachers, pedagogues, and educational publishers, who are not aware of the importance of type design (Bessemans, 2016). There is no consensus about which visual features of the letters contribute to legibility for young readers (Walker & Reynolds, 2003). Apart from a few exceptions (such as the studies by Walker³), much of what we know about typefaces for children's reading is based on prejudices, habits, feelings, and traditions rather than on typographic knowledge. Therefore, the multidisciplinary approach is necessary for gaining better knowledge about children typography (Bessemans A. , 2016).

2.5 Typography for Individuals with Autism

There are accessibility and topographic instructions made for people with several disabilities. Autism has a large scale and symptom. Therefore, some instructions created for people with disabilities have also been using for autism. These instructions have included typography knowledge such as

3. Walker stated that established typefaces for children's reading should have generous ascenders, descenders and proportions making a clear distinction between characters that are sometimes confused.

point size, fonts, line spacing, and space between characters. These instructions, published by the UK Department of Health (Department of Health, 2009) and ILSMH European Association (1998), are intended make material easy to read.

These guidelines explained how to prepare easy-to-read documents for individuals with low IQ, learning disabilities, and autism. The following guidelines have been recommended to use in these groups: OPEN BOOK (software & website), and Autism Europe (Website) benefited from the following information.

T A B L E 1

ILSMH European Association
(1998)

The main instructions in guidelines as follows;
• Use clear typefaces. A clear typeface is preferred, for example Arial, Helvetica or Times New Roman.
• Use a large body size. The size of the letterforms should not be too small then 14 points is the recommended minimum for people with visual impairments.
• Be careful about how you emphasize text. Do not use block capitals and italics in the text. Use bold weight or underlining for emphasis.

T A B L E 2

UK Department of Health (2009)

The main rules in guidelines as follows;
Rule 10: Words go on the right.
Rule 11: Words must be written clearly – A clear typeface is preferred, for example Arial, Helvetica or Times New Roman.
Rule 12: Words must be large – a font size at least 14 points is good.

According Janan & Wray (2012), the key features in the legibility of various text display options may be useful for autism. The features are listed in the Table 3.

Previous studies have focused on reading comprehension problem of autism (Fernandes F.D.M, 2015) For this reason, studies have not presented any specific information on character perception by individuals with autism in reading. However, Yaneva (2016) cited that exploration of the effects of font sizes, font styles, line spacing, and background colors on autism may prove to be valuable for future research. Still, the literature lacks specifics needed to design a typeface for people with autism. However, a study by Åsberg & Sandberg, (2012) has shown that the reading pattern of autism is quite similar to the impaired reading pattern, which may also overlap people with learning disabilities. This suggests that a typeface for individuals with autism may also cover the needs of learning disabilities.

T A B L E 3

(Janan & Wray, 2012)

Text Display Characteristic	Legibility Features
Body size	Optimal font size is between 10 pt. and 15 pt. small size becomes less legible. Compare the following: How easy is this to read? (10 pt.) How easy is this to read? (12 pt.) How easy is this to read? (18 pt.)
Font weight	Medium-weight fonts are the easiest to read. Bold fonts attract attention in comparison. Compare the following: How easy is this to read? (Arial Narrow) How easy is this to read? (Arial) How easy is this to read? (Arial Black)
Font style	Roman is easier to read than italic. Italic can be used to emphasize short blocks of text for greater attention. There has been debate about the merits of serif and sans-serif Typefaces. How easy is this to read? (Italic) How easy is this to read? (Sans-serif) How easy is this to read? (Serif)
Line length	Roughly 50 to 65 characters is an ideal measure. Anything significantly smaller or larger loses legibility.
Letterspacing	Most fonts do not need extra letter-spacing (leading) because it should be part of the font design. It is best to keep with the original design.
Wordspacing	The space between words should be large enough to indicate clearly that they are different words, but not so large as to lose their connection to each other. Compare the following: How easy is this to read? (single word spacing) How easy is this to read? (triple word spacing)
Leading	The vertical space between lines of type should increase as the length of the lines increases. The lack of white space between lines makes it difficult for the eye to track from one line to the next. Usually a line-height between 1.15 and 1.5 works well.
Justified or Text alignment (justify left and right)	Type that is alignment left with a soft right edge is the easiest to read. Full justification risks creating uneven spaces between words. Compare the following: These lines are flushed left and have an unjustified right edge. Their advantage is that they maintain the same distance between words throughout. These lines are fully justified – that is, straight on both left and right sides. It will be apparent that the between-word spaces are not equal here, which can be reading harder.
Lowercase, all caps, small caps	Lowercase letterforms have more contrast in their strokes, making them easier to read. ALL CAPS should be reserved for display type. SMALL CAPS can be used for emphasis, but sparingly.
Contrast between type and background	Black text on a white background is the most legible. Everything else reduces legibility.

Table 3 (Janan & Wray, 2012)

3 . M e t h o d

Our study consists of two phases. The first phase follows a mixed non-interventional methodology. We used qualitative methods as bibliographic research, literature review, survey methods, and quantitative methods for the analysis of the results. From these, we established the state of the art in order to conceptually frame the second phase of the research. In this second phase, we follow a qualitative interventional methodology. We used qualitative methods such as exploratory drawing by hand, vector drawing, letter spacing, and kerning in order to develop a font family.

4. Survey

4.1 Procedure

The survey was prepared in Portuguese⁴, Turkish, and German languages. The survey was shared on the social media group pages (Facebook). These groups are where teachers share information that will contribute to the educational activities of individuals with autism. These social media group pages are listed in the table below.

T A B L E 4

Social-media group pages

English Language Group; United Kingdom, Australia, United States of Amerika
Autism Teachers Unite!
Autismus-Gruppe
Autism Spectrum Disorder, through my eyes Discussion Group
Special Education Teachers
Autism Support For Parents And Teachers UK
ASD Classroom Support (teachers only)
Autism Acceptance Group
AUTISM. From Awareness to Acceptance
German Language Group; Germany
Autismus-Gruppe
Autismus - einfach anders e.V.
Frühkindlicher Autismus (AS Autismus Spektrum)
Kinder mit Autismus
Autismus oder Tourette Syndrom oder beides
asperger autisten
Portuguese Language; Brazil, Portugal
AUTISMO DIARIO - BRASIL
Autismo, Ciência e Espiritualidade
Asperger e Autismo no Brasil - Grupo
Autismo no Brasil
Turkish Language; Turkey
Özel Eğitim Öğretmenleri
Otizm Haber
Otizm kardeşliği
Otizmli Aileler Öğretmenler
Özel eğitim öğretmenleri ve aileleri buluşturan platform
Otizm

4. Despite the efforts that have been made to have participants in the survey, no feedback was received from Portugal or Brazil.

