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SCOPING REVIEW ON EYE-GAZE AS AN ACCESS METHOD FOR AUGMENTATIVE AND ALTERNATIVE COMMUNICATION

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Digital Object Identifier: https://doi.org/10.13023/etd.2023.120

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SCOPING REVIEW ON EYE-GAZE AS AN ACCESS METHOD FOR AUGMENTATIVE AND ALTERNATIVE COMMUNICATION

THESIS

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in the
College of Health Sciences
at the University of Kentucky

By

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Lexington, Kentucky

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2023

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ABSTRACT OF THESIS

SCOPING REVIEW ON EYE-GAZE AS AN ACCESS METHOD FOR AUGMENTATIVE AND ALTERNATIVE COMMUNICATION

Background: Eye-gaze is an access method used for people with severe motor impairments to communicate when other access methods for augmentative and alternative communication (AAC) are not feasible. The purpose of this research was to conduct a scoping review on eye-gaze as an access technique for AAC. This scoping review uses Light's communicative competences (i.e., linguistic, operational, social, and strategic) as a framework to analyze recent literature.

Methods: Five databases were searched to find relevant articles that considered eye-gaze as an access method for communicative purposes. Results were charted and analyzed to determine which, if any, communicative competences and associated factors were being targeted in current research.

Results: Sixteen studies were selected for analysis. Of these sixteen, ten studies had an intervention. None of the studies reviewed targeted or measured all areas of communicative competence and associated factors.

Discussion: In order for people to become effective communicators, they must be competent in all the following domains: linguistic, operational, social, and strategic. Approaching future research from a communicative competence framework may be beneficial in improving outcomes for targeted populations.

KEYWORDS: Augmentative and Alternative Communication, Alternative and Augmentative Communication, Augmentative Communication, Communication Aids for Disabled, Eye-gaze, Eye Movements

Sara Elise Craig

03/30/2023

SCOPING REVIEW ON EYE-GAZE AS AN ACCESS METHOD FOR AUGMENTATIVE AND ALTERNATIVE COMMUNICATION

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DEDICATION

To the students that taught me the power of eye-gaze.

ACKNOWLEDGMENTS

The following thesis, while an individual work, benefited from the insights and direction of several people. First, my Thesis Co-Chairs, Dr. Hidecker and Dr. Page, who exemplify the high-quality scholarship to which I aspire. Dr. Hidecker and Dr. Page have encouraged and provided guidance at every stage of the thesis process. Their feedback and thought-provoking conversations have been invaluable. Next, I wish to thank the third member of my thesis committee, Dr. Kearns, who provided insights related to my thesis from a special education perspective. I am deeply grateful for the motivation and support provided by my thesis committee. Each individual guided my thinking and provided insights which substantially improved the final product.

In addition to the technical and instrumental assistance above, I received equally important assistance from family and friends. My husband, Parker Craig, provided on-going support and encouragement throughout the thesis process, spending many evenings with me at UK. I would like to thank my family and friends for believing in me and for helping me accomplish this goal in my academic journey.

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CHAPTER 1. INTRODUCTION

This scoping review used Light's communicative competences (1989) as a framework to analyze recent research on eye-gaze as an access method for augmentative and alternative communication (AAC).

1.1 Background Information

AAC is used to provide additional ways to communicate for anyone who is unable to communicate all desired messages to all communication partners across all settings (Beukelman & Light, 2020, p. 5). Different types of AAC range from unaided, such as gestures, to aided high-tech AAC, such as eye-gaze speech-generating devices (SGD). People with many different diagnoses require AAC in order to communicate, and, depending on their comorbidities, they may require different access methods in order to operate their AAC devices (Beukelman & Light, 2020, pp. 243-268). Access considers how a person selects the message which they are attempting to transmit. Eye-gaze is the access method on which this review will focus.

An additional component of AAC systems is whether they are high-tech or low-tech. Low-tech AAC systems are those in which there are no electronic components. Considering eye-gaze AAC, a low-tech option would be an eye transfer (E-TRAN) board (Figure 1.1). High-tech AAC are AAC systems which involve the use of an electronic system, and these systems are able to produce speech output. High-tech, speech-generating, eye-gaze technology involves the use of an AAC system which detects where the person is looking for a specified amount of time and speaks the selected message (Figure 1.2).

1.2 Eye-gaze AAC Users

Eye-gaze is typically used for communication purposes by people with severe motor impairments combined with communication difficulties. The most common diagnoses with which people use an eye-tracking communication system include: cerebral palsy (CP), Rett syndrome (RTT), and amyotrophic lateral sclerosis (ALS) (Caligari et al., 2013; Hwang et al., 2014; Karlsson & Wallen, 2017; Käthner et al., 2015; Townend et al., 2016). Additionally, eye-gaze AAC may be beneficial for those in a locked-in state (Caligari et al., 2013; Hwang et al., 2014; Karlsson & Wallen, 2017; Käthner et al., 2015; Townend et al., 2016). Children with motor impairments may be able to use eye-gaze technology as a means of communication as early as 9-months of age (Hemmingsson et al., 2018).

