Finding the best fit: A discrete choice experiment on the decision making of augmentative and alternative communication professionals

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ABSTRACT

Objectives: Many children can benefit from augmentative and alternative communication (AAC) systems for a wide range of reasons (e.g. cerebral palsy, autism). However, little is known about professionals’ decision making when recommending symbol based AAC systems for children. This study examines AAC professionals’ preferences for attributes of AAC systems and how they interact with child characteristics.

Design: AAC professionals answered a discrete choice survey (DCE) survey with six AAC system attributes and four child attributes. Participants chose which AAC system to provide for a child vignette.

Setting: The survey was administered online in the UK.

Participants: 155 UK-based AAC professionals were recruited between 20/10/17 and 4/3/18.

Outcomes: AAC professionals’ preferences were quantified using a mixed logit model, with model selection performed using a stepwise procedure and the Bayesian Information Criterion.

Results: Significant differences were observed in preferences for AAC system attributes, and large interactions were seen between child attributes, e.g. participants made more ambitious choices for children who were motivated to communicate using AAC, and predicted to progress in skills and abilities. These characteristics were perceived as relatively more important than language ability and previous AAC experience.

Conclusions: AAC professionals make trade-offs between attributes of AAC systems, and these trade-offs change depending on the characteristics of the child for whom the system is being provided.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This is the first discrete choice experiment, and only the second stated preferences study in the field of augmentative and alternative communication technology.
- The study used unusual and innovative methodology by (1) using a best-worst scaling case 1 study in attribute selection; (2) having AAC system choices be made in the context of a child vignette
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formed from a set of attributes; and (3) introducing a new measure termed relative interaction attribute importance to interpret results.

- Child vignettes were relatively simple, and a single vignette could represent children with very different needs.
- In some ways the discrete choice experiment task differed from how augmentative and alternative professionals make decisions in practice.

INTRODUCTION

Many people struggle to produce speech for a wide range of reasons, including cerebral palsy, intellectual/developmental delays and autism spectrum. Even within diagnoses, individuals’ communication related needs and abilities are extremely varied. Augmentative and alternative communication (AAC) refers to methods of supporting their communication. AAC systems encompass a large number of unaided methods including signing, facial expressions and body language as well as the use of aided systems.\(^1\) This article focuses on aided AAC systems, also known as communication aids, which include high-tech electronic devices, such as those used by Stephen Hawking or Britain’s Got Talent winner Lee Ridley, as well as low-tech systems, such as boards and communication books.

AAC can improve the lives of people with communication disabilities.\(^2\)-\(^4\) It is especially important for children, as their language and communication abilities are still developing and their needs evolving,\(^5\)-\(^7\) in contrast to adults. What system they use thus has an impact not just in the immediate future but over their whole lifetime.

It has been estimated that approximately 1 in 200 children in the UK would benefit from AAC\(^8\)-\(^10\), although rates of abandonment of AAC systems by children of 30-50% have been observed\(^11\)\(^12\), with the causes of abandonment not well understood. AAC systems can be costly (up to £10,000 for high-tech systems) and require a large amount of professional support.\(^13\) However, they have been suggested to be a cost-effective use of NHS resources.\(^14\)
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The process through which children receive AAC systems can vary, both across and within countries. In the UK, children’s needs and abilities are commonly assessed by a team of AAC professionals, which may include speech and language therapists, occupational therapists and/or specialist teachers. The team makes recommendations, and a final decision is made with variable input from the child and family, depending on individual circumstances. This contrasts with, for example, the USA, where AAC professionals commonly work individually rather than in teams.

Choosing an AAC system requires consideration of many features. For example, what type of graphic symbols (e.g. photos, stylized pictures, words) to use, how many symbols are available, how they are organized, and how they are accessed. The large degree of heterogeneity in the population of people who benefit from AAC, and in the systems available, means the assessment and subsequent matching of individual and system is a complex task and unique to each person.

There is currently a lack of documented evidence for assessment and decision making processes, and what does exist is frequently individual case studies. AAC professionals must often make difficult and complex decisions in a complicated, heterogeneous and rapidly evolving environment, balancing the needs of an individual child, and available resources. They must also take account of the cultural and contextual influences that shape each assessment. While there are studies which highlight some important factors in decision making, available guidelines tend to focus on the organisational structure of services, rather than decision making as such.

This study addresses this lack of knowledge by providing quantitative evidence about how AAC professionals make decisions. It uses a survey method termed a discrete choice experiment (DCE). DCEs are commonly used in healthcare, and can quantify the preferences of patients, health professionals and the public for treatments, service delivery methods, policies, or other things. In this case the goal was to measure the preferences of AAC professionals for providing AAC systems.

This study is part of a wider project entitled Identifying Appropriate Symbol Communication aids for children who are non-speaking (I-ASC), which examines provision of AAC systems for children in the UK. It has
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several components, using several different research methods\textsuperscript{27-30} to generate a body of research evidence on current practice and recommendations for best practice. This has resulted in a set of tools and resources to aid AAC professionals who work with children in their everyday practice, available here: https://iasc.mmu.ac.uk.

