Augmentative and Alternative Communication

ISSN: 0743-4618 (Print) 1477-3848 (Online) Journal homepage: informahealthcare.com/journals/iaac20

# From Basic to Applied Research to Improve Outcomes for Individuals Who Require Augmentative and Alternative Communication: Potential Contributions of Eye Tracking Research Methods

Janice Light & David McNaughton

*Augmentative and Alternative Communication*, 2014; 30(2): 99–105

ISSN 0743-4618 print/ISSN 1477-3848 online
DOI: 10.3109/07434618.2014.906498

informa
healthcare

**EDITORIAL**

# From Basic to Applied Research to Improve Outcomes for Individuals Who Require Augmentative and Alternative Communication: Potential Contributions of Eye Tracking Research Methods

JANICE LIGHT[1] & DAVID MCNAUGHTON[2]

[1]*Department of Communication Sciences and Disorders, and* [2]*Department of Educational and School Psychology and Special Education, The Pennsylvania State University, University Park, PA, USA*

## Abstract

In order to improve outcomes for individuals who require AAC, there is an urgent need for research across the full spectrum – from basic research to investigate fundamental language and communication processes, to applied clinical research to test applications of this new knowledge in the real world. To date, there has been a notable lack of basic research in the AAC field to investigate the underlying cognitive, sensory perceptual, linguistic, and motor processes of individuals with complex communication needs. Eye tracking research technology provides a promising method for researchers to investigate some of the visual cognitive processes that underlie interaction via AAC. The eye tracking research technology automatically records the latency, duration, and sequence of visual fixations, providing key information on what elements attract the individual's attention (and which ones do not), for how long, and in what sequence. As illustrated by the papers in this special issue, this information can be used to improve the design of AAC systems, assessments, and interventions to better meet the needs of individuals with developmental and acquired disabilities who require AAC (e.g., individuals with autism spectrum disorders, Down syndrome, intellectual disabilities of unknown origin, aphasia).

**Keywords:** *Complex communication needs; Eye tracking; Basic research; Applied research*

## Introduction

There is a growing body of research that demonstrates convincingly that augmentative and alternative communication (AAC) (i.e., the use of a wide range of unaided and aided strategies and techniques to enhance communication) can have positive effects on communication and participation, including turn taking skills, the expression of communicative functions such as requesting and commenting, acquisition of receptive and expressive vocabulary, narrative development, the length and complexity of messages expressed, acquisition of phonological awareness and literacy skills, and overall communication effectiveness (e.g., Beukelman, Fager, Ball, & Dietz, 2007; Branson & Demchak, 2009; Fried-Oken, Beukelman, & Hux, 2012; Ganz, et al., 2011; Machalicek et al., 2010; Roche et al., 2014; Schlosser, Sigafoos, & Koul, 2009; Wendt, 2009). Furthermore, the research demonstrates that AAC intervention does not impede speech production or recovery; in fact, it suggests that AAC intervention can have positive effects on the frequency and intelligibility of speech production (e.g., Hanson, Beukelman, & Yorkston, 2013; Millar, Light, & Schlosser, 2006; Romski et al., 2010). Beyond these benefits to communication, speech, language, and literacy skills, the research also demonstrates convincingly that AAC intervention can successfully reduce challenging behaviors, enhance on-task behavior, and ease transitions across activities (Bopp, Brown, & Mirenda, 2004; Walker & Snell, 2013). Perhaps most importantly, there is clear evidence that AAC increases access to (and participation in) valued life experiences, including community life, education, work, and volunteer experiences (Batorowicz, McDougall, & Shepherd, 2006; Chung & Carter, 2013; Hunt-Berg, 2005; McNaughton & Bryen, 2007; Mechling & Cronin, 2006; Trembath, Balandin, Togher, & Stancliffe, 2010).