Eye-gaze AAC systems can provide many benefits for users and their families such as giving people a way to communicate to form social connections and relationships (Caligari et al., 2013; Hwang et al., 2014). Children using eye-gaze as an access technique for AAC have a way to actively engage and demonstrate increased participation over time in activities such as circle time, listening to music, and playing games. Using gaze-based AT can give children, previously without a formal means of communication, a way to control their lives (Borgestig, Rytterström, et al., 2017).

1.3 Communicative Competence Framework

Communicative competence has been defined as "the quality or state of being functionally adequate in daily communication, or of having sufficient knowledge, judgement, and skill to communicate" (Light, 1989, p. 138). Light (1989) identified four areas of communicative competence in which a person must become proficient in order to

be an efficient, successful communicator. The four areas of communicative competence are linguistic, operational, social, and strategic competence. Competence in these areas depends on the interrelation between knowledge, judgement, and skills, as well as psychosocial and extrinsic factors (Light, 1989; Light & McNaughton, 2014). Psychosocial factors are concepts such as motivation, attitude, confidence, and resiliency. Extrinsic factors include policies, practices, attitudes, and environmental supports and barriers such as knowledge and skills of communication partners (Light, 1989; Light & McNaughton, 2014). Some specific environmental considerations that may facilitate successful use of an AAC system or hinder success include parent attitude and support, amount of training, communicative functions available with system, and medical factors (Baxter et al., 2012; Borgestig et al., 2016; Johnson et al., 2006; Moorcroft et al., 2020). Environmental considerations such as these are an important factor to consider when developing interventions because of the role they can play in the success of the AAC user.

Linguistic competence involves mastering the linguistic code of a language; or, in the case of AAC, the user must become competent in both the spoken language(s) of their community as well as the AAC system. This includes both the receptive and expressive components of the language. Operational competence involves becoming proficient in the actual operation of the AAC system including any motor movements necessary to control the access method. This may include turning the device on/off, programing the system, and changing system settings. Social competence relates to pragmatic language concepts such as communicative intent, turn-taking, and discourse management. This competence differs for AAC users in that different strategies and skills may need to be learned in order

to use AAC to become skilled in social situations such as knowing when to use different modes of communication based on the setting and communication partner. Last, strategic competence involves using strategies to compensate for any communication limitations and overcoming communication breakdowns due to limitations of an AAC system such as using multiple modalities to communicate and pre-stored phrases (Light, 1989).

All communicators must demonstrate competence within the linguistic and social domains, but the operational and strategic domains are unique to AAC users. AAC users in general must consider how to achieve social and operational competence. Eye-gaze AAC users have additional considerations such as calibrating and positioning the device in direct view of the user's eyes, environmental lighting, and adjustments which may need to be made due to the presence of eye disorders (Chen & O'Leary, 2018).

1.4 Purpose

To the author's knowledge, no research has examined eye-gaze access by AAC users from the view of the communicative competence framework (Light, 1989; Light & McNaughton, 2014). Considering the importance of achieving competence across linguistic, operational, social, and strategic domains to become an effective communicator, the purpose of this scoping review is to determine (1) what communicative competences are currently being targeted by interventions for eye-gaze users and (2) what competences are being considered in outcome measures across the literature.

Figure 1.1 Low-Tech Eye-Transfer Board


Figure 1.2 High-Tech, Speech-Generating Eye-Gaze AAC System

CHAPTER 2. METHODS

2.1 Protocol

Protocol was based on the Preferred Reporting Items for Systematic Reviews and Meta-analysis for Scoping Reviews Protocols (PRISMA-ScR;(Tricco et al., 2018). The PRISMA-ScR protocol includes a checklist of 20 mandatory items and two optional items. These reporting guidelines were developed by an expert panel outlining the minimum items to be included in research reports. The PRISMA-ScR checklist and explanation can be found in the *Annals of internal medicine* journal (https://doi.org/10.7326/M18-0850) (Tricco et al., 2018).

2.2 Eligibility Criteria

To be included in this review, papers were required to be a peer-reviewed journal article, written in the past ten years (2012-2022), and considered high-tech eye-gaze AAC for the purpose of communication. These inclusion criteria were implemented to focus on the most recent eye-gaze systems, interventions, and issues surrounding the use of high-tech eye-gaze AAC systems. Papers were excluded if they were a systematic review, did not focus on eye-gaze for the purpose of communication, were published prior to 2012, or were not peer-reviewed. 2012 was selected as the cutoff following an initial overview of literature in which the author determined this to be the date when literature shifted to studying the most recent high-tech eye-gaze AAC systems.