T A B L E 5

Contributors to the survey by sharing and participating in the survey.

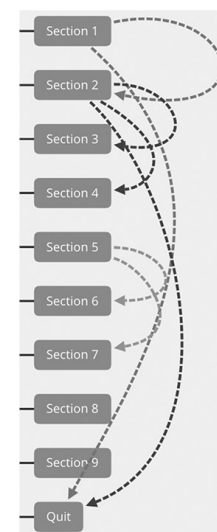
Saniye Karagözoğlu Special Education School
Lerzan Special Education Center
Dolunay Özentürk – Special Education Teacher in reading education of child with autism.
Kudret Nurdağ, principle of speial education school

The survey consists of 9 Sections. The Sections contain different combinations (Relationships) of questions, which can re-direct participants to the different sections according to their answers. In this way, we eliminated the participants who have not enough knowledge about the education process of individuals with autism. This was aimed to make the survey more productive. The survey was conducted via google forms to reach more people online.

4.1.1 Survey Sections

F I G U R E 1

Survey sections



Section 1: This section has an explanation for participants that describes why the survey was conducted, by whom, and what was the purpose of the survey. In addition, it included information and contact numbers of the person who prepared the survey. The participants had to write their e-mail in this section, otherwise, they would not participate in the survey.

Section 2: Section 2 was created to eliminate participants who have no relationship with the education of autistic individuals. It was given five options in the question:

- Teacher of students with autism,
- Researchers of autism
- Parents of kids with autism,
- no association with autism and
- others.

Participants who marked 'Parents of kids with autism' and no association with autism were excluded from the survey. This section intended to limit the Survey to experts in the education of individuals with autism.

Section 3: This section is connected to Section 2. This was made for participants who chose the option 'others.' When participants choose option other in Section 2 they direct to Section 3 to explain their relationship with autism that is not in the options at Section 2.

Section 4: The questions in this section were intended to know whether individuals with autism have reading difficulties and learning to read difficulties.

Section 5: Section 5 was created to discover the learning-to-read differences between students with autism and without autism. This section guided the participants to different questions according to their answers, as in Section 2. The option 'it depends' led the participant to the sixth section, while the other options led the participant to Section 7. The option "it depends" allowed us to get more detailed data about the reading status of the student with autism by sending the participant to 6.

Section 6: Section 6 had the same question as Section 5. It is a matrix question. It ensured that the participant gave a value to the options from one to seven. Its purpose was to receive more detail information about reading status between individuals with autism and without autism.

Section 7: Section 7 was a matrix question like 6. Participants were asked to show reading problems of individuals with autism and their variable value.

Section 8 and 9: Section 8 and 9 were multiple-choice questions. Participants were asked to show the letter-pairs which can cause the reading error for individuals with autism. In this Section, participants could choose more than one option or could pass the question without giving an answer.

The results of the survey will be given separately according to the language of the participants. The results from the German group are not sufficient because just two experts participated in the survey. Accordingly, the English and Turkish groups will be the basis for discussion and debate. The number of participants is listed in the table below.

T A B L E 6

Participants in the survey

English Group	30
Turkish group	45
German	18
The total number of participants in the survey	93

We can separate in three the group of participants: no association (Parents and family members of children with autism), experts (researchers on autism, Teacher of students with autism) and 'Other'. Who selected the option 'Other' is directed to Section 3 for explaining their relationship with people with autism and accepted to participate in the survey. Some participants were removed from the survey in the Section 2, because they did not have enough knowledge about the education process of individuals with autism. The list of participants who accepted and who excluded the survey are listed in below.

T A B L E 7

Group of participants comparison

Groups	Experts	No Association	Other	Total accepted participants to the survey	Total
English Group	17	3	10	27	30
Turkish group	28	15	2	30	45
German	2	12	4	6	18
Total	47	30	16	63	93

It was summaries participants information in the below. In the English group, just 27 persons were accepted from 30 persons. Three persons have not accepted to survey because they have not professional knowledge about the education of individuals with autism.

4.2 Result and Analysis

4.2.1 Section 4

In Turkish group, just 30 persons were accepted from 47 people. Seventeen persons were not accepted to survey. The Turkish group of participants are listed in the below.

Some participants did not answer all questions. Therefore, different values can be seen among the questions. Sections one, two, and three were not included in the results because they were developed to eliminate the participants who did not have an educational relationship with autism. Since the questions used in the questionnaire started in Section 4, the results are presented starting from Section 4.

Two questions were asked in Section 4. First, 'Do you think the Autism spectrum disorder (ASD) have reading difficulties?' A total of 65 answers were received from the Turkish and English groups. In the English group, 88% of subjects thought that individuals with autism have reading difficulties and in Turkish group %93 of the participant thought that individuals with autism have reading difficulties. In addition to the results that showed that people with autism generally had reading difficulties, the question is an open question. The participants might have misunderstood the question or they could think we were asking about hyperlexia or reading comprehension problems. Therefore, this question-answer should be examined carefully, or not taken into account.

English Group, 30 Participants

C H A R T 1

English group participants Section 2 and three results of the summary

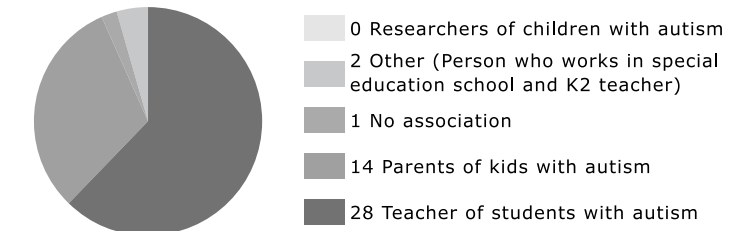


Section 4 also asked "Do you think the Autism spectrum disorder (ASD) has the learn to read difficulties?". 83% of the English participants respond yes option, and 100% of the Turkish participants respond yes option. It is shows most of the consulted experts think the individuals with autism have learning to read difficulties.

Turkish Group, 30 Participants

C H A R T 2

Turkish group participants Section 2 and three results of the summary



T A B L E 8

Section 4 results

Question	Yes	No	Total answers	Group
Do you think the Autism spectrum disorder (ASD) have reading difficulties?	28	2	30	Turkish
	23	3	26	English
Do you think the Autism spectrum disorder (ASD) has the learn to read difficulties?	17	0	17	Turkish
	15	3	15	English

It is known that individuals with autism may have learning difficulties and need special education. Usually, they have reading comprehension problems. But the literature emphasizes that they are good decoders and they can learn to read easily, but with poor comprehension (Newman, et al. 2007). This section identified the general thoughts of the experts about learning-to-read difficulties of people with autism because literature gave differing conclusions.