Yet, despite the strong evidence of the benefits of AAC intervention, the potential of AAC remains unrealized for many individuals with complex communication needs. Many individuals who require AAC struggle

Correspondence: David McNaughton, Department of Educational and School Psychology and Special Education, 227 CEDAR, Penn State University, University Park, PA 16802, USA. E-mail: DBM2@psu.edu

*(Received 14 March 2014; accepted 15 March 2014)*

to develop communicative competence, demonstrate deficits in key linguistic skills (pragmatic, semantic, syntactic, and morphological skills), and fail to demonstrate functional literacy skills; as a result, they are limited in their participation in many aspects of daily life: education, employment, home, and community living (Chung, Carter, & Sisco, 2012; Light & McNaughton, 2013; Stancliffe et al., 2010). The challenge for the field is to improve outcomes for individuals who require AAC so that they have the opportunity and support required to develop communicative competence and attain their full potential (Light & McNaughton, 2014).

Why is there such a gap between the potential offered by AAC interventions and the actual outcomes for many individuals with complex communication needs? The answer is simple: There remain many unanswered questions. We do not yet have a clear understanding of which AAC interventions are best for which individuals to achieve which outcomes in which environments. The field urgently needs research aimed at advancing our understanding and providing guidelines for evidence-based practices, in order to improve outcomes for the many individuals who could benefit from the use of AAC.

In developing AAC interventions, it is possible to implement a wide range of systems, both unaided and aided, low tech and high tech (with different representations, organizations, layouts, selection techniques, and outputs), taught using a wide array of instructional technologies and a range of environmental /partner supports (Beukelman & Mirenda, 2013). The permutations and combinations are endless. How do we decide which ones are the best approaches for any given child or adult with complex communication needs?

Unfortunately, most current AAC systems and interventions are atheoretical. They have been developed based on the best guesses of clinicians, technology developers, and researchers as to effective systems and practices; existing AAC interventions are seldom grounded in a strong theoretical understanding of the basic motor, visual, auditory, cognitive, and linguistic processes of individuals with complex communication needs. As a result, although there is evidence that many existing AAC interventions can affect positive outcomes, it is not at all clear that the outcomes represent the best possible outcome that could be achieved. With a better understanding of the strengths and challenges in motor, visual, auditory, cognitive, and linguistic processing for individuals with complex communication needs, it should be possible to develop more appropriate and effective AAC systems and interventions – ones that truly and more predictably respond to the needs and skills of these individuals (Light & McNaughton, 2013).

## Call for Basic Research in AAC

To date, most research in the AAC field has been applied clinical research, focused on the performance of individuals with complex communication needs with specific AAC systems and interventions. Clearly, this research is very important. However, investigating the effectiveness of all of the different interventions in order to gain a better understanding of their impact for each individual or population group would be a seemingly endless task.

To date, there has been a notable lack of basic research in the AAC field to investigate basic underlying processes and test theories to drive the development of effective AAC systems and interventions. A better understanding of the role of these basic processes, as they relate to the use of AAC, would enable us to develop systems and interventions that are a better match for persons with complex communication needs. There is an urgent need for research across the full continuum in order to advance the field and maximize outcomes – from basic research to unearth fundamental language and communication processes, to applied clinical research to test applications of this new knowledge in the real world. Basic research aims to explain, predict, and describe the fundamental bases of behavior, in this case, communication (Stanovich, 2007). Too often, there is the mistaken belief that basic research has no real-world applications; in fact, it is of critical importance in the development of theories of communication and human-system interaction (e.g., human computer interaction, HCI) for individuals with complex communication needs; these theories are fundamental to designing AAC systems and interventions that can be used by people to maximize communication in the real world (Higginbotham, Shane, Russell, & Caves, 2007; Wilkinson & Jagaroo, 2004).