2.3 Information Sources

Initial search was conducted within the following electronic databases: Cumulative Index to Nursing and Allied Health Literature (CINAHL), Educational Resources Information Center (ERIC), PsycInfo, Linguistics and Language Behavior Abstracts

(LLBA), and MEDLINE. Expanders used included "Apply Equivalent Subjects" on all databases except LLBA in which this was not an option. Search mode for ERIC, CINAHL, PsycInfo, and Medline was Boolean/Phrase. Search strategies were drafted by professor (M.J.C.H) and further refined by team discussion. Controlled vocabulary was determined for each database for the following terms "augmentative and alternative communication" and "eye gaze" (Table 2.1). The controlled vocabulary determined for each database was then used to search for relevant articles. These articles were exported to EndNote through which duplicates were removed. Search was last conducted 19 October 2022.

2.4 Search Strategy

See Table 2.2 for search terms and search options used within each database.

2.5 Selection of Sources of Evidence

Titles and abstracts were screened for relevant articles using inclusion/exclusion criteria. Full text of articles initially meeting inclusion/exclusion criteria were then read to determine if the article would be included in the review. Articles selected for full-text review were reviewed by first author, and a second reader determined agreement of inclusion/exclusion. Consensus was reached through discussion when disagreements occurred.

2.6 Data Charting Process

A data-charting form was developed by professor (M.J.C.H.) and graduate student (S.E.C.) to determine which information to extract. S.E.C. independently charted the data, and a second reviewer checked agreement on data extracted. Second reviewers recorded disagreements which were then discussed in order to reach a decision. If a decision could not be reached, a third reviewer was consulted.

2.7 Data Items

Data recorded regarding participants was charted based on AAC users discussed in articles. For example, if a study included one child using AAC, their caregiver, and their teacher, this was charted as one participant (the child using AAC). The following data was extracted from included records: type of study, study location, number of participants, sex of participants, race/ethnicity of participants, age of participants, additional population specifications (e.g., disorders), how data was measured, type of eye-gaze system, communication software, intervention, person targeted by intervention (e.g., AAC user, parent of AAC user, teachers), duration of intervention, components of the intervention, location of the intervention, outcome measures, and the aim of the study/research questions(s).

Ages of participants were sorted as follows: infants and toddler (birth – 2 years), preschool (3 - 4 years), elementary school-age (5 - 9 years), pre- and young adolescent (10 - 14 years), older adolescent and young adult (15 - 20 years), adult (21 - 65 years), and older adult (65+ years). Studies were only coded in age groups specifically stated (e.g., study listing participants as 21+ years-old was only coded as 'adult'). In longitudinal studies, the age ranges that participants fell in at any point during the duration of the study were included when extracting data for review (e.g., if child participated in study as a 1-year-old until they were 3-years old, study coded as 'infant and toddler' and 'preschool'). The 21-year cut-off for the 14-20-year age group was selected due to this being the age at which the majority of states in the United States of America have set as the age at which a person may no longer attend high school (Statistics, 2017).

Outcome measures were recorded as stated in the article and charted in groups with similar outcome measures grouped together (e.g., a study looking at 'eye gaze performance – accuracy and time on task' and a study looking at 'time on task' were grouped together into one outcome measure titled "accuracy and time on task").

2.8 Synthesis of Results

Once the data was charted, author determined that current research related to eye-gaze and AAC is looking at a wide array of outcome measures and interventions are targeting many different areas. In order to analyze the research using communicative competences as a framework, interventions and outcome measures were evaluated to determine what communicative competences were targeted through interventions and measured in outcomes (e.g., "accuracy and time on task" was associated with the operational competency). Data was charted for communicative competences and additional factors based on descriptions of communicative competences (Light, 1989; Light et al., 2003; Light & McNaughton, 2014). This grouping included the following domains and associated factors: linguistic, operational, social, and strategic competencies, psychosocial factors, extrinsic factors, and knowledge, judgement, and skills.

Table 2.1 Controlled Vocabulary by Database

Database	Term Used to Find Controlled Vocabulary	Controlled Vocabulary
CINAHL	Augmentative and Alternative Communication	(MM "Alternative and Augmentative Communication")
CINAHL	Eye gaze	(MM "Eye Movements+")
ERIC	Augmentative and Alternative Communication	DE "Augmentative and Alternative Communication"
ERIC	Eye gaze	DE "Eye Movements"
PsycInfo	Augmentative and Alternative Communication	MM "Augmentative Communication"
PsycInfo	Eye gaze	MM "Eye Fixation"
LLBA	Augmentative and Alternative Communication	MAINSUBJECT.EXACT.EXPLODE ("Augmentative and Alternative Communication")
LLBA	Eye gaze	MAINSUBJECT.EXACT("Eye Movements")
Medline	Augmentative and Alternative Communication	(MM "Communication Aids for Disabled")
Medline	Eye gaze	(MM "Eye-Tracking Technology")