Both questions and answers are general and do not allow us to analyze if there are problems of visual recognition of the letterforms. However, it is clear that there are 'reading difficulties' and 'difficulties in learning to read' in the autism population. This question's results are sufficient to support new research on individuals with autism about reading because these data completely contradict the literature.

4.2.2 Section 5

In Section 5 it was asked, 'Can you compare the students with autism in the process of learning how to read to students without autism?' A total of 50 answers were received in this question from both Turkish and English groups. This question was asked to discover the general knowledge about learning-to-read difficulties in autism because the information in the literature is insufficient to make a conclusion. In the literature, only Nation (2006) emphasized that reading ability is variable among individuals with autism. The survey reiterates this information but at the same time, it shows that learning to read is not easy compared with students without autism. This is a new data that contradicts this literature. Except for Nation (2006), generally the literature emphasizes that the reading pattern of individuals with autism is characterized by the hyperlexia reading profile.

Section 5 is a very general question and the answers are inadequate to arrive at a conclusion. For this reason, 'It depends' option has been made and 70% to 60% of the participants have marked this option. This option guided the participants to Section 6 and enabled them to rate the learning-to-read process of the individuals with autism in the autism population from small to large. In this way, we aimed to receive more detail information about learning-to-read difficulties in the autism population.

T A B L E 9

English group survey Section 5

Options	Answers	Value
Easier than students without disabilities	0	0.00%
Same as student without disabilities	1	4.00%
More difficult than students without disabilities	4	15.00%
Difficult and challenging; it takes much longer than the student without disabilities	3	11.00%
It depends	19	70.00%

T A B L E 10

Turkish group survey Section 5

Options	Answers	Value
Easier than students without disabilities	0	0.00%
Same as student without disabilities	2	6.7%
More difficult than students without disabilities	1	3.3%
Difficult and challenging; it takes much longer than the student without disabilities	7	23.3%
It depends	20	66.7%

The participants listed the learning status of individuals with autism respectively according to the students without autism in Section 5. In the English group based on the participant's answers, students with autism have problems in learning to read compared to students without autism. However, it can depend among the individuals.

Similar results were obtained from the Turkish group. However, there seems to be more consensus among experts in the Turkish group about the difficulties of learning to read. This may because of the difference in the alphabet (accent letterforms).

The participants who marked the option 'it depends' in Section 5 were directed to Section 6, and the others to Section 7.

4.2.3 Section 6

Section 6 is a matrix question. Participants were asked in Section 6 to reflect the variability pattern with a rating from 1 to 7 and to consider which group is larger than the other. The question was asked to discover differences of the learning-to-read process in students with autism and without autism. Also, it enabled the participants to rate the learning-to-read issue in the autism population from difficult to easy with scale from 1 to 7. The results have made it possible to define the learning-to-read process from small to large in the autism population. These are available in the following table.

4.2.4 Section 7

4.2.4.1 English language group

Section 7 is a matrix question like Section 6. It was designed to identify the reading issues in autism population individuals. Participants rated these issues from one to seven.

T A B L E 1 3

English group survey Section 7

Options	1	2	3	4	5	6	7	Average
Reading the word with the missing letter.	11,11% 3	11,11% 3	18,52% 5	18,52% 5	18,52% 5	7,41% 2	14,81% 4	4,04
Reading the word with responding different letter in the word and/or blending the letter.	14,81% 4	14,82% 4	18,52% 5	22,22% 6	14,81% 4	3,70% 1	11,11% 3	3,63
Has difficulty with learning letter names and mixing sounds they make with similar letters.	14,81% 4	11,11% 3	18,52% 5	18,52% 5	14,81% 4	14,81% 4	7,41% 2	3,81
Confuses letters that looks similar (b, d, p, q...).	18,52% 5	11,11% 3	7,41% 2	25,93% 7	11,11% 3	11,11% 3	14,81% 4	3,92

The highest value in the table is the first option as ‘reading the word with the missing letter.’ Perhaps this problem can be corrected by opening the spaces between the letterforms. While further research is needed on the subject, this input is valuable to identify possible factors in learning to read problems.

The second option shows the lowest rating between the options. The value of this option does not prove that the problem is characteristic with the individuals with autism, therefore, it must be investigated more clearly to know whether the characterize with the individuals with autism.

The third option has a value slightly closer to the medium average. It may indicate learning difficulty. However, it should be examined in detail to know what cause of this problem.

The fourth option is a feature that is usually characterized with dyslexia. This problem may be caused by difficulties in learning letterforms. The fourth option answer supports the idea of creating a new typeface for teaching strategies to the individual with autism.

According to these results, it is obvious that individuals with autism have reading difficulties, even if it is not the high level. These problems are not mentioned in the literature. Therefore, it would be useful to be examined in detail by additional research. Consequently, it has been determined that individuals with autism may confuse letterforms or find it difficult to learn similar letterforms, and they can make letter jumping while reading.

T A B L E 1 1

English group survey Section 6

Options	1	2	3	4	5	6	7	Average
Easier than students without disabilities	26,32% 5	21,05% 4	5,26% 1	36,84% 7	0,00% 0	5,26% 1	5,26% 1	3
Same as students without disabilities	15,79% 3	21,05% 4	10,53% 2	42,11% 8	5,26% 1	5,26% 1	0,00% 0	3,16
More difficult than students without disabilities	15,79% 3	5,26% 1	5,26% 1	15,79% 3	21,05% 4	21,05% 4	15,79% 3	4,47
Difficult and challenging; it takes much longer than the student disabilities	10,53% 2	5,26% 1	5,26% 1	31,59% 6	15,79% 3	21,05% 4	10,53% 2	4,42

T A B L E 1 2

Turkish group survey Section 6

Options	1	2	3	4	5	6	7	Average
Easier than students without disabilities	35,00% 7	20,00% 4	20,00% 4	10,00% 2	15,00% 3	0,00% 0	0,00% 0	2,5
Same as students without disabilities	50,00% 10	15,00% 3	20,00% 4	5,00% 1	10,00% 2	0,00% 0	0,00% 0	2,1
More difficult than students without disabilities	10,00% 2	5,00% 1	15,00% 3	20,00% 4	25,00% 5	21,05% 4	5,00% 1	4,25
Difficult and challenging; it takes much longer than the student without disabilities	5,00% 3	0,00% 0	30,00% 6	10,00% 2	15,00% 3	25,00% 5	10,00% 2	4,1

Both tables show that individuals with autism have a variable learning-to-read pattern. According to the participants’ answers, it is clear that people with autism learn to read in a more difficult and sometimes challenging way than students without autism. Participants were asked to the reflect on the autism population’s learning to read. If we sort the results from the largest to the smallest groups thus: ‘Difficult and challenging; it takes much longer than the student without disabilities.’ > “Difficult and challenging; it takes much longer than the student without disabilities.’ > ‘Same as students without Disabilities’ > ‘Easier than students without disabilities.’