In recent years, consideration of basic research has started to emerge in the AAC field with the publication of forum papers and studies that have explored the basic processing of individuals with complex communication needs and applied the results to suggest ways to improve the design of AAC systems and interventions (e.g., Dukhovny & Soto, 2013; Wilkinson & Light, 2011; Wilkinson, Light, & Drager, 2012). The papers in this special issue of *Augmentative and Alternative Communication* represent an important step forward in this process: They highlight uses of innovative eye tracking research technologies to investigate the basic visual and cognitive processes of individuals with complex communication needs, including those with developmental disabilities (e.g., individuals with autism spectrum disorders, Down syndrome, and/or intellectual/developmental disabilities of unknown origin; Brady, Anderson, Hahn, Obermeier, & Kapa, 2014; Wilkinson & Light, 2014; Dube & Wilkinson, 2014; Gillespie-Smith & Fletcher-Watson, 2014), and those with acquired disabilities such as aphasia (e.g., Thiessen, Beukelman, Ullman, & Longenecker, 2014). They then apply this understanding of basic visual cognitive processes to suggest guidelines to enhance AAC assessment and intervention.

One of the challenges in conducting basic research in AAC has been finding noninvasive techniques to investigate the underlying processing and learning of individuals with complex communication needs. In the past, these processes had to be inferred, based on observable behaviors such as selecting AAC symbols or messages (Wilkinson & Mitchell, 2014, this issue). Obviously such behavioral research is critical because ultimately communication via AAC relies on the observable behaviors of the person with complex communication needs. However, these behaviors are the end products of a complex interplay of visual, cognitive, linguistic, and motor processing; ultimately, it is important to understand these underlying processes in order to minimize processing demands and maximize the communication performance of individuals who require AAC. Understanding the underlying processes allows clinicians, researchers, and developers to make informed and theoretically sound decisions about the design of AAC systems and interventions so that these systems and interventions are far more likely to affect positive outcomes. Eye tracking research technology provides one method for researchers to better understand some of the visual cognitive processes that underlie interaction via AAC.

**Potential Contributions of Eye Tracking Research to the AAC Field**

Eye tracking research methods offer additional advantages over traditional research methods that rely solely on behavioral responses. Traditional assessment and data collection procedures that require behavioral responses (e.g., pointing) may underestimate the capabilities of many individuals with complex communication needs, including those with comprehension impairments that limit their understanding of instructions or task requirements; those with motor impairments that limit their access to required behavioral responses; those with attention deficits that limit their ability to complete tasks; and those with challenging behaviors that limit their compliance with task requirements (Wilkinson & Mitchell, 2014). Typically, these individuals have been considered untestable; it has been difficult to derive information on their understanding and performance via traditional means.

Innovative eye tracking research technologies offer the potential to investigate the underlying visual cognitive processes of individuals with complex communication needs, including those that have previously been considered untestable. Eye tracking research methods are particularly attractive because they place minimal demands on the individual: Specifically, there is no need for the individual to understand oral instructions, comply with these directions, or produce motor responses (Wilkinson & Mitchell, 2014). All that the individual needs to do in most cases is look. The eye tracking research technology (once calibrated appropriately) tracks and records the gaze patterns of the individual over time.

Eye tracking research technologies differ significantly from the AAC systems that are controlled via eye gaze. The research technologies are not designed as communication systems; the individual does not use eye gaze to control the system; rather, he or she simply looks at the screen and the eye tracking research technology rapidly samples the position of the eyes in relation to the computer display and automatically measures the latency, duration, and sequence of fixations (Wilkinson & Mitchell, 2014). These data provide important information and insights into what elements gain and hold an individual's visual attention (and which ones do not), for how long, and in what sequence; they also provide information on how rapidly information is fixated and processed, what causes distractions, and what may be the source of errors in performance (e.g., items to which the individual does not attend, but should; or items to which the individual attends, but should not). This information can be used to improve the design of AAC systems and interventions by maximizing attention to important information and minimizing distractions that may impede processing and reduce the rate of communication. Eye tracking research is particularly powerful because it enables focused investigation of the effects of underlying processes that cannot be directly observed (i.e., allocation of visual attention).