Table 2.2 Search Strategy

Database	Search Terms	Search Options
CINAHL with Full Text	(MM "Alternative and Augmentative Communication") AND (MM "Eye Movements+")	Expanders – Apply equivalent subjects Search modes – Boolean/Phrase
ERIC	DE "Augmentative and Alternative Communication" AND DE "Eye Movements"	Expanders – Apply equivalent subjects Search modes – Boolean/Phrase
PsycInfo	MM "Eye Fixation" AND MM "Augmentative Communication"	Expanders – Apply equivalent subjects Search modes – Boolean/Phrase
LLBA	MAINSUBJECT.EXACT.EXPLODE("Augmentative and Alternative Communication") AND MAINSUBJECT.EXACT("Eye Movements")	
Medline	((MM “Eye Movements”) OR (MM “Eye-tracking technology”)) AND (MM “Communication AIDS for Disabled”)	Expanders – Apply equivalent subjects Search modes – Boolean/Phrase

CHAPTER 3. RESULTS

3.1 Search and Selection of Sources of Evidence

Seventy-six articles were identified from the initial search (CINAHL n=15; ERIC n=13; PsycInfo n=8; LLBA n=20; Medline n=20) (see PRISMA-ScR flowchart; Figure 3.1). Fifty-eight articles remained once duplicates were removed. Once articles were screened, author decided to use the date limitation of 2012-2022 to include the most relevant literature focusing on contemporary eye-gaze AAC. Forty-seven articles were removed during the screening process. Of the nine remaining articles, three were removed due to not considering high-tech eye-gaze AAC system (n=1), not being peer-reviewed (n=1), or not using eye-gaze for communication (n=1). These nine articles were reviewed by primary author and a second reader to ensure consistency of inclusion criteria. The six remaining articles were found in CINAHL (n=4; n=3 duplicates), PsycInfo (n=2; n=1 duplicate), LLBA (n=2; n=2 duplicates), and Medline (n=1).

Citation searching revealed thirteen records for possible inclusion, and three were excluded due to the following reasons: not looking at high-tech eye-gaze AAC system (n=1), not looking specifically at communication (n=1), or not focusing on eye-gaze AAC (n=1). These thirteen records were reviewed by primary author and a second reader to ensure consistency of inclusion criteria. Disagreements were resolved through discussion and brought in a third reviewer if disagreement persisted. In total, sixteen articles were identified and selected for review. This search was last conducted on 19 October 2022.

3.2 Characteristics of Sources of Evidence

Data were extracted to determine characteristics of participants included in studies. Overall, when considering participants using eye-gaze as an access technique for communication, there were 195 participants. Diagnoses included RTT (n=71), ALS (n=56), CP (n=44), spinal cord injury (SCI) (n=10), and no disorder noted (n=14). People with CP were included in the most articles (n=7 sources) followed by SCI (n=5 sources) and RTT (n=5 sources). Age ranges of participants were also determined. The age range most commonly included in studies was 21-64 years (n=9 sources). See Table 3.1 for participant and intervention information from individual sources of evidence.

3.3 Results of Individual Sources of Evidence

See Table 3.2 for results of individual sources of evidence.

3.4 Synthesis of Results

The following sections will provide an overview of interventions followed by an analysis of those interventions. The analysis will consider what communicative competences were targeted across interventions. Next, an overview of outcome measures across studies is provided followed by an analysis of those outcome measures. The analysis will consider which communicative competences are measured in outcome measures across the selected articles.

3.4.1 Interventions

Intervention targets, person(s) targeted by the intervention (e.g., AAC user, parents, teachers), who delivered the intervention, and duration of the intervention were abstracted from each article which included an intervention. Eleven of the sixteen selected articles included an intervention. It is important to note that four of these articles were part of the

same longitudinal study. The first component of the intervention considered was the target of the intervention. Of the eleven articles with interventions, ten sources targeted the intervention towards the AAC user, six sources targeted the parents/family/caregiver, and four sources targeted teachers/assistants. Just over half (n=6 sources) of the interventions targeted multiple groups.

The next component considered was the duration of interventions. Six sources had interventions that lasted between nine and twelve months, one had a duration of six months, two took place between ten and twelve weeks, and two lasted for less than one month with sessions lasting for a total of less than five hours.

The third aspect of interventions considered was the individual components that made up the intervention. The most commonly occurring components of the interventions were giving time to practice (n=5 sources), personalizing applications/adapting the device/software (n=5 sources), and providing individual support/training for the AAC user (n=4 sources). Other components of interventions that were less common included the following: planning meetings (n=3 sources), follow-up meetings (n=3 sources), goal setting/planning (n=2 sources), education for involved parties (n=3 sources), demonstration of the system (n=3 sources), help with positioning (n=1 source), and provision of strategies (n=4 sources). Additionally, in two of the articles, the use of an AAC system was the only component of intervention discussed.