Resources to aid AAC professionals’ decision-making are needed in part due to major advances in the AAC landscape in recent years.\textsuperscript{31,32} This induces technological innovation, for example the introduction of iPads and eye-tracking, though low-tech systems still represent the best solution in many cases.\textsuperscript{22,33}

Another development is a greater expectation that people who use AAC will contribute to all aspects of life,\textsuperscript{31,34,35} coupled with advocacy for the right to communicate.\textsuperscript{33} New possibilities for AAC have been created by the advent of new communication methods such as text messaging\textsuperscript{36}, email\textsuperscript{37} and social media.\textsuperscript{38} This has led to the definition of what communication competence means for people who use AAC.\textsuperscript{39}

Although, as mentioned above, there is a lack of robust evidence surrounding the decision-making process, some factors in successful adoption of AAC have been identified. An AAC system is more likely to be adopted by a motivated child\textsuperscript{11} with good support from the child’s network.\textsuperscript{16,19,29} Another important factor is that the AAC system must meet a child’s individual needs and circumstances, which will be unique to every child.\textsuperscript{11,33,40}

That it is so important for children to be given AAC systems that are highly tailored to their circumstances means it is important to study the process by which the decisions are made. A previous study from the current research project did so using a Best-worst Scaling case 1 survey.\textsuperscript{30} This method was chosen as it could quantify which of a large number of child and AAC system related factors (37 in total) AAC professionals considered most and least important in decision-making.

The current study sought to complement the previous results by examining a smaller number of factors in more detail using a DCE. The study aimed to quantify the trade-offs AAC professionals make between different attributes of AAC systems, and how those trade-offs change depending on the characteristics of children. This is the first DCE carried out in AAC, and there were challenges associated with performing a
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DCE with a target population of AAC professionals (for details see discussion). Thus an additional goal was to establish the feasibility of using DCEs as a research tool in AAC.

As yet, there is limited quantitative research in AAC decision making. A study from the current research project ran a Best-worst Scaling (BWS) Case 1 survey 30, which quantified what AAC professionals considered the most and least important factors related to both children and AAC systems. However, the earlier study did not examine the trade-offs professionals make between different attributes of AAC systems, nor how trade-offs change depending on the characteristics of children.

This study presents a discrete choice experiment (DCE) which seeks to achieve both these aims. Participants were shown a series of vignettes describing hypothetical children and made choices as to which among a set of hypothetical AAC systems they would choose for each child. Analysing the results revealed respondents’ preferences for the levels of various AAC system attributes, as well as how those preferences are influenced by the children’s characteristics.

METHODS

Survey development

No stated preference work existed in AAC prior to this research project. Thus there were a large number of potential attributes and little evidence as to which ones to include in a DCE. A BWS case 1 study was hence performed initially and the results used to guide attribute selection for the DCE. It is considered good practice with stated preference studies to generate attributes using qualitative methods41 42. This ensures that attributes are meaningful to participants, capture what they consider the most important factors of a decision-making situation, and are interpreted in the same way by both participants and researchers. Attributes for the BWS study were created using focus groups and interviews with AAC professionals, people who use AAC, their families, and other stakeholders; systematic literature reviews; and input from an expert panel. For more details see section 2 of Webb et al. 30
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The BWS study produced relative importance scores for 19 child and 18 system attributes given in Appendix B with their rank in terms of relative importance. DCE attributes were selected from these during consensus discussions between authors with expertise in AAC, speech and language therapy, and health economics. The selection criteria were that attributes should: (1) form coherent and realistic descriptions of children and systems; (2) address the research aims of the wider research project, e.g. a focus on symbol communication; (3) include mainly attributes with high relative importance scores in the BWS study; and (4) be small in number so choice tasks would not overburden respondents. Consensus was achieved via unstructured discussions until all authors were in agreement. This resulted in four child and five system attributes. The attributes are listed in Tables 1 and 2, together with non-specialist descriptions for the benefit of the general reader. Please note these are not intended as formal definitions, for a rigorous treatment see e.g. Beukelman and Miranda.43

Broadly speaking, child attributes capture a child’s language ability, experience with AAC, attitude/motivation to communicate with AAC, and whether the child is expected to regress, plateau or progress in communication ability. A total of 54 child vignettes can be formed from the child attributes. Authors with expertise in AAC and speech and language therapy identified and removed 18 child vignettes representing unrealistic combinations, leaving 36.

System attributes broadly capture what vocabulary set(s) are pre-provided by manufacturers, how many vocabulary items are provided, how they are organised, the type of graphical symbols used, and how consistent the layout of words/symbols are in terms of position or interface and/or navigation to select them. It was not stated whether a system was high-tech or low-tech, although certain levels (e.g. vocabulary sets with staged progression) would only be feasible with a high-tech system. Authors with experience in AAC and speech and language therapy removed 158 unrealistic combinations from the 432 AAC systems which could be formed from the system attributes, leaving 274.

Prior experience from the BWS study suggested it would be difficult to recruit a large respondent sample, thus a relatively heavy response burden of 12 choices between three systems was selected. Participants were shown
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three child vignettes, referred to as Child A, B and C, and made four choices for each child vignette. An example question is shown in Appendix A.

The survey’s statistical design (i.e. which levels of the AAC system attributes were presented in each question) was generated using NGene (©ChoiceMetrics) with five blocks, with 60 choice tasks split into five blocks. The design sought to maximise D-efficiency, which may be thought of as a measure of how much information it is possible to extract from survey respondents.\(^4\)

The survey was tested by five AAC professionals and the wording of some attributes and levels altered.