Eye tracking research technologies have been available for a number of years and have a well-established history as a reliable scientific means to investigate a range of underlying visual cognitive processes, including visual attention, perception, memory, and language (Karetekin, 2007). It is only recently that these methods have been applied to populations with disabilities (e.g., Fletcher-Watson, Leekam, Benson, Frank, & Findlay, 2009; Riby & Hancock, 2008, 2009); initially, this research focused on populations that were believed to have no significant oculomotor difficulties (e.g., strabismus, nystagmus), visual acuity impairments, or visual field deficits (e.g., individuals with autism spectrum disorders, Williams syndrome). However, more recently eye tracking research technologies have been successfully calibrated and implemented with children and adults with a wide range of disabilities, including those with complex communication needs who are at risk for concomitant visual impairments (e.g., oculomotor impairments, field deficits). Table I summarizes the success rate of calibration of eye tracking research technologies with individuals with a wide range of disabilities who may require AAC. These data suggest the feasibility of these research methods as tools to investigate visual cognitive processes with these populations, including individuals who have been previously considered untestable. Of course, eye tracking research is not appropriate for everyone. Some individuals with complex communication needs may have severe visual impairments and may not benefit from eye tracking research methods. However, these methods do offer a valid and reliable means to investigate visual cognitive processes with many individuals with a wide range of developmental and acquired disabilities.

Table I. Percentage of Participants (by Disability Group) who Attained Successful Calibration for Eye Tracking Research.

| Disability group | References | Calibration % | |
|---|---|---|---|
| | | Successful | Not successful |
| Children with typical development | de Bordes, Cox, Hasselman, and Cillessen (2013); Ito, Jincho, Minai, Yamane, and Mazuka (2012); Lee and Kuhlmeier (2013); Lochbuehler, Otten, Voogd, and Engels (2012); Mani, Johnson, McQueen, and Huettig (2013); Navab, Gillespie-Lynch, Johnson, Sigman, and Hutman (2012); Sasson, Elison, Turner-Brown, Dichter, and Bodfish (2011); Wilkinson and Light (2014); Wilkinson, O'Neill, and McIlvane (2014) | 92–100% | 0–8% |
| Children with ASD | Sasson et al. (2011); Wilkinson and Light (2014) | 90–100% | 0–10% |
| Children with DS | Wilkinson and Light (2014) | 88% | 12% |
| Children with IDD | Wilkinson and Light (2014) | 83% | 17% |
| Adults with aphasia | Thiessen, Beukelman, Ullman et al. (2014) | 91% | 9% |
| Adults with TBI | Thiessen, Beukelman, and Brown (2014) | 72% | 18% |

*Note*. ASD, Autism spectrum disorder; DS, Downs syndrome; IDD, Intellectual and developmental disabilities of unknown origin; TBI, Traumatic brain injury.

## Special Issue on Eye Tracking Research in the AAC Field

Given the potential of eye tracking research to explore the basic visual cognitive processes of individuals with complex communication needs, we are very excited about this special issue of *Augmentative and Alternative Communication*, which is intended to introduce eye tracking research methods to the field and to share current research and implications for AAC. We are especially grateful to Dr Krista Wilkinson who worked with us to develop the vision for this issue and who served as guest editor for three of the papers (Brady et al.; Gillespie-Smith & Fletcher-Watson; Thiessen, Beukelman, Ullman, et al.).

The issue starts with a paper by Wilkinson and Mitchell that introduces the field to eye tracking research methods and their utility for answering important questions to advance understanding in AAC. Specifically, these authors introduce basic terminology, provide examples of implementation of eye tracking research methods to investigate AAC issues, and explore some of the special challenges of conducting eye tracking research with populations with disabilities who might use AAC, including those related to inferring attention from the presence of fixation and those related to calibration.

The remaining papers then provide examples of specific applications of eye tracking research to inform AAC interventions. Thiessen, Beukelman, Ullman, et al. utilize eye tracking research methods with individuals with aphasia to better understand their visual cognitive processing and the implications for AAC visual scene displays. Specifically, they investigate the effects on the visual attention of individuals with aphasia of the presentation of people within visual scenes and the objects/activities with which they are engaged. They then apply their results to inform the design of AAC displays that maximize visual attention to important information and minimize processing demands in order to enhance communication.