Interventions, including where the AAC system was used throughout the study, took place in the home (n=6 sources), school (n=4 sources), and an inpatient center (n=1 source). Location of intervention was not reported in four articles. See Table 3.3 for an overview of components of interventions.

3.4.2 Analysis of Interventions from Communicative Competence Framework

Interventions were analyzed by components of intervention and Light's (1989) communicative competences (Table 3.4). Considering the components of each intervention and which communicative competences were targeted, one intervention targeted all four communicative competences, six interventions targeted two competences, two interventions targeted one competence, and two interventions did not target any of the communicative competences. The linguistic domain was targeted by one intervention, the operational domain was targeted by nine interventions, the social domain was targeted by seven interventions, and the strategic domain was targeted by one intervention. Considering associated factors, extrinsic factors were targeted by six interventions, and psychosocial factors were targeted as part of one intervention.

Additionally, knowledge, judgement, and skills were considered due to the necessary interplay of these three factors to become competent in any of the communicative competence domains. Knowledge was targeted in eight interventions, judgement was targeted in no interventions, and skills were targeted in nine.

3.4.3 Outcome Measures

The most commonly occurring outcome measures used throughout the selected articles included the following: accuracy and time on task (n=6 sources), activities for which the AAC system is (n=6 sources), parent perceptions, experiences, and satisfaction (n=5 sources), goal attainment and progress (n=4 sources), and psychosocial measures (n=4 sources) (Table 3.5). Nineteen other outcome measures were each measured in three or fewer articles.

3.4.4 Analysis of Outcome Measures from Communicative Competence Framework

Outcome measures were coded based on the communicative competence(s) with which they were associated (Table 3.4). Eleven of sixteen articles measured outcomes in areas associated with more than one communicative competence. Three articles measured outcomes associated in the areas of three communicative competences. The first communicative competence, the linguistic domain, was associated with outcome measures in one article. The second communicative competence, the operational domain, was associated with outcome measures in six articles. The social domain communicative competency was associated with outcome measures in five articles. The strategic domain was associated with outcome measures in one article. Considering associated factors, extrinsic factors were associated with outcome measures in twelve articles and psychosocial factors in nine articles. Considering knowledge, judgment, and skills, knowledge was measured in one article, judgment was measured in three articles, and skills were measured in eight articles.