**Survey administration**

The DCE was administered online for ease of recruitment. Recruitment was carried out using email lists of AAC professionals gathered by the research project as part of prior activities, publically available lists and websites and the professional contacts of authors. The study was also advertised via the mailing list of Communication Matters (www.communicationmatters.org.uk), a UK wide AAC charity, through the project website and online media. Responses were collected between 20/10/17 and 4/3/18. Ethical approval was received for the study from an NHS Research Ethics Committee (REC reference 6/NW/0165) and informed consent was obtained from participants at the start of the survey.

Participants began by confirming they contributed towards AAC decision making for children, and those who did not answered only demographic questions. The precise wording of the question was: “I confirm my work involves assessing children for aided AAC systems and I contribute to the decision making in relation to the language and vocabulary organisation with in AAC systems.” During testing it was revealed that some AAC professionals did not have sufficient input into the decision making process in their day-to-day practice for the DCE questions to be meaningful (e.g. occupational therapists specialising in optimising physical access to an AAC system recommended by other members of the team), and this question was designed to filter out such respondents.
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Three child vignettes and one survey block were randomly allocated to each participant. The order of system attributes was randomised between participants, but consistent within participants and which systems appeared on the left, middle and right of the screen was also randomised. At the end of the survey, participants answered questions about themselves and their experiences with AAC (for details, see supplementary online material).

Analysis

Analysis of participants’ choices was grounded in random utility theory. This is a standard approach in which participants are assumed to choose the object which maximises their utility. The utility of an object is modelled as depending partly on the attributes of the object and partly random, the latter component capturing the influence of all factors not included in the model. In a given choice scenario \( t \), participant \( i \) chooses which of three AAC systems to allocate to child \( c \). The utility to participant \( i \) of allocating AAC system \( s \in \{1,2,3\} \) to child \( c \) in choice scenario \( t \) is

\[
u_{isc} = \alpha_s + \beta_{ic}x_s + \varepsilon_i
\]

where \( \alpha_s \) is an alternative specific constant for AAC system \( s \), \( x_s \) is a vector of dummy variables indicating AAC system levels, \( \beta_{ic} \) is a vector of coefficients which differ across participants and children, and \( \varepsilon_i \) is a random error term which varies across choice scenarios and alternatives.

The coefficient on level \( l \) of system attribute \( a \), \( \beta_{ilc} \), depends of the characteristics of the child vignette according to

\[
\beta_{ilc} = \gamma_{il0} + \gamma_{il}z_c
\]

where \( \gamma_{il0} \) is a constant giving the preference for a system attribute at baseline child levels, \( z_c \) is a vector of dummy variables indicating vignette levels and \( \gamma_{il} \) is a vector of coefficients, allowing for heterogeneity in relative preference for AAC system attributes depending on child characteristics.

A full model with all interaction terms includes too many parameters to estimate reliably. Thus parameters were eliminated in a stepwise process and a final preferred mixed logit model identified using the Bayesian
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Information Criterion. The mixed logit model incorporates participant heterogeneity by allowing AAC system attribute parameters to be random, following a normal distribution with both means and variances depending on child characteristics. For details, see Appendix C.

Models were estimated using the CMC Choice Modelling Centre Code for R version 1.1 and all analysis was carried out using R version 3.3.1. Statistical significance was assessed at the 5% level after adjusting for multiple testing using Holm’s sequential Bonferroni correction.

Results are presented using a new measure termed relative interaction attribute importance (RIAI) which assesses how big an impact child attributes have on AAC professionals’ decision making. It is analogous to relative attribute importance, often used to present DCE results, and it may be calculated either with respect to a single choice object attribute or overall with respect to all choice object attributes. For details, see Appendix D.

Note relative attribute importance is not an appropriate measure of the importance of AAC system attributes here, as their relative importance changes depending on which child AAC professionals are presented with. Nor is it appropriate to take the mean relative importance over all child vignettes. The set of child vignettes used is not representative of the case mixes seen by AAC professionals: some vignettes may represent children commonly seen, while other vignettes may represent a child with a combination of characteristics seldom encountered. Thus averaging over the set of vignettes would not give meaningful insight as to the relative importance of an attribute in AAC professionals’ decision making in the real world.

Patient and public involvement

One author (SM) is an AAC user, and one (LM) is the parent of an AAC user, and both were involved in all stages of the research. DCE attributes were developed with impact from AAC stakeholders and the survey tested with AAC professionals as detailed above. Findings from the study and the wider research project have been disseminated to AAC stakeholders and the public at events at the Scottish Parliament (Edinburgh, UK), the Science and Industry Museum (Manchester, UK) and the Houses of Parliament (London, UK).
A total of 172 participants completed the survey, of whom 155 indicated they contributed to decision making regarding AAC systems and answered DCE questions. Summary statistics of their demographics and professional experience are given in Table 3. Most participants were female (~90%) and white. We believe this to be reasonably representative of the population of AAC professionals in the UK. The mean age of DCE participants was around 40, with a range from 24 to 65, and they had around 10 years’ experience on average. Around 75% of DCE participants had a speech and language therapy background, with no other background reported by more than 10%. Those who did not answer DCE questions were less likely to have a speech and language therapy background (~50%), with teacher (~20%) and occupational therapist (~30%) more common.