This indicates that generally individuals with autism are not good readers, and at the same time they have difficulty in learning to read. This demonstrates that there are individuals who have difficulties learning to read within the autism population. The literature review did not show specific information about what can cause learning-to-read difficulties. Also, literature did not show detailed data about autism’s learning-to-read difficulties. Our results show that people with autism have difficulty in learning to read. We think that this data is valuable for future research and literature.

4.2.4.2 Turkish language group

The Turkish and English group results are not consistent with each other. First option in the English group has a higher value than others, it is exactly the opposite in the Turkish group. The second-highest value in Turkish group is the second option as 5,1. However, this second option has the lowest value in the English group as 3,63. These inconsistencies do not have any scientific explanation, but it is clear Turkish group has more difficulty in reading.

The highest values in Turkish group that are the fourth option and the third option. These results emphasize that Turkish students with autism may have strong difficulties in learning the letterforms and they can confuse the characters with similar shapes. Both tables show significant problems which may benefit in creating a typeface for autism's education problems.

T A B L E 1 4

Turkish group survey Section 7

Options	1	2	3	4	5	6	7	Average
Reading the word with the missing letter.	10,00% 3	10,00% 3	20,00% 6	6,67% 2	10,00% 3	23,33% 7	20,00% 6	4,47
Reading the word with responding different letter in the word and/or blending the letter.	3,33% 1	0,00% 0	23,33% 7	6,67% 2	13,33% 4	30,00% 9	23,33% 7	5,1
Has difficulty with learning letter names and mixing sounds they make with similar letters.	0,00% 0	0,00% 0	20,00% 6	3,33% 1	16,67% 5	30,00% 9	30,00% 9	5,47
Confuses letters that looks similar.	3,33% 1	6,67% 2	13,33% 4	6,67% 2	13,33% 4	16,67% 5	40,00% 12	5,30

4.2.5 Section 8

4.2.5.1 English Group

In the English language group survey, the letter-pair 'b-d' took the highest value in section 8, with a rate of 45.8% of participants. This problem is generally characterized by dyslexia. it is obvious that it is the most important pair to be edited in the typeface to be made for individuals with autism and the differences between the two letterforms should be more. This problem may be caused by the perception or learning issue of letterforms; for this reason, it needs to redesigned and tested. The second highest value is the letter-pair of 'b-p' with 33.3% value. Other letter pairs are, respectively, 'd-p' 'd-q' 29.2%, 'f-t' 25%, 'm-n' 20.8%, 'i-l' 'a-e' 16.7%, 'e-c' 'a-d' 'b-h' 'n-h' 12.5%, 'a-u' 'c-a' 'c-u' 'c-o' 'c-q' 'e-o' 'g-q' 'j-l' 'm-w' 'u-n' 'v-x' %8.3.

These letter-pairs share common features making them have similar forms with each other. Section 8 emphasis that individuals with autism are having difficulties with letterforms that are similar to each other. Also, similar letter-pairs may lead to misreading. These letter-forms should be redesigned to improve the learning-to-read-experience for individuals with autism. A newly designed typeface might help people with autism. However, it is apparent that this needs to be tested.

T A B L E 1 5

English group survey section 8

English Language	
Letter pairs	Value
b-d	45.8%
b-p	33.3%
d-p, d-q	29.2%
f-t	25%
m-n	20.8%
a-e, i-l	16.7%
e-c, a-d, b-h, n-h,	12.5%
a-u, c-a, c-u, c-o, c-q, e-o, g-q, j-l, m-w, u-n, v-x	%8.3

4.2.5.2 Turkish group

The results of the Turkish group survey did not differ very much from the survey of the English group. The highest value was the same letterform pair in both groups. The 57.1% of participants choose the letter-pair of b-p, and 60.7% of participants choose the letter-pair of d-b. The letter pair of c-ç and o-ö is the highest numbered letter pair in this group. Experts say that this problem arises from the similarity of letterforms. However, it is clear that this problem should be examined in detail.

T A B L E 1 6

Turkish group survey section 8

Turkish Language	
Letter pairs	Value
b-d	60.7%
b-p	57.1%
c-ç, o-ö	46.4%
ı-i, d-p	42.9%
m-n	32.1%
f-t, g-ğ	28.6%
i-I, s-ş	25%
a-e, a-o, i-I,	21.4%
v-y	17.9%
a-d, d-q, f-l, g-y, g-q, j-i, u-n, s-z, v-w	14.3% - 7.1%

Table 16 Turkish group survey section 8

It was not clear in the literature whether the individual with autism have problems with some letterforms. So, this information supports future research to conduct a detail investigation on autistic people as a poor reading subgroup.

4.2.6 Section 9

In section 9, the selected characters consist from the narrow, wide and rounded groups of letterforms. These letterforms are cited in the literature as the letters that may cause misreading (Beier S. , 2009; Sanford, 1888; Bouma. 1971; Tinker, 1928; Geyer, 1977; Dockeray, 1910). The results obtained were not different from the results in Section 8, the highest value is the group **b = h, d, p** with %50 value, others like '**i = j, l, t**' and '**u = m, n, y, h, v**' have the highest second value in the English language group result.

T A B L E 1 7

English language similar letter groups

English Language	
Letter and groups	value
a = n, u, s, e, d, o, u	%15
b = h, d, p	%50
c = e, o, a, d, u,	%15
e = c, o, g, s, a	%20
f = l, t, i, r	%20
i = j, l, t	%30
l = j, t, f	%20
u = m, n, y, h, v	%30

Table 17 English language similar letter groups

However, We added accent character in Turkish language group survey and the second-highest result came from ‘s = ş, z.’ These results show us the character with similar shape may cause miss reading problems in individuals with autism. Also, the results tell us which characters have to be redesigned or investigated to improve character identification or better learning experience.

T A B L E 1 8

Turkish language similar letter groups

English Language	
Letter and groups	value
a = n, u, s, e, d, o, u	%25,9
b = h, d, p	%48,1
c = e, o, a, d, u,	%3,7
e = c, o, g, s, a	%14,7
f = l, t, i, r	%7,4
i = j, l, t	%3,7
l = j, t, f	%7,4
r = f, t, n	%3,4
ö = o, u, ü, a	%33,3
s = ş, z	%44,4

Table 18 Turkish language similar letter groups

5. Survey discussion

The survey provided the information needed to design a typeface. This information could not be obtained from the literature. Based on this survey result, a typeface can be designed. In addition, we hope the results will inspire further research on this subject. The results of the survey emphasized the following information:

- Special education teachers thinking individuals with autism has learning to read difficulties.
- Learning-to-read is more difficult for a student with autism than the student without autism, and sometimes it can be a long and challenging process.
- Individuals with autism can have problems such as reading the letterforms incorrectly, mixing the shape of the letterforms with similar letterforms, difficulty learning letter names, and letter jumping⁵.