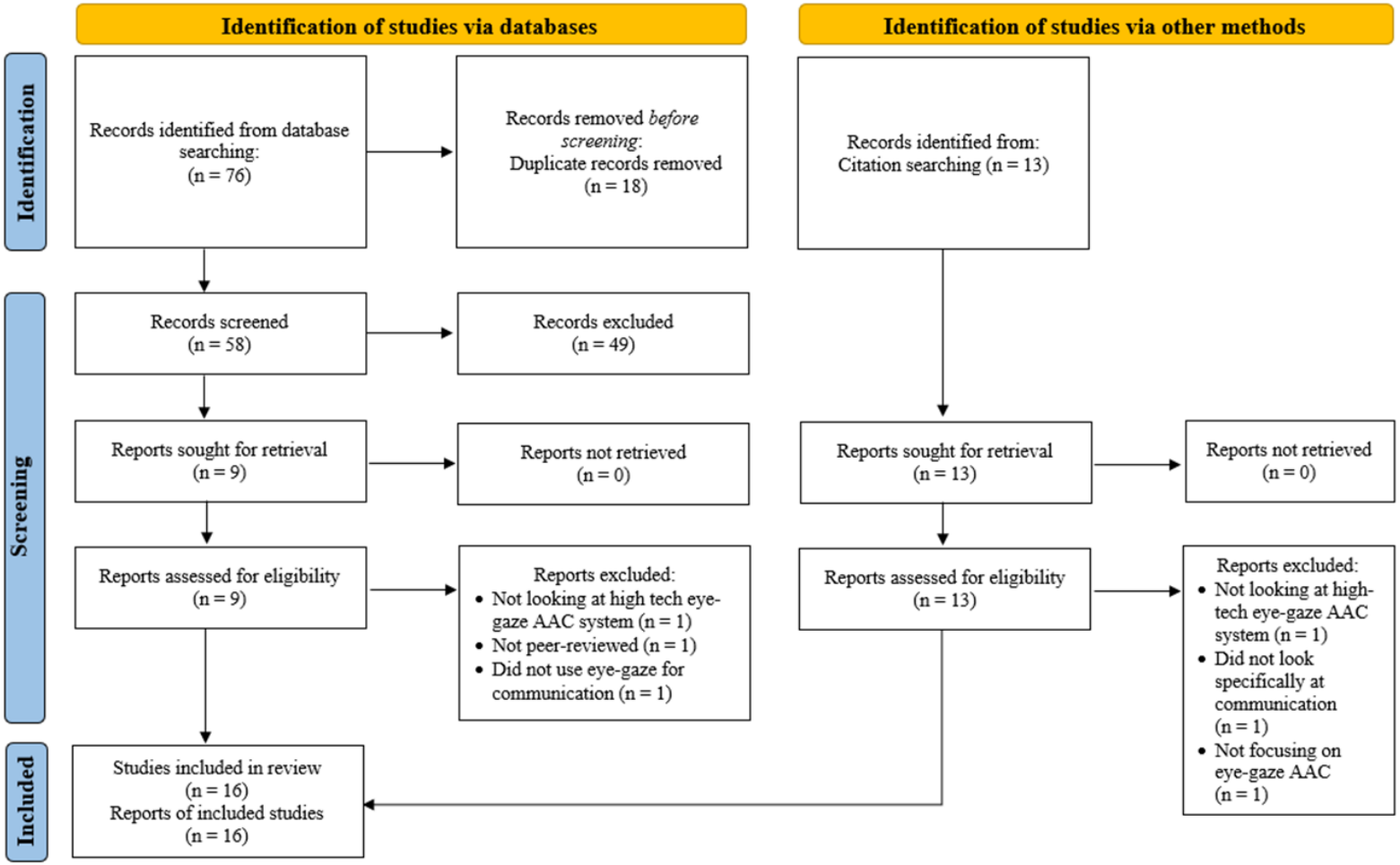

Figure 3.1 PRISMA-ScR Flowchart (Page et al., 2021)

Table 3.1 Characteristics of Sources of Evidence

Source	Participants		Intervention			
	Age	**Diagnosis/ Description**	**Type of Eye-gaze System**	**Recipient**	**Facilitator**	**Duration**
(Borgestig & Hemmingsson, 2017)	1-15 years	CP SCI	Tobii C12 or P10	AAC Users Teachers	Multidisciplinary communication team	10 months
(Borgestig, Rytterström, et al., 2017)	5-15 years	CP	Unspecified	AAC Users Parents Teachers	Multi-professional communication team	9-10 months
(Borgestig, Sandqvist, et al., 2017)	1-15 years	CP SCI	Tobii C12 or P10	AAC Users Parents Teachers Assistants Local services	Multi-professional communication team	14 days spread across 9-10 months
(Borgestig et al., 2016)	1-15 years	CP SCI	Tobii C12 or P10	AAC Users Parents Teachers	Multi-professional communication team	9-10 months (with continued access to gaze-based AT until 15-20 months)

Table 3.1 (continued)

Source	Participants		Intervention			
	Age	**Diagnosis/ Description**	**Type of Eye-gaze System**	**Recipient**	**Facilitator**	**Duration**
(Caligari et al., 2013)	51.5 years^{M}	ALS	Tobii P10	No Intervention Provided		
(Engelke & Higginbotham, 2013)	44 years	ALS	Eye-gaze Response Interface Computer Aid	No Intervention Provided		
(Hemmingsson et al., 2018)	9-36 months	SCI	Tobii C12	AAC Users Parents	Multi-Professional Team	11 months
(Hwang et al., 2014)	40-66 years	ALS	Unspecified - provided by Spring Track, Utechzone Co., LTD (Taipei, Taiwan)	AAC Users	NR	6 months
(Karlsson & Wallen, 2017)	3-5 years	CP	PCEye Go (Tobii Dynavox) and myGaze eye tracker	AAC Users Families	NR	12 weeks (2 systems x 6 weeks each)
(Käthner et al., 2015)	55 years	ALS	Tobii EyeX	AAC Users	NR	4 days (3 access methods; 1 day for eye-gaze)

Table 3.1 (continued)

Source	Participants		Intervention			
	Age	**Diagnosis/ Description**	**Type of Eye-gaze System**	**Recipient**	**Facilitator**	**Duration**
(Porta, 2015)	22-42 years	Able-bodied with no uncorrected visual impairment	Tobii 1750	Volunteer testers	NR	Approximately 1-2 hours
(Tegler et al., 2020)	14 and 18 years	CP	Tobii C12 and Tablet Computer with PCEye	No Intervention Provided		
(Townend et al., 2016)	3.5-60.5 years	RTT	Unspecified	No Intervention Provided		
(Van Middendorp et al., 2015)	51-72 years	SCI	Tobii Eyegaze C15 System	AAC Users	Trained Staff	10 weeks
(van Niekerk & Tönsing, 2015)	7 and 9 years	CP	Unspecified	No Intervention Provided		
(Vessoyan et al., 2018)	9-15 years	RTT	Tobii SGD	Parents	Researchers	12 months

Note. AAC = augmentative and alternative communication; ALS = Amyotrophic Lateral Sclerosis; SCI = spinal cord injury; CP = Cerebral Palsy; NR = not reported; SGD = speech-generating device; M = mean