Approximately 30% of the sample worked with all age groups, while 50-60% worked with each of pre-school, primary school and secondary school age children. The sample also encountered a wide range of diagnoses, e.g. physical disability (~80% of DCE participants), intellectual disability/developmental delay (~70%) and autism spectrum disorder (~65%).

Turning to DCE responses, respondents chose the left-hand option 37.6% of the time, and the central and right-hand options 33.1% and 29.2% of the time respectively, significantly different from an equal distribution (one sample Kolmogorov-Smirnov p = 0.002).

Table 4 contains the results of the final preferred model, with 24 coefficients. The “constant” terms give participants’ preferences for AAC system allocation when shown a child vignette with all attributes at baseline levels, which represents the most challenging profile that can be formed from the set of child levels:

“Child A/B/C has delayed expressive and receptive language and no previous AAC experience. Child A/B/C does not appear motivated to communicate through any methods and means. Child A/B/C is predicted to progress in skills and abilities (regression).”

The interaction terms in the model hence represent how respondents’ preferences for AAC systems change if choosing for a child vignette presenting less of a challenge on a given child attribute.
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For the baseline child vignette, vocabulary sets which are fixed or have staged progression were preferred to no pre-provided vocabulary. There were no significant differences in preferences between up to 50 and 50-1000 vocab items, but over 1000 items was considered significantly worse. There was no significant preference between visual scene, taxonomic or semantic-syntactic vocabulary organisation, but pragmatic organisation was preferred. There was no preference between graphic representation using photos or pictographs, but text was less preferred than either, and idiographic symbols were considered even worse. Finally, having only some aspects of system layout consistent was less preferred than having all aspects consistent or an idiosyncratic layout.

Compared to this baseline child vignette, professionals were much more likely (odds ratio, OR 3.88) to choose systems with staged progression vocabulary sets with staged progression to no pre-installed set if the child vignette predicted progress in skills and ability. An intermediate number of vocabulary items (50-1000) became more preferable compared to 50 or fewer for a child vignette motivated to communicate using AAC. Over 1000 items became significantly more preferable for child vignettes with a variety of characteristics: receptive language exceeding expressive language, an ability to use a range of AAC functions, motivated to communicate using AAC and predicted to progress.

Two significant interactions exist between vocabulary organisation and motivation. A child vignette with motivation to communicate using AAC became more likely to be allocated a system with taxonomic (OR 2.03), or semantic-syntactic (OR 2.29) organisation compared to visual scene.

Motivation to communicate using AAC also had a large influence on graphic representation. It increased the probability of choosing pictographic symbols (OR 3.88), idiographic symbols (OR 5.31) or text (OR 4.00) rather than photos. However, being predicted to progress made pictographic symbols less preferable.

Figure 1 illustrates the RIAI of child attributes for each system attribute and overall. Consistency of layout is omitted, as there are no interactions for this attribute. Predicted future skills and abilities was the only child attribute to influence preferences for type of vocabulary set. It was also one of only two to influence preferences for graphic representation, although determination and persistence was more important (67% vs.
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33%). Determination and persistence was the only child attribute to impact preferences for type of vocabulary organisation. All child attributes had an influence on preferences for vocabulary size, with communication ability with AAC (32%) and determination and persistence (28%) relatively more important than future skills and abilities (22%) and receptive and expressive language (17%). Overall, future skills and abilities had the greatest relative importance (38%), followed by determination and persistence (19%), communication ability with AAC (20%), and receptive and expressive language (12%).

DISCUSSION

This DCE has revealed AAC professionals’ priorities when choosing AAC systems for children, and shown that these priorities change when faced with children with different characteristics. This is not unexpected, and in line with previous research showing that AAC professionals recognise the importance of matching an AAC system to an individual person’s needs.\textsuperscript{39,11} However, this study builds on these findings by showing the magnitude of preference changes, as for some system attributes their preferences for different levels could completely reverse depending which child vignette was shown. For example, for the baseline child vignette, a system with more than 1000 vocab items was less likely to be chosen then one with less than 50 (OR 0.395). However, for a vignette with a receptive-expressive language gap, can use AAC for a range of functions, is motivated to use AAC and is predicted to progress, a system with more than 1000 vocab items was much more likely to be chosen (OR 22.5). Such flexibility is encouraging, as it is in line with one of Williams et al.’s\textsuperscript{33} five principles for AAC: “AAC systems must be highly individualised and appropriate to individual needs”.

Overall, motivation to communicate with AAC had the greatest number of interactions with preferences, and was more important in terms of RIAI than language ability or previous experience with AAC. Specifically it was motivation to communicate using AAC, as motivation to communicate through non-AAC methods had no bearing on preferences in the final model. Motivation to communicate via AAC tended to drive participants towards what can be regarded as more “ambitious” choices, for example more vocabulary items. It may be that participants believed that motivated children are more likely to succeed with such AAC systems, in line
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with previous findings that motivation and attitude towards AAC, and valuing an AAC system are important factors in successful adoption of AAC.$^{39,11}$

Visual scene vocabulary organisation and graphic representation using photos can both involve items/scenes from an individual’s own life, and use literal, rather than abstract depictions. Both were less preferred for child vignettes motivated to communicate via AAC. Rather, participants favoured more abstract methods of organisation (taxonomic and semantic-syntactic) and graphic symbols that require more grammar (pictographs, ideographs and text). This may be interpreted as AAC professionals believing that motivated children will be better able to use more complex AAC systems. An alternative and by no means mutually exclusive interpretation is that lack of motivation requires an AAC system involving familiar cues from their everyday environment.