Like Thiessen, Beukelman, Ullman, et al. (2014), Wilkinson and Light (2014) also utilize eye tracking research technology to investigate the visual attention of individuals with complex communication needs, with a view to improving the design of AAC systems. Whereas Thiessen Beukelman, Ullman, et al. focus on adults with aphasia, Wilkinson and Light focus specifically on children with typical development and three groups of children with developmental disabilities who would benefit from AAC (i.e., children with autism spectrum disorders, Down syndrome, and intellectual developmental disabilities of unknown origin). Wilkinson and Light specifically investigate the effects of people within visual scenes on the latency and duration of visual attention by the different population groups, with a view to optimizing the design of visual scene displays as a component of AAC systems.

Brady et al. (2014) also focus on the performance of children, but this time, children with typical development and those with autism spectrum disorders. However, rather than investigating patterns of visual attention as a means to inform the design of AAC systems, the authors explore the utility of eye tracking research methods to assess the receptive language skills of individuals with ASD, especially those who are difficult to test via traditional methods that require behavioral responses (e.g., pointing to a picture in response to a spoken word). Their study provides a preliminary investigation of the feasibility of utilizing eye tracking research technologies to measure comprehension of single words presented orally by measuring duration of fixations to the target, compared to foils in a field of four options, with the hypothesis that children will look longer at targets (i.e., correct responses) than foils (i.e., incorrect responses) when they understand the spoken words.

Gillespie-Smith and Fletcher-Watson (2014) also address issues related to individuals with autism spectrum disorders. However, these authors step back and provide a broad-based review of the eye tracking research with this population; they summarize the results of this research and suggest potential implications for the design of AAC systems. Specifically, they consider four variables of interest: (a) the inclusion of social content (people, faces) in AAC displays; (b) the realism of the images used in AAC displays (e.g., realistic photographs, line drawings, cartoons); (c) the inclusion of written text (traditional orthography) alongside picture symbols; and (d) the complexity of the images used in AAC displays.

Finally, Dube and Wilkinson (2014) consider evidence from behavioral and eye tracking research studies on the phenomenon of overselective attention (i.e., overselectivity) in individuals with developmental disabilities. Overselectivity refers to a limitation in the number of stimuli or stimulus features to which an individual attends; this limitation of attention affects subsequent learning. In the case of AAC, this might include limitations in the features of AAC symbols to which individuals attend (e.g., attending only to the color red in the PCS for *APPLE*, resulting in confusion with other symbols that also are red; or attending only to the first letter of written words such as mom, resulting in confusion with other written words that begin with the same first letter, such as man). Stimulus overselectivity limits learning and generalization. Dube and Wilkinson consider how data from eye tracking research can be used to better understand the processes underlying this phenomenon and explore how these data can be used to develop interventions to address overselectivity and ensure attention to all relevant details.

## Conclusion

As these papers demonstrate, eye tracking research technologies provide an innovative noninvasive method to investigate the basic visual cognitive processes that underlie communication by individuals with complex communication needs via AAC. This type of basic research can serve to elucidate understanding of these processes and support the development of scientifically grounded theories to inform the design of AAC systems specifically and interventions generally. As previously noted, research in AAC has, unfortunately, largely shied away from basic research, perhaps because of the realization that there are urgent immediate real world problems that must be solved to improve outcomes for individuals with complex communication needs and because of the erroneous belief that basic research has nothing to contribute to this process. However, there are innumerable potential permutations and combinations to design AAC systems (e.g., representations, organizations, layouts, selection/production techniques, output) and interventions, and the options continue to increase exponentially. In the absence of well-developed theory to guide the design of AAC systems and interventions, we face the daunting task of testing these myriad combinations until we light upon ones that work. Basic research of the underlying communication process for individuals with complex communication needs provides crucial data to allow us to develop scientifically sound theory to guide our AAC system and intervention development and hence to focus our clinical research agenda. Perhaps Stanovich (2007) articulated the position best, when he wrote:

> … [It is] a mistake to view the basic-versus-applied distinction solely in terms of whether a study has practical applications, because this difference often simply boils down to a matter of time. Applied findings are of use immediately. However, there is nothing so practical as a general and accurate theory. (p.107)