Table 3.2 Results of Individual Sources of Evidence

Reference	Communicative Competence(s) - Intervention	Additional Impacting Factors - Intervention	Categories of Outcome Measures	Communicative Competence - Outcome Measure(s)	Additional Impacting Factors - Outcome(s)
(Borgestig & Hemmingsson, 2017)	Operational Social	Extrinsic	-Accuracy and time on task -Activities for which the AAC system is used -Amount of use -Goal attainment and progress -Parent perceptions, experiences, and satisfaction -duration of use	Operational Social	Psychosocial Extrinsic
(Borgestig, Rytterström, et al., 2017)			-Activities for which the AAC system is used -Parent perceptions, experiences, and satisfaction	Social	Psychosocial Extrinsic
(Borgestig, Sandqvist, et al., 2017)	Operational Social	Psychosocial Extrinsic	-Accuracy and time on task	Linguistic Operational Social	Psychosocial Extrinsic
(Borgestig et al., 2016)	Operational Social	Extrinsic	-Activities for which the AAC system is used -Amount of use -Goal attainment and progress -Parent perceptions, experiences, and satisfaction	Operational	

Table 3.2 (continued)

Reference	Communicative Competence(s) - Intervention	Additional Impacting Factors - Intervention	Categories of outcome measures	Communicative Competence - Outcome Measure(s)	Additional Impacting Factors - Outcome(s)
(Caligari et al., 2013)	No Intervention		-Client perception and satisfaction of AT -Impact of AT on functional independence -Psychosocial measures	Social	Psychosocial Extrinsic
(Engelke & Higginbotham, 2013)	No Intervention		-Reasons for communication breakdowns	Strategic	Extrinsic
(Hemmingsson et al., 2018)	Operational Social	Extrinsic	-Accuracy and time on task -Activities for which the AAC system is used -Amount of use -Goal attainment and progress	Linguistic Operational Social	
(Hwang et al., 2014)		Extrinsic	-Psychosocial measures -Caregiver burden		Psychosocial
(Karlsson & Wallen, 2017)	Operational Social		-Parent perceptions, experiences, and satisfaction -Advice and support		Psychosocial Extrinsic
(Käthner et al., 2015)	Operational		-Accuracy and time on task -Ease of use -Operator fatigue	Operational	Extrinsic
(Porta, 2015)	Operational		-Accuracy and time on task -User preference	Operational	Psychosocial

Table 3.2 (continued)

Reference	Communicative Competence(s) - Intervention	Additional Impacting Factors - Intervention	Categories of outcome measures	Communicative Competence - Outcome Measure(s)	Additional Impacting Factors - Outcome(s)
(Tegler et al., 2020)	No Intervention		-Scaffolding and collaborative practices	Social	Extrinsic
(Townend et al., 2016)	No Intervention		-Goal attainment and progress -Experiences during trial periods and longer-term use -Expert knowledge -Advice and support -Funding -Family satisfaction		Extrinsic
(Van Middendorp et al., 2015)	Operational Social		-Psychosocial measures -Amount of training -Number of training interruptions	Operational	Psychosocial Extrinsic
(van Niekerk & Tönsing, 2015)	No Intervention		-Environment -Factors contributing to success/failure		Extrinsic
(Vessoyan et al., 2018)	Linguistic Operational Social Strategic	Extrinsic	-Accuracy and time on task -Activities for which the AAC system is used -Parent perceptions, experiences, and satisfaction -Psychosocial measures -Environment -Factors contributing to success/failure -Participants' health	Linguistic Operational Social	Psychosocial Extrinsic

Table 3.2 (continued)

Reference	Communicative Competence(s) - Intervention	Additional Impacting Factors - Intervention	Categories of outcome measures	Communicative Competence - Outcome Measure(s)	Additional Impacting Factors - Outcome(s)
			-Technical issues -Level of prompting required		

Note. AAC = augmentative and alternative communication; AT = assistive technology

Table 3.3 Overview of Components of Interventions

Person Targeted During Intervention	Duration of Intervention	Components of the Intervention	Location of Intervention
- AAC user (n = 10) - Parents/family/ caregiver (n = 6) - Teachers/ assistants (n = 4)	- 9 – 12 months (n = 6) - 6 months (n = 1) - 10-12 weeks (n = 2) - < 1 month (n = 2)	- Time to practice (n = 5) - Personalizing applications/adapting the device/software (n = 5) - Providing individual support/training for the AAC user (n = 4) - Planning meetings (n=3) - Goal setting/planning (n=2) - Education for involved parties (n=3) - Demonstrations of the system (n = 3)	- Home (n = 6) - School (n = 4) - Inpatient center (n = 1) - NR (n = 4)

Note. AAC = augmentative and alternative communication; n = number of sources; NR = not reported.