Previous studies have also studied how AAC professionals choose graphic symbols for children. For example, Thistle and Wilkinson$^{19}$ found that cognitive abilities are an important factor, as did Dada et al.$^{40}$, and also determined what symbol sets were most commonly chosen over the range of children they saw. However, the advantage of the DCE approach is demonstrated here, in that the precise interactions between child characteristics and symbol type have been enumerated. Thus rather than a general finding that cognitive ability is a factor in decision-making, it was shown which children were more likely to be given AAC systems with photos, and which were more likely to be given systems with text.

AAC system preferences did not significantly differ between child vignettes with skills and abilities predicted to regress or plateau, which may be due to children predicted to regress not being commonly encountered. However, if a child was predicted to progress, this had a large impact on decision making, and future skills and abilities was the highest ranked attribute in terms of RIAI. As with motivation, it lead to more ambitious choices, with more vocabulary items preferred and pictographs depreciated compared to ideographs and text. This could reflect participants wishing to provide AAC systems that would fulfil the future needs of children who will progress, given the large investment that goes into learning a new AAC system.$^{49,50,51}$
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Unless the child vignette featured both predicted progress and motivation to communicate via AAC, photos were still most preferred. This possibly indicates that they remain a good starting point for a child who is not engaged, regardless of prognosis, and reflects recommendations to reduce the learning demands of AAC systems.32,52

Even in the light of potentially high rates of abandonment, AAC professionals had high expectations of motivated children expected to progress, even if their receptive and expressive language were both delayed and they had no previous AAC experience. It has previously been noted that people who use AAC experience an asymmetry between the language they receive and the language they express.53 One interpretation is thus that participants wished to minimise the asymmetry by choosing text for children they believed could cope with it. Ambitious choices are also encouraging given the greatly increased expectations of participation and engagement for AAC users in recent years.31,34,35 It is also in line with official guidance54 and one of Williams et al.’s33 five principles for AAC: “AAC must support full participation in all aspects of 21st century life”.

For many vignettes, there are non-linear preferences for vocabulary size. Between 50 and 1000 items was considered better than 50 or fewer for all child vignettes, although the difference was not always significant. This may indicate that AAC professionals do not wish to limit potential for expression, even for children with low ability and poor prognosis, again showing a desire to make ambitious choices.

Respondents commonly preferred levels of AAC systems that can require a lot of personalisation, e.g. photographic graphic representation, pragmatic vocabulary organisation or an idiosyncratic layout, in line with previous findings that personalisation is important in successful AAC adoption.18 It is also an indication that it is not possible to achieve the goal of AAC systems being closely tailored to individuals’ needs33,55 with “off-the-shelf” AAC systems: some alteration is necessary. (Note that this is not intended as a criticism of the range of AAC systems available from manufacturers.)

The above results are potentially contrasted by preferences for vocabulary sets. No pre-provided vocabulary set was always considered worse than having pre-provided sets that were either fixed or with staged progression, in line with other studies which find that selecting core vocabulary is an important part of AAC
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professionals’ decision-making process. Yet even here, it is likely that AAC professionals intended to supplement pre-provided vocabulary sets with customised words/symbols.

Comparing the DCE results with the previous BWS Case 1 study, some similarities may be observed. For example, graphic representation was the lowest ranked attribute in terms of importance in the BWS to be included in the DCE, and was selected as one of the aims of the wider research project was to investigate the properties of graphic symbols. In concordance with this finding, when the relative importance of AAC system attributes was calculated for each child vignette in the DCE, it was never the most important attribute.

Many differences can also be seen. Language abilities was the most important child attribute in the BWS, yet its RIAI in the DCE was below predicted future abilities, ranked sixth in the BWS. However, differences in results do not necessarily imply contradiction, as the two methodologies do not measure the same thing. The BWS measured the importance of AAC system attributes over the case mix AAC professionals encounter in practice, whereas for the DCE respondents were presented with a specific child vignette.

Receptive and expressive language had the lowest RIAI overall, with only a single interaction term in the final model. This contrasts with some previous findings that a child’s language abilities play a large role in selecting an appropriate AAC System. A possible explanation is that the aspects of language ability which were most relevant were captured in this study by other elements of the child vignettes. For example, Dietz et al. reported that considering a more abstract symbol system if a child’s language skills were likely to improve, which here would have been captured by the future skills and abilities attribute.

This study has demonstrated the feasibility of conducting a DCE with a target population of AAC professionals. This is noteworthy given the relative rarity of DCEs studying health professionals’ decision making, for example in a systematic review of DCEs in health published between 2013 and 2017, only 39 out of 301 (13%) included a sample of health professionals. In addition, there were particular challenges associated with performing a DCE with AAC professionals. The target population in the UK is small, meaning it was uncertain that sufficient participants could be recruited. There were also concerns that participants might not find the DCE format acceptable, as they might reject having to choose a suboptimal AAC system. Yet despite informal
feedback that some respondents found the tasks uncomfortable, many were still willing to complete them. Finally, as interactions between child characteristics and AAC systems are so important, it was necessary to present hypothetical child vignettes, as well as AAC systems. This leads to harder choice tasks than in a typical DCE, as well as a more complicated design. However, despite these potential pitfalls, the DCE was successfully carried out, and having demonstrated the feasibility of the method in this area, further DCE studies should be considered in future.