The development of effective AAC technologies and interventions requires coordinated research activities across the continuum of basic research to applied research. Those who develop new AAC technologies and applications must be aware of the basic science underlying human performance, and must use this theory to inform their designs in order to reduce processing demands and maximize performance (see, for example, Thiessen, Beukelman, Ullman, et al., 2014; Wilkinson & Light, 2014; Gillespie-Smith & Fletcher-Watson, 2014). Those who develop new procedures for AAC assessment and interventions can benefit from a fuller understanding of the processes that underlie human behavior (see Brady et al., 2014; Dube & Wilkinson, 2014). Recent technological developments, including advances in eye tracking technology, provide important new tools for better understanding the underlying processes that influence the effective use of AAC systems. This special issue represents an important first step in developing new approaches to basic research, specifically utilizing eye tracking research methods, to determine underlying visual cognitive processing of individuals with complex communication and to use this information to drive the design of scientifically sound AAC systems and interventions to improve outcomes for individuals with complex communication needs.

***Declaration of interest:*** The authors report no conflicts of interests. The authors alone are responsible for the content and writing of this paper.

## References

Batorowicz, B., McDougall, S., & Shepherd, T. A. (2006). AAC and community partnerships: The participation path to community inclusion. *Augmentative and Alternative Communication, 22,* 178–195.

Beukelman, D. R., Fager, S., Ball, L., & Dietz, A. (2007). AAC for adults with acquired neurological conditions: A review. *Augmentative and Alternative Communication*, *23*, 230–242.

Beukelman, D., & Mirenda, P. (2013). *Augmentative and alternative communication: Supporting children and adults with complex communication needs* (4th ed.). Baltimore, MD: Paul H. Brookes.

Bopp, K. D., Brown, K. E., & Mirenda, P. (2004). Speech-language pathologists' roles in the delivery of positive behavior support for individuals with developmental disabilities. *American Journal of Speech-Language Pathology*, *13*, 5–19.

Brady, N. C., Anderson, C. J., Hahn, L. J., Obermeier, S. M., & Kapa, L. L. (2014). Eye tracking as a measure of receptive vocabulary in children with autism spectrum disorders. *Augmentative and Alternative Communication, 30*, 147–159.

Branson, D., & Demchak, M. (2009). The use of augmentative and alternative communication methods with infants and toddlers with disabilities: A research review. *Augmentative and Alternative Communication*, *25*, 274–286.

Chung, Y. C., & Carter, E. W. (2013). Promoting peer interactions in inclusive classrooms for students who use speech-generating devices. *Research and Practice for Persons with Severe Disabilities, 38,* 94–109.

Chung, Y. C., Carter, E. W., & Sisco, L. G. (2012). Social interactions of students with disabilities who use augmentative and alternative communication in inclusive classrooms. *American Journal on Intellectual and Developmental Disabilities, 117*, 349–367.

De Bordes, P. F., Cox, R. F., Hasselman, F., & Cillessen, A. H. (2013). Toddlers' gaze following through attention modulation: Intention is in the eye of the beholder. *Journal of Experimental Child Psychology*, *116*, 443–452.

Dube, W. V., & Wilkinson, K. M. (2014). The potential role of "stimulus overselectivity" in AAC: information from eye-tracking and behavioral studies of attention. *Augmentative and Alternative Communication, 30*, 172–185.

Dukhovny, E., & Soto, G. (2013). Speech generating devices and modality of short term word storage. *Augmentative and Alternative Communication, 29*, 246–258.

Fletcher-Watson, S., Leekam, S. R., Benson, V., Frank, M. C., & Findlay, J. M. (2009). Eye movements reveal attention to social information in autism spectrum disorder. *Neuropsychologia, 47*, 248–257.

Fried-Oken, M., Beukelman, D. R., & Hux, K. (2012). Current and future AAC research considerations for adults with acquired cognitive and communication impairments. *Assistive Technology*, *24*, 56–66.