5 To read a word with a missing letter.

In addition, experts have shown the letters-pairs which can cause misreading by the student with autism.

In the survey, individuals with autism and their problems in reading were investigated. But the literature shows that these problems not be characterized with autism’s symptoms nor dyslexia. It was mention in the literature, this problem may be due to the normally delayed or impaired reading pattern (Åsberg & Sandberg, 2012). This knowledge led us to think that this problem might be a cause of learning disabilities. However, new research to identify this should be carried out. Considering this information, we hypothesized that a typeface might be designed not only for individuals with autism but also for individuals with learning disabilities. Also, as empirical knowledge, teachers thought that changing similar character forms or reducing the similarity between similar letterforms can be useful to teach the phonics and show the main structure of the letter skeleton.

6. Practical Work Typeface

6.1 Method

The typeface was designed according to the information obtained from the survey, empirical knowledge, literature review and studies on the relative legibility of characters and typeface design. Firstly, all characters were designed on paper and then were moved into a vector-based computer software and were drawn again via Glyphs software. The typeface family was designed by considering the information given in the survey output.

6.2 Design process

Much legibility research has been utilized in the design process of the Accessible font (Arditi, 2004; Beier & Larson, 2010; Beier, 2012; Bernard, Aguilar, & Castet, 2016; Bessemans A., 2016; Dyson & Beier, 2016; Legge, 2006; Oruç, Landy, & Pelli, 2006; Perea, Panadero, Moret-Tatay, & Gómez, 2012). However, two studies primarily guided the structure of the typeface. Firstly, we utilized visibility of single characters from Beier (2009). After, it was utilized and examined Larson and Carter’s (2016) study of letter confusion; misreading a letterform or confusion of a letterform in the rows of three letters. Both these studies conclusions founded the main structure of the typeface. Both studies investigated detail letter visibility, misreading, and confusion. Firstly version 1 was made, other versions were designed using the main structure of the version 1. The overall aim of the design was to create a typeface family that could be used by teachers in reading and education, with low similarities between similar letterforms or with a stimulus.

6.2.1 Study of character shape

We created the Typeface with considering information from the survey, empirical knowledge, legibility studies, and literature review. According to these studies, the new typeface can have the following features;

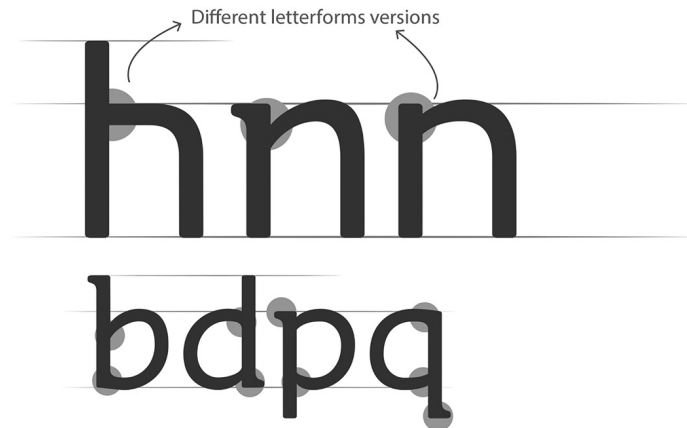
- Differentiation between similar letter shape,
- Different versions according to different needs,
- Legible structure (open counter, large x- height, open terminal)
- Large letter space between characters,
- Contrast and large accents (large dote and large contrast cedilla).

6.2.2 Similar Characters

A different approach than conventional typeface design was applied while designing the character shape in version 2, 3, 4. Serif features on similar letterforms were added to make differences between similar letterforms. In addition to these features, different traits were used on character shapes, which can be seen as basic examples of some differences below.

FIGURE 2 .

Differences between similar letterforms



According to the special education expert opinions in the survey, we know the letter pairs which individuals with autism may misread. But not all individuals with autism have the same problem. This is just a subgroup in the autism population. According to these results, we need to make a font that is accessible to everyone and can address different needs. At the same time design of the characters should not disturb the reader. It should be compatible and easy to read, but at the same time, it should be able to emphasize the places of the character and to be distinctive from the similar shapes. To meet these requirements, 5 fonts and at least one set for each font have been designed. These five versions and sets made to ensure to meet individuals' needs in the reading process.

6.2.3 Extended Characters

In a Turkish survey study, it was seen that Latin extended characters in the Turkish alphabet can cause misreading by being confused with basic Latin characters. In the Turkish script, lowercase 'i' and capital 'I' are the same character. If we compare to English we can see as lowercase 'i' and capital 'I'. Also, in Turkish script there are several accent characters as ö-o, ü-u, i-i, ç-c, ş-s and g-ğ. Therefore, we tried to reduce these similarities between accented characters by using serifs and sets in regular version 2, version 3 and version 4.

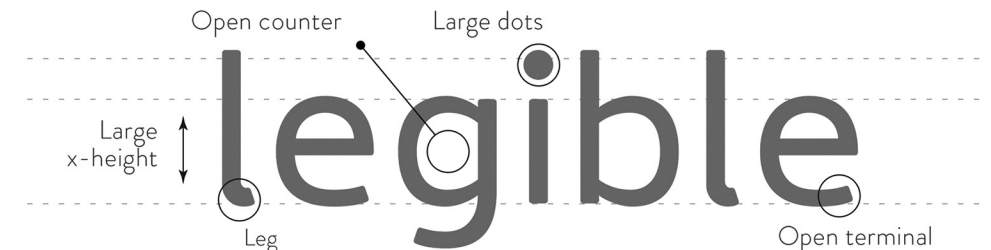
6.3 Accessible Font

6.3.1 Character Design of Version 1 (v.1)

In Accessible Font Version 1, the elements that disturb the reader were avoided and a neutral form was tried to be obtained. The aim was to reveal a font using only the factors affecting legibility. These factors are x-height, counters, and terminals. See the structure and feature of the v.1 font at the bellow.

FIGURE 3 .

Accessible font designed with a high x-height metric, to be more legible. Accessible font metrics are: Ascender: 1505 Cap Height: 1434 x-Height: 1024 Descender: -410 (Units).