Limitations

This study has several limitations. The sample size was relatively small, with 155 participants, compared with a median sample size of 401 for DCEs in healthcare published between 2013-2017. However, many studies exist with smaller sample sizes (e.g. Shingler et al. with 99 and Spinks et al. with 35), and it was possible to estimate robust statistical models using the collected data. Further, it would have been difficult to collect a larger sample, as 155 participants represents a large proportion of the population of AAC professionals in the UK working with children, which is estimated at around 800 (Communication Matters, personal correspondence).

In some ways, the DCE task does not match how UK AAC professionals make decisions in practice. Typically, participants will work together with families and children, as well as part of an AAC team, which could include diverse areas of expertise. They also generally make recommendations, rather than unilaterally choosing a system. However, there is evidence that AAC professionals compare the attributes of AAC systems in everyday practice, akin to DCE tasks and that they make trade-offs between system attributes, which is the basis of the DCE approach. In addition, it is still useful to study the individual decision-making of AAC professionals. Lynch et al. report that a wide variety of team structures are used, and the mode of service delivery can have an influence on outcomes. Gathering evidence on individual-level decision-making can thus inform an assessment on how different ways of organising services influence decisions.
A DCE on AAC professionals’ decision making

The DCE tasks presented one-off static decisions, whereas in reality the process is dynamic, with a child being reassessed several times and potentially several different AAC systems being provided. These differences are a limiting factor in the external validity of results.

Attributes and levels use a mixture of speech and language therapy terms (e.g. receptive and expressive language) and more technological language (e.g. staged progression). This may have made it difficult for respondents from any one speciality to interpret all of them. However, this issue is not limited to the current study, but reflects an ongoing struggle in AAC to establish a common language, given its interdisciplinary nature. For example, Judge et al. found several different terms being used in the literature to describe the same way of organising vocabulary. In addition, respondents may have been unfamiliar with the generic term ideographic symbols, since only a single commercial set of ideographic symbols is in popular use (Minspeak, © Semantic Compaction Systems, Inc.).

Respondents were more likely to choose AAC systems on the left of the screen and less likely to choose ones on the right, potentially introducing bias in estimated coefficients. However, alternative specific constants were included when modelling responses, and did not provide enough explanatory power to be included in the final model. In addition, the positions in which AAC systems were presented was randomised, mitigating any possible bias.

Compared to the real children AAC professionals encounter, vignettes were simple, and lacked information previously shown to influence decision-making, such as the child’s preferences and contextual factors. A single vignette also represents potentially very different children. For example, the needs of a child who has plateaued in skills and abilities at age five will be very different to a child who has plateaued at age 15. However, this is an inherent limitation of the DCE methodology, and vignettes with a greater number of attributes and levels would have made decisions overly burdensome. In addition, significant interactions between AAC systems and child attributes implies the vignettes were meaningful enough that respondents changed their preferences in response to them, often dramatically.
A DCE on AAC professionals’ decision making

For a given child vignette, it is only possible to determine relative preferences for system attributes, rather than absolute preferences. Thus it is not possible to tell how suitable a given system is for a given vignette, which is important as some vignettes presented a challenging profile for which it may be hard to find a suitable AAC system. It does not follow from this analysis that there is “something for everyone”.

CONCLUSION

A lack of rigorous evidence on how to best assess and provide AAC systems for children has previously been identified, as well as a gap between research and current practice. In the light of this, the current study’s results are encouraging, as it shows AAC professionals following best practice in many areas, for example ensuring AAC systems suit individual needs, and having high expectations for children.

However, there is still demand from AAC professionals for better support in decision-making, and undoubtedly current practice could be improved. Thus the results of this study, together with evidence from the wider research project, have been used to create a suite of resources, available at https://iasc.mmu.ac.uk. It is hoped these resources will aid AAC professionals in their clinical practice, and help them provide the best possible service for children.

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A DCE on AAC professionals’ decision making

**Competing interests:** The authors have no competing interests to declare.

**Author statement:** All authors conceived the study and defined the study aims. EW, DM, YL, NR, SJ, JG, SM and LM developed attributes and levels. EW, DM and SH constructed the survey statistical design. EW and DM collected data. EW conducted statistical analysis. EW, YL, NR, SJ, JG, SM, LM and JM interpreted findings. EW wrote the manuscript first draft. All authors contributed to and approved the final manuscript.

**Ethical approval:** Ethical approval was received for the study from an NHS Research Ethics Committee (REC reference 6/NW/0165) and informed consent was obtained from participants at the start of the survey.

**Data availability:** Survey data is not publicly available as respondent consent was not obtained for this. However, it is available on request to the corresponding author or to Leeds Institute of Health Sciences if a formal data sharing agreement is entered into.
A DCE on AAC professionals’ decision making

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44. Kuhfeld WF, Tobias RD, Garratt MJJoMR. Efficient experimental design with marketing research applications. 1994;31(4):545-57.