Ganz, J. B., Earles-Vollrath, T. L., Mason, R. A., Rispoli, M. J., Heath, A. K., & Parker, R. I. (2011). An aggregate study of single-case research involving aided AAC: Participant characteristics of individuals with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *5*, 1500–1509.

Gillespie-Smith, K., & Fletcher-Watson, S. (2014). Designing AAC systems for children with autism: Evidence from eye tracking research. *Augmentative and Alternative Communication, 30*, 160–171.

Hanson, E., Beukelman, D.R., & Yorkston, K. (2013). Communication support through multimodal supplementation: A scoping review. *Augmentative and Alternative Communication, 29*, 310–321.

Higginbotham, D. J., Shane, H., Russell, S., & Caves, K. (2007). Access to AAC: Present, past, and future. *Augmentative and Alternative Communication, 23*, 243–257.

Hunt-Berg, M. (2005). The Bridge School: Educational inclusion outcomes over 15 years. *Augmentative and Alternative Communication, 21*, 116–131.

Ito, K., Jincho, N., Minai, U., Yamane, N., & Mazuka, R. (2012). Intonation facilitates contrast resolution: Evidence from Japanese adults and 6-year olds. *Journal of Memory and Language*, *66*, 265–284.

Karetekin, C. (2007). Eye tracking studies of normative and atypical development. *Developmental Review, 27*, 283–348.

Lee, V., & Kuhlmeier, V. A. (2013). Young children show a dissociation in looking and pointing behavior in falling events. *Cognitive Development*, *28*, 21–30.

Light, J. & McNaughton, D. (2013). Putting people first: Re-thinking the role of technology in augmentative and alternative communication intervention. *Augmentative and Alternative Communication, 29*, 299–309.

Light, J. & McNaughton, D. (2014). Communicative competence for individuals who require augmentative and alternative communication: A new definition for a new era of communication? *Augmentative and Alternative Communication, 30*, 1–18.

Lochbuehler, K., Otten, R., Voogd, H., & Engels, R. C. (2012). Parental smoking and children's attention to smoking cues. *Journal of Psychopharmacology*, *26*, 1010–1016.

Machalicek, W., Sanford, A., Lang, R., Rispoli, M., Molfenter, N., & Mbeseha, M. K. (2010). Literacy interventions for students with physical and developmental disabilities who use aided AAC devices: A systematic review. *Journal of Developmental and Physical Disabilities*, *22*, 219–240.

Mani, N., Johnson, E., McQueen, J. M., & Huettig, F. (2013). How yellow is your banana? Toddlers' language-mediated visual search in referent-present tasks. *Developmental Psychology*, *49*, 1036.

McNaughton, D., & Bryen, D. N. (2007). AAC technologies to enhance participation and access to meaningful societal roles for adolescents and adults with developmental disabilities who require AAC. *Augmentative and Alternative Communication, 23,* 217–229.

Mechling, L. C., & Cronin, B. (2006). Computer-based video instruction to teach the use of augmentative and alternative communication devices for ordering at fast-food restaurants. *The Journal of Special Education, 39*, 234–245.

Millar, D. C., Light, J. C., & Schlosser, R. W. (2006). The impact of augmentative and alternative communication intervention on the speech production of individuals with developmental disabilities: A research review. *Journal of Speech, Language and Hearing Research*, *49*, 248–264.

Navab, A., Gillespie-Lynch, K., Johnson, S. P., Sigman, M., & Hutman, T. (2012). Eye-tracking as a measure of responsiveness to joint attention in infants at risk for autism. *Infancy*, *17*, 416–431.

Riby, D. M., & Hancock, P. J. B. (2008). Viewing it differently: Social scene perception in Williams syndrome and autism. *Neuropsychology, 46*, 2855–2860.

Riby, D. M., & Hancock, P. J. B. (2009). Do faces capture the attention of individuals with Williams syndrome and autism? Evidence from eye tracking movements. *Journal of Autism and Developmental Disorder, 39*, 421–431.

Roche, L., Sigafoos, J., Lancioni, G. E., O'Reilly, M. F., Green, V. A., Sutherland, D., .. Edrisinha, C. D. (2014). Tangible symbols as an AAC option for individuals with developmental disabilities: A systematic review of intervention studies. *Augmentative and Alternative Communication, 30*, 28–39.