Table 3.4 Analysis of Interventions and Outcomes

	Communicative Competences				Interrelated Areas			Associated Factors	
	Linguistic	**Operational**	**Social**	**Strategic**	**Knowledge**	**Judgement**	**Skills**	**Psychosocial**	**Extrinsic**
Interventions	n = 1	n = 9	n = 7	n = 1	n = 8	n = 0	n = 9	n = 1	n = 6
Outcome Measures	n = 3	n = 8	n = 7	n = 1	n = 1	n = 3	n = 8	n = 9	n = 12

Note. n = number of sources

Table 3.5 Overview of Most Commonly Measured Outcomes from Sources of Evidence

Accuracy and Time on Task	Activities for which the AAC System is Used	Parent Perceptions, Experiences, and Satisfaction	Goal Attainment and Progress	Psychosocial Measures
n = 6	n = 6	n = 5	n = 4	n = 4

Note. n = number of sources; AAC = augmentative and alternative communication

CHAPTER 4. DISCUSSION

4.1 Summary of Evidence

The first purpose of this study was to determine what communicative competences are currently being targeted by interventions for eye-gaze users. The results demonstrate that among interventions targeting eye-gaze AAC users the most commonly targeted communicative competences are operational and social. Linguistic and strategic competences and psychosocial factors were rarely targeted. Extrinsic factors were targeted in just over half of the articles. Knowledge, judgement, and skills were also a consideration of some articles, but none of the three were targeted in all articles reviewed, and judgement was never targeted.

The second purpose was to determine what competences are being considered in outcome measures across the literature. The results demonstrate similar findings from the first purpose. Operational and social domain competences were the most commonly measured outcomes. Linguistic and strategic competences were rarely targeted. A difference was seen in the amount psychosocial and extrinsic factors were considered as they were both measured in a majority of the articles.

4.2 Future Research

Many factors must be taken into consideration when developing an intervention plan for people using AAC. As well as developing skills in the linguistic and social domains, emphasis of interventions must also target operational and strategic skills and consider the interplay of knowledge, judgement, and skills. Additionally, considering the effects of psychosocial and extrinsic factors, these should play a role in the development of interventions as well. As illustrated by the results of this scoping review, although

current literature surrounding eye-gaze as an access technique currently considers many aspects across outcome measures, these same factors are not always those targeted in interventions.

Overall, a relatively small number of recent studies look at eye-gaze as an access technique for AAC, and an even smaller number consider interventions. Among the eleven studies reviewed that implemented an intervention, the majority targeted areas that correspond with one to two communicative competence(s). In order for communication interventions to be most successful, they should target, or at least consider a person's competence, in linguistic, operational, social, and strategic domains as well as factors related to psychosocial and extrinsic considerations.

It is reasonable to conclude that not all people will need intervention targeting each communicative competence because some people needing eye-gaze as an access method may already be competent in some areas. For instance, a person with ALS who needs an eye-tracking communication system is likely competent in the linguistic and social domains. In this case, an intervention would only need to target operational and strategic areas and consider extrinsic and psychosocial factors. On the other hand, a child with RTT would likely need an intervention to target all communicative competences as they are still developing linguistic and social skills. This being said, when clinicians and researchers are developing interventions, approaching the intervention using communicative competences as a framework would ensure that people are being supported in all areas of communication which would make them an effective communicator.

Additionally, approaching research using the communicative competences as a framework could ensure that future research looking at eye-gaze as an access method for

communication considers all communicative competences and associated factors when measuring outcomes. As the current literature is not approaching the research with this framework, the linguistic and strategic competences are rarely targeted in interventions or measured in outcomes. Furthermore, of all articles that had an intervention, the communicative competences and additional impacting factors targeted by the intervention were not an exact match of the competences and impacting factors measured in the outcomes. It is understandable why the targets and outcome measures did not align as the articles did not approach the studies using communicative competences as a framework. However, as the field continues to research this area, approaching studies using the communicative competence framework could ensure that all domains of communicative competence and additional impacting factors are considered.

4.3 Limitations

Although the current review was comprehensive in the search terms used, only literature found in the listed databases was used in the review. Consequently, it is possible that relevant studies may have been missed. Furthermore, second readers only checked for disagreements rather than blindly reviewing the data. Considering this, it is feasible that their analyses of data may have been persuaded by the first author's analysis. Further research could conduct a more thorough review of the literature including grey literature and have researchers independently review data.

An additional limitation of this study was that some of the reviewed articles did not provide enough information to determine what communicative competences and associated factors were targeted by interventions or measured in outcomes.

4.4 Conclusions

This scoping review analyzed the degree to which research studying eye-gaze as an access method for AAC is approaching interventions and outcomes using communicative competences. Overall, most articles considered in this scoping review did target or measure areas of at least one communicative competence, but none considered all communicative competences and associated factors. Moving forward, considering the importance of ensuring overall communicative competence, it may be beneficial to approach research using the communicative competences and associated factors as a framework to design studies and interventions.

CHAPTER 5. FUNDING

Sara Elise Craig did not receive any funding to complete this scoping review. Dr. Mary Jo Cooley Hidecker and Dr. Judith Page receive a salary from University of Kentucky.

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