A DCE on AAC professionals’ decision making


### Table 1: Child attributes and levels including brief descriptions

<table>
<thead>
<tr>
<th>Child attributes and levels</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Receptive and expressive language (1)</strong></td>
<td>Child’s ability without AAC to understand communication from (receptive) and communicate with others (expressive) Both receptive and expressive abilities below expectation given child’s age</td>
</tr>
<tr>
<td><em>Delayed</em></td>
<td>Ability to understand communication from others greater than ability to communicate with others</td>
</tr>
<tr>
<td>Receptive language exceeding expressive language</td>
<td></td>
</tr>
<tr>
<td><strong>Communication ability with AAC (3)</strong></td>
<td>How well a child can communicate when using AAC</td>
</tr>
<tr>
<td><em>No previous AAC experience</em></td>
<td>Has never communicated using AAC before</td>
</tr>
<tr>
<td>Able to use AAC for a few communicative functions</td>
<td>Can use AAC for some basic functions, e.g. simple requests</td>
</tr>
<tr>
<td>Able to use AAC for a range of communicative functions</td>
<td>Can use AAC for more complex tasks, e.g. constructing sentences</td>
</tr>
<tr>
<td><strong>Child’s determination and persistence (4)</strong></td>
<td>Attitude of child towards communication and using AAC</td>
</tr>
<tr>
<td><em>Does not appear motivated to communicate through any methods and means</em></td>
<td>Child is not inclined to develop communication skills</td>
</tr>
<tr>
<td>Motivated to communicate through symbol communication systems</td>
<td>Child has demonstrated motivation and willingness to use AAC</td>
</tr>
<tr>
<td>Only motivated to communicate through methods other than symbol communication</td>
<td>Child may be motivated to communicate, but is not inclined to use AAC</td>
</tr>
<tr>
<td><strong>Predicted future skills and abilities (6)</strong></td>
<td>Professional assessment of how child’s communication abilities will develop</td>
</tr>
<tr>
<td><em>Regression</em></td>
<td>Abilities projected to become worse in future, e.g. due to a degenerative condition such as Rett syndrome</td>
</tr>
<tr>
<td>Plateau</td>
<td>Abilities will not change significantly in future, e.g. a child aged 16-17</td>
</tr>
<tr>
<td>Progression</td>
<td>Communication abilities will develop in future</td>
</tr>
</tbody>
</table>

*Note:* * indicates baseline level; numbers in parentheses indicate attributes’ rank in relative importance from Webb et al. 30 These are not intended as rigorous definitions of AAC terminology, but as a rough guide for the non-AAC specialist reader.
### Table 2: AAC System attributes and levels, including brief descriptions

<table>
<thead>
<tr>
<th>AAC System attributes and levels</th>
<th>Definition</th>
</tr>
</thead>
</table>
| **Vocabulary sets (1)**         | Words and/or symbols pre-provided with system “out of the box”, e.g. as part of a software package for a high-tech system.  
*No vocabulary set* | AAC practitioners/child’s support network provides all vocabulary content.  
**Fixed vocabulary set** | A single fixed set of vocabulary which may be customised.  
**Vocabulary set with staged progression** | A series of vocabulary sets with pre-determined progression through them that simulate language development. E.g. an initial set including just basic words, with subsequent sets introducing more grammatical structure. May be customised. |
| **Consistency of layout (2)**  | How consistent positions of words/symbols are in system interface, and how consistent navigation to find different symbols is.  
*Consistency of some aspects of layout* | Words/symbols in multiple categories appear in different positions across categories, but always in the same place in a given category.  
**Consistency of all aspects of layout** | All/nearly all words/symbols always appear in same position in interface.  
**Idiosyncratic layout** | Layout that has been personalised for an individual child. |
| **Type of vocabulary organisation (5)** | How words/symbols are organised within the system.  
*Visual scene* | Interface shows photos, most likely of scenes familiar to the child, with areas of it highlighted to represent words.  
**Taxonomic** | Words/symbols organised according to subject, analogous to non-fiction books in a library.  
**Semantic-syntactic** | Words/symbols organised according to sentence structure, e.g. verbs, nouns, adjectives.  
**Pragmatic** | Words/symbols organised around function in language rather than grammar, e.g. request, mood. |
| **Size of vocabulary (7)**     | How many words/symbols system can output.  
*Up to 50 vocabulary items* | Implies only simple communication functions possible.  
**50-1000 vocabulary items** | Implies combining words/symbols to create grammatical structures.  
**More than 1000 vocabulary items** | Does not imply more complex communication than 50-1000 items, but means a greater load on child’s memory. |
| **Graphic representation (12)** | Type of symbols used by system.  
*Photos* | Photographs, possibly of items or environments personal to the child.  
**Pictographic symbol set** | Non-photorealistic pictures with specific meanings attached. May be accompanied by text.  
**Ideographic symbol system (with rules or encoding)** | Stylised symbols combined with fixed rules and grammar analogous to Chinese/Japanese characters, e.g. Minspeak.  
**Text** | Text unaccompanied by other symbols. |