6.3.2 Accessible Font Version 2 (v.2)

The Regular v.2 font was designed especially for individuals who have difficulty distinguishing the letter forms between basic Latin and extended characters. Serif features were applied on extended letterforms so that extended letterforms could be separated from the basic Latin characters as a different shape. This hybrid version was developed to help the individuals who learn reading with letter-based learning system but, it can be used in the word-based learning system to identify better the characters in the word. The letterforms 'o' and 'ö' contain different forms in order to have a distinctive shape. The teacher can choose the set 1 option and convert the serif character into sans serif so that only the letterforms of 'a, b, d, p, q, f'

stays as different letterforms from v.1. Set 2 lets us swap the serif feature on the extended characters to basic Latin characters (see figure7). In this way, basic characters will have serif but extended characters will not contain the serif feature.

FIGURE 4.

Font sets and character features of Regular v.2

Basic Latin	ö o ü u i l
Stylistic Alternates ss.01	ö o ü u i l
Stylistic Alternates ss.02	ö o ü u i l

6.3.3 Accessible Font Version 3 (v.3)

The v.3 typeface was designed specifically for individuals who have difficulty in distinguishing similar letterforms. In the v.3 font, the main purpose of the design was to distinguish the similar glyphs to avoid the distractive elements which would disturb the typeface balance and harmony in the typeface family. The similarities were tried to be reduced by adding serif features and different character shapes on similar shapes (like b, d, p, q). In addition to these features, V.3 extended letterforms have serif features in the set 1 option. So, teachers can add serif features on the extended letter like in v.2. If the teachers want to swap the serif between basic Latin and extended version, they can use set 2 (see figure 9).

FIGURE 5.

Regular v.3 typeface feature.

Basic Latin	b d ü u ö y
Stylistic Alternates ss.01	b d ü u ö y
Stylistic Alternates ss.02	b d ü u ö y

A balance between the ‘i-l’ and ‘ı-l’ (see figure10) were tried to be created because in Turkish alphabet, both letterforms are a separate letterform pair.

FIGURE 6.

Differences of the narrow letterforms between Arial, Helvetica and Regular v.3

Regular v.3	i l i l l t j
Arial	i l i l l t j
Helvetica	i l i l l t j

In wide characters, we tried to reduce similarities with adding serifs to change the shapes without breaking the harmony (see figure11).

FIGURE 7.

Differences of the shapes between Arial, Helvetica and Regular v.3

Regular v.3	p d q p n y
Arial	p d q p n y
Helvetica	p d q p n y

The experts showed⁶ the following letterform pairs that can generally be misread by individuals with autism. The changes were applied to characters to avoid these misreadings. These changes can be compared with Helvetica typeface to understand the differences between similar character shapes.

FIGURE 8.

Differences between the similar letterforms of the Regular v.3

b d b p d a f t m n
i l n h

FIGURE 9.

Differences between the similar letterforms of the Helvetica

b d b p d a f t m n
i l n h

6 Special education teachers cited in the survey section 8 and 9 the letter-pairs, which can cause misreading by individuals with autism.

6.3.4 Accessible Font Regular v.4

An approach was applied to reduce the harmony between the similarities of the characters as much as possible. The main feature of v.4 is that there are more elements that can disturb the reader than v.3. It is a version designed with applying originality to the structure of similar characters. On this design, while some extended Latin characters have serifs, some characters have no serifs. So, in the design of v.2, all the extended Latin characters have serifs, while in v.4 only some characters (s-ş,g-ğ,c-ç,i-ı,ü-u,o-ö) have serifs. These characters are letterform pairs obtained from the results of the Turkish survey, which can lead to reading errors.

In v.4 font, the characters 'a', 'b', 'e', 'h', 'n', and 'p' were designed in a different shape from the v.3. In this way, care was taken to increase the differences between the letterforms compared to v.3.

Below, the increasing of differences between similar letterforms from version 1 to version 4 are shown. These differences were made according to needs in the reading education. Teachers can choose the version or sets according to the individual problem in the special education process.

FIGURE 10.

Development of the versions from Regular v.1 to Regular v.4.

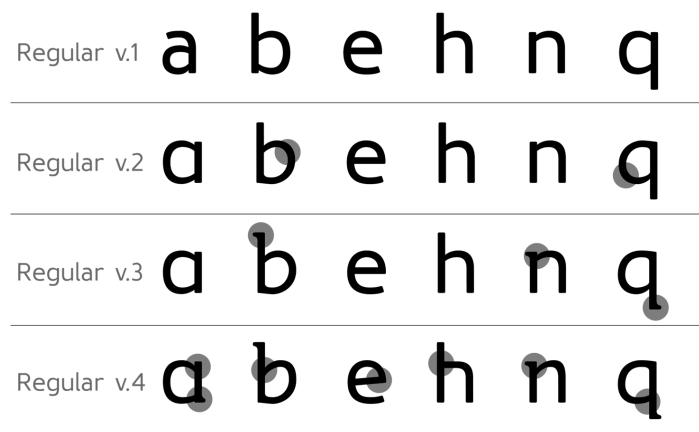
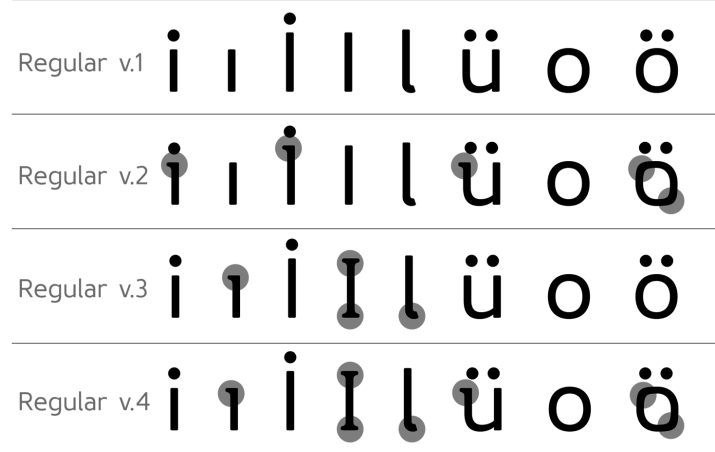


FIGURE 11.

Differences of the similar letterform characters from v.1 to v.4

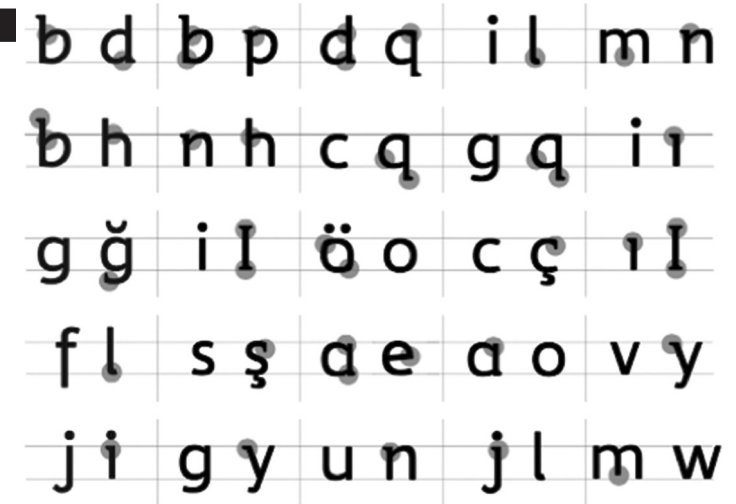


Below, it is possible to see the changes

made to teach and to separate the letterform pairs which are similar. The light coloured shapes indicate the distinctive stimuli on the characters. Teachers can use these stimuli to show these are not the same letter pair it has a different sound and different shape.