Romski, M. A., Sevcik, R. A., Adamson, L. B., Cheslock, M., Smith, A., Barker, R. M., & Bakeman, R. (2010). Randomized comparison of augmented and nonaugmented language interventions for toddlers with developmental delays and their parents. *Journal of Speech, Language, and Hearing Research*, *53*, 350–364.

Sasson, N. J., Elison, J. T., Turner-Brown, L. M., Dichter, G. S., & Bodfish, J. W. (2011). Brief report: Circumscribed attention in young children with autism. *Journal of Autism and Developmental Disorders*, *41*, 242–247.

Schlosser, R., Sigafoos, J., & Koul, R. (2009). Speech output and speech-generating devices in autism spectrum disorders. In P. Mirenda & T. Iacono (Eds.), *Autism spectrum disorders and AAC* (pp. 141–170). Baltimore, MD: Paul H. Brookes.

Stancliffe, R. J., Larson, S., Auerbach, K., Engler, J., Taub, S., & Lakin, K. C. (2010). Individuals with intellectual disabilities and augmentative and alternative communication: Analysis of survey data on uptake of aided AAC, and loneliness experiences. *Augmentative and Alternative Communication*, *26*, 87–96.

Stanovich, K. (2007). *How to think straight about psychology.* Boston, MA: Allyn & Bacon.

Thiessen, A., Beukelman, D., & Brown, J. (2014). The effects of two types of engagement on visual attention for adults who have sustained traumatic brain injuries. *Manuscript submitted for publication*.

Thiessen, A., Beukelman, D., Ullman, C., & Longenecker, M. (2014). Measurement of the visual attention patterns of people with aphasia: A preliminary investigation of two types of human engagement in photographic images. *Augmentative and Alternative Communication, 30*, 120–129.

Trembath, D., Balandin, S., Togher, L., & Stancliffe, R. J. (2010). The experiences of adults with complex communication needs who volunteer. *Disability & Rehabilitation, 32,* 885–898.

Walker, V. L., & Snell, M. E. (2013). Effects of augmentative and alternative communication on challenging behavior: A meta-analysis. *Augmentative and Alternative Communication*, *29*, 117–131.

Wendt, O. (2009). Research on the use of manual signs and graphic symbols in autism spectrum disorders: A systematic review. In P. Mirenda & T. Iacono (Eds.), *Autism spectrum disorders and AAC* (pp. 83–140). Baltimore, MD: Brookes.

Wilkinson, K. M., & Jagaroo, V. (2004). Contributions of principles of visual cognitive science to AAC system display design. *Augmentative and Alternative Communication, 20*, 123–136.

Wilkinson, K. M., & Light, J. (2011). Preliminary investigation of visual attention to human figures in photographs: Potential considerations for the design of aided AAC visual scene displays. *Journal of Speech-Language-Hearing Research*, *54*, 1644–1657.

Wilkinson, K. M., & Light, J. (2014). Preliminary study of gaze toward humans in photographs by individuals with autism, Down syndrome, or other intellectual disabilities: Implications for design of Visual Scene Displays. *Augmentative and Alternative Communication, 30*, 130–146.

Wilkinson, K. M., Light, J., & Drager, K. (2012). Considerations for the composition of Visual Scene Displays: Potential contributions of information from visual and cognitive sciences. *Augmentative and Alternative Communication, 28*, 137–147.

Wilkinson, K. M., & Mitchell, T. (2014). Eye tracking research to answer questions about augmentative and alternative communication assessment and intervention. *Augmentative and Alternative Communication, 30*, 106–119.

Wilkinson, K., O'Neill, T., & McIlvane, W. J. (2014). Eye-tracking measures reveal how changes in the design of aided AAC displays influence the efficiency of locating symbols by school-aged children without disabilities. *Journal of Speech, Language, and Hearing Research*, early on line, doi:10.1044/2013_JSLHR–L–12–0159