FIGURE 12.

Differences of the similar letterform form of Regular v.4

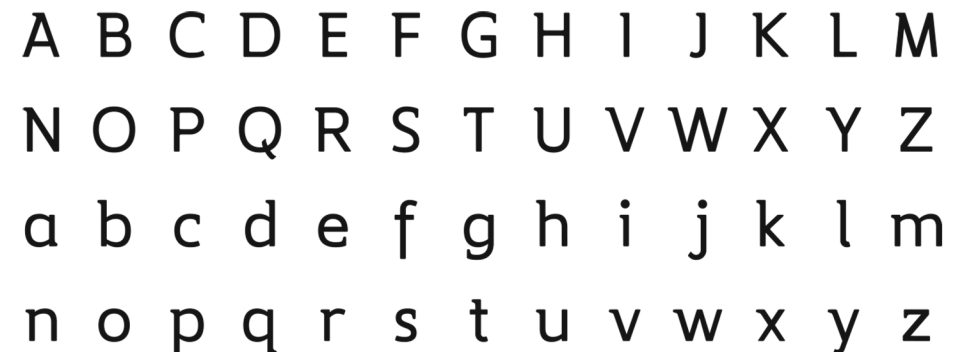


6.3.5 Accessible Font Regular v.5

Version 5 doesn't include differences among similar letterforms. It has the same feature as of version 1. The main character structure of v.5 was taken from v.1 and added some serif features. v.5 and v.1 are clear fonts. They can be used in the long paragraph. In the following table, you can see the basic Latin characters of the Regular v.5.

FIGURE 13.

Accessible Font version 5



6.4 Chapter Discussion

The accessible font should be seen as a test model for educators to prevent reading errors and teach the letters more easily on individuals with autism and learning disabilities. All of these changes on similar letterforms are made for teachers to use in teaching letters. These changes aimed to provide teachers with better reading education by emphasizing differences in similar letterforms. These changes can be an essential tool in an effective educational strategy for teachers because of the difficulties encountered in reading instruction, difficulties in teaching letters, and the difficulty of confusing letterforms because of their similarities.

It would not be right to make certain judgments about its effectiveness without testing the accessible font. Individuals who are receiving special education may have individual needs in education, therefore teachers need to have many educational materials and various educational interventions to make their education effective. We are hoping that the accessible font will be one of these educational materials in reading education, thanks to customization options of the typeface with five different version and stylistic sets.

We recommend to use the typeface in the following areas; V.1 and v.5 are suitable fonts for longer text. They can be used in illustrated reading books for children, in the bodies of large text. We recommend to use v.2, v.3, v.4 in word reading studies according to individual's requirements, in Pecs system, letter-based and word-based learning systems, in titles or everywhere where the picture is presented with a word.

7. Conclusions

The survey study has shown the opinions of special education teachers about the reading abilities of autistic individuals. Teachers' practice-based opinions are that autistic individuals have problems and difficulties in learning to read. The information collected from these professionals gave us a concept on how to develop a typographic prototype (a font) that meets the needs of customization of educators and contributing to a more personalized teaching approach. According to our findings, a typeface can be useful to increase the differences between the letterforms without disturbing the typeface harmony for individuals with autism or learning disabilities. Also, a typeface can use letter spacing to address the letter jumping problem (Omar & Bidin, 2015). We believe it is possible to create a new typeface that serves as a tool for reading-based strategies for autistic individuals. According to our results, while designing for individuals with autism and individuals with learning disabilities, these groups should not be generalized and design should be made these group's individual needs. However, these findings have to be tested on individuals with autism. It is not right to mention benefits without testing a typeface. Future research is essential to definitive conclusions.

The survey results provided the following information to test in feature research: Experts showed that the letter pairs which can cause misreadings in individuals with autism, which are b-p, d-p, d-q, f-t, m-n, a-e, i-l in English survey result. Also, experts showed that letter pairs of c-ç, o-ö i-l, i-i, g-ğ, s-ş as the ones which can cause the misreading in Turkish survey. In addition, some of the students with autism were found to have the following difficulties in learning to read and in the reading process; reading a word with the missing letter, difficulty in learning the names of the letters, confusing the letters that look similar.

These results should not be generalized to the autism population. It is known that while some students with autism can have difficulties in learning to read, some of them do not.

We hope that this investigation will contribute to the existing literature, exposing some difficulties identified by professionals regarding the learning to read and character recognition by autistic individuals. However, to prove its effectiveness, the prototype (typeface) will have to be tested on teaching and eventually improved. The future test should be made on poor word reading subgroup in autism or learning disabilities.

References

- Åsberg, J., & Sandberg, D. (2012). Dyslexic, delayed, precocious or just normal? Word reading skills of children with autism spectrum disorders. *Journal of Research in Reading*, 35, 20 - 31.
- Alberto, P., Fredrick, L., Hughes, M., McIntosh, L., & Cihak, D. (2007). Components of visual literacy: Teaching logos. *Focus on Autism and Other Developmental Disabilities*, 22, 234-243.
- Arditi, A. (2004). Adjustable typography: An approach to enhancing low vision text accessibility. *Ergonomics*, 47(5), 469-482.
- Beier, S. (2012). *Reading letters: Designing for legibility*. BIS Publishers.
- Beier, S., & Larson, K. (2010). Design improvements for frequently misrecognized letters. *Information Design Journal*, 18(2), 118-137.
- Bernard, J. B., Aguilar, C., & Castet, E. (2016). A new font, specially designed for peripheral vision, improves peripheral letter and word recognition, but not eye mediated reading performance. *PloS One*, 11(4).
- Bessemans, A. (2016). Chapter 2: Matilda: a typeface for children with low vision. In *Series on Language Processing, Pattern Recognition, and Intelligent Systems* (pp. 19-36). World Scientific.
- Bessemans, A. (2016). Typefaces for Children's Reading. *TIJDSCHRIFT VOOR MEDIAGESCHIEDENIS*, 19(2).
- Bouma, H. (1971). Visual recognition of isolated lower-case letters. *Vision Research*, 11, 459-474.
- Dockeray, F. (1910). The span of vision in reading and the legibility of letters. *Journal of Educational Psychology*, 1, 123-127.

- Dynia, J. M., Brock, M. E., Justice, L. M., & Kaderavek, J. N. (2017). Predictors of decoding for children with autism spectrum disorder in comparison to their peers. *Research in Autism Spectrum Disorders*, 37, 41–48.
- Dyson, M. C., & Beier, S. (2016). Investigating typographic differentiation: Italics are more subtle than bold for emphasis. *Information Design Journal*, 22(1), 3–18.
- Fernandes F.D.M, d. L.-A. (2015). Reading in Autism Spectrum Disorders: A Literature Review. *Folia Phoniatr Logop*, 169–177.
- Fombonne, E. (1999). The Epidemiology of Autism: A Review. *Psychological Medicine*, 29, 769–86.
- Fombonne, E. (2005). Epidemiological studies of pervasive developmental disorders. . (R. P. F. R. Volkmar, Ed.) *Handbook of autism and pervasive developmental disorders*. , 42–69.
- Gabig, C. S. (2010). Phonological awareness and word recognition in reading by children with autism. *Communication Disorders Quarterly*, 31, 67–85.
- Garfield, S. (2010). *Just My Type: A Book About Fonts*. London: Profile Books.
- Geyer, L. (1977). Recognition and confusion of the lowercase alphabet, *Perception & Psychophysics*, . 22(), (5), 487–490.
- Grigorenko, E., Kiln, A., Pauls, D., Sent, R., Hooper, C., & Volkmar, F. A. (2002). descriptive study of hyperlexia in a clinically referred sample of children with developmental delays. *Journal of Autism and Developmental Disorders*, 32, 3–11.
- Janan, D., & Wray, D. (2012). *Guidance on the principles of language accessibility in National Curriculum Assessments: research background*. London, UK: OFQUAL.
- Kelly J. Whalon, S. A. (2009). Evidence-Based Reading Instruction for Individuals with Autism Spectrum Disorders. *Focus Autism Other Dev Disabl*, 1(24), 3–16.
- Kliewer, C., & Landis, D. (1999). Individualizing literacy instruction for young children with moderate to severe disabilities. *Exceptional Children*, 66, 85–100.
- Koegel, R., & Koegel, L. (2006). *Pivotal Response Treatment for Autism: Communication, Social, & Academic Development*. Baltimore (MD): Paul H Brookes Publishing Co.
- Lanter, E., & Watson, L. (2008). Promoting literacy in students with ASD: The basics for the SLP. *Language, Speech, and Hearing Services in Schools*, 33–43.
- Larson, K., & Carter, M. (2016). Sitka: a collaboration between type design and science', in: *Digital Fonts and Reading*. (M. C. Dyson., & C. Y. Suen., Eds.) World Scientific Publishing Co. Pte. Ltd.
- Legge, G. E. (2006). *Psychophysics of reading in normal and low vision*. Lawrence Erlbaum Associates.
- McLean, R. (1980). *The Thames and Hudson Manual of Typography*. London: Thames and Hudson Ltd.

- Nally, A., Healy, O., Holloway, J., & Lydon, H. (2018). An analysis of reading abilities in children with autism spectrum disorders. *Research in Autism Spectrum Disorders*, 14–25.
- Nation, K., Clarke, P., Wright, B., & Williams, C. (2006). Patterns of reading ability in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 911–919.
- National Early Literacy Panel. (2008). *Developing early literacy: Report of the National Early Literacy Panel*. Washington, DC: National Institute for Literacy.
- National Research Council. (2001). *Educating Children with Autism*. Washington, DC: THE NATIONAL ACADEMIES PRESS.
- Newman, T. M., Macomber, D., Naples, A. J., Babitz, T., Volkmar, F., & Grigorenko, E. L. (2007). Hyperlexia in children with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, 760–774.
- O'Brien, G., & Pearson, J. (2004). Autism and Learning Disability. *SAGE Publications and The National Autistic Society*, 125–140. Retrieved from Sage Publishing.
- Omar, Sarah & Bidin, Azman. "The Impact of Multimedia Graphic and Text with Autistic Learners in Reading." *Universal Journal of Educational Research*. 3 (2015):989-996. 10.13189/ujer.2015.031206.
- Poulton, E. "Size, style, and vertical spacing in the legibility of small type-faces." *Journal of Applied Psychology*. 56/2 (1972):156-161.
- Reynolds, L. "Legibility studies: Their relevance to present-day documentation methods." *Journal of Documentation*. 35/4 (1979): 307-340.
- Tinker, M. *Legibility of Print* (3rd ed.). Iowa: Iowa State University Press, 1963.
- Tracy, W. *Letters of Credit: a View of Type Design*. Boston: David R. Godine, 1986.
- Walker, S. *The Songs the Letters Sing: Typography and Children's Reading*. Reading: National Centre for Language and Literacy/The University of Reading, (2005).
- Woods, Rebecca & Davis, K. & Scharff, L.F.V.. "Effects of typeface and font size on legibility for children." *American Journal of Psychological Research*, 1. (2005):86-102.

References from internet

- Beier, S. (2009, May). *Typeface Legibility: Towards defining familiarity* Sofie Beier. Retrieved May 26, 2018, from researchonline: http://researchonline.rca.ac.uk/957/1/Sofie_Beier_Typeface_Legibility_2009.pdf
- National Health Service. (2018, 07 30). *Overview - Dyslexia*. Retrieved 02 6, 2019, from National Health Service: <https://www.nhs.uk/conditions/dyslexia/>

- Laz, L. (2009, January). *Teaching Emergent Literacy Skills to Students with Autism*. Retrieved from scholarworks.boisestate.edu: https://scholarworks.boisestate.edu/cgi/viewcontent.cgi?referer=https://www.google.com.tr/&httpsredir=1&article=1003&context=spe-ed_gradproj
- Centers for Disease Control and Prevention. (2018, April 16). *Centers for Disease Control and Prevention*. Retrieved 08 25, 2018, from cdc.gov: <https://www.cdc.gov/ncbddd/autism/data.html>
- Department of Health. (2009, March 31). Retrieved May 18, 2018, from <http://www.easy-read-online.co.uk>: <http://www.easy-read-online.co.uk/media/10612/comm%20basic%20guidelines%20for%20people%20who%20commission%20easy%20read%20info.pdf>
- ILSMH European Association. (1998, June). *Make it Simple European Easy-to-Read Guidelines*. Retrieved May 2018, 17, from <https://digitalcommons.ilr.cornell.edu>: <https://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=1271&context=gladnetcollect>

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