**Note:** * indicates baseline level; numbers in parentheses indicate attributes’ rank in relative importance from prior BWS study (reported in Webb et al. 30). These are not intended as rigorous definitions of AAC terminology, but as a rough guide for the non-AAC specialist reader.
Table 3: Demographics and professional experience of participants

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>s.e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>40.8</td>
<td>11</td>
</tr>
<tr>
<td>Experience (years)</td>
<td>11.4</td>
<td>9.2</td>
</tr>
<tr>
<td>% of role relating to AAC</td>
<td>53.7</td>
<td>34.3</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>155</td>
<td>90.1</td>
</tr>
<tr>
<td>Male</td>
<td>10</td>
<td>5.81</td>
</tr>
<tr>
<td>Prefer not to say</td>
<td>7</td>
<td>4.07</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White - English/Welsh/Scottish/Northern Irish/British</td>
<td>149</td>
<td>86.6</td>
</tr>
<tr>
<td>White – other</td>
<td>12</td>
<td>6.98</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>3.49</td>
</tr>
<tr>
<td>White – Irish</td>
<td>5</td>
<td>2.91</td>
</tr>
<tr>
<td>Professional background</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speech and language therapist</td>
<td>125</td>
<td>72.7</td>
</tr>
<tr>
<td>Occupational therapist</td>
<td>16</td>
<td>9.3</td>
</tr>
<tr>
<td>Teacher</td>
<td>14</td>
<td>8.14</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>6.98</td>
</tr>
<tr>
<td>Assistive technology specialist</td>
<td>5</td>
<td>2.91</td>
</tr>
<tr>
<td>Clinical scientist</td>
<td>5</td>
<td>2.91</td>
</tr>
<tr>
<td>Age groups worked with</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary school age</td>
<td>99</td>
<td>57.6</td>
</tr>
<tr>
<td>Secondary school age</td>
<td>94</td>
<td>54.7</td>
</tr>
<tr>
<td>Pre-school age</td>
<td>85</td>
<td>49.4</td>
</tr>
<tr>
<td>All age groups</td>
<td>56</td>
<td>32.6</td>
</tr>
<tr>
<td>Higher education</td>
<td>30</td>
<td>17.4</td>
</tr>
<tr>
<td>Further education</td>
<td>21</td>
<td>12.2</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>6.98</td>
</tr>
<tr>
<td>Adults</td>
<td>10</td>
<td>5.81</td>
</tr>
<tr>
<td>Among most common three diagnoses seen in practice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical disability (e.g., neuromuscular, cerebral palsy etc.)</td>
<td>140</td>
<td>81.4</td>
</tr>
<tr>
<td>Intellectual Disability/Developmental Delay</td>
<td>118</td>
<td>68.6</td>
</tr>
<tr>
<td>Autism spectrum disorder</td>
<td>113</td>
<td>65.7</td>
</tr>
<tr>
<td>Syndromes</td>
<td>61</td>
<td>35.5</td>
</tr>
<tr>
<td>Neurological</td>
<td>45</td>
<td>26.2</td>
</tr>
<tr>
<td>Specific Speech/Language Impairment</td>
<td>22</td>
<td>12.8</td>
</tr>
<tr>
<td>Dyspraxia</td>
<td>14</td>
<td>8.14</td>
</tr>
</tbody>
</table>

Note. For some questions, participants could select more than one response, thus some percentages do not sum to 100%
Table 4: Parameter means and standard deviations for final mixed logit model. * indicates significance at the 5% level corrected using Holm’s sequential Bonferroni 47, s.e. = standard error

<table>
<thead>
<tr>
<th>AAC system attribute</th>
<th>Child attribute</th>
<th>Parameter mean</th>
<th>s.e.</th>
<th>σ</th>
<th>s.e.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary sets (baseline none)</td>
<td>Fixed</td>
<td>Constant</td>
<td>0.283*</td>
<td>0.0966</td>
<td>0.131</td>
</tr>
<tr>
<td></td>
<td>Staged progression</td>
<td>Constant</td>
<td>0.364*</td>
<td>0.141</td>
<td>0.941*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Predicted to progress</td>
<td>1.36*</td>
<td>0.221</td>
<td>-1.09*</td>
</tr>
<tr>
<td>Consistency of layout (baseline some aspects)</td>
<td>Consistency of all aspects</td>
<td>Constant</td>
<td>0.892*</td>
<td>0.121</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>Idiosyncratic layout</td>
<td>Constant</td>
<td>1.46*</td>
<td>0.14</td>
<td>0.757*</td>
</tr>
<tr>
<td>Type of vocabulary organisation (baseline visual scene)</td>
<td>Taxonomic</td>
<td>Constant</td>
<td>0.0629</td>
<td>0.165</td>
<td>0.383</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motivated to communicate through symbol communication systems</td>
<td>0.707*</td>
<td>0.206</td>
<td>-0.563</td>
</tr>
<tr>
<td></td>
<td>Semantic-syntactic</td>
<td>Constant</td>
<td>-0.178</td>
<td>0.166</td>
<td>0.549</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motivated to communicate through symbol communication systems</td>
<td>0.826*</td>
<td>0.197</td>
<td>-0.112</td>
</tr>
<tr>
<td></td>
<td>Pragmatic</td>
<td>Constant</td>
<td>0.443*</td>
<td>0.123</td>
<td>0.723*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>50-1000 items</td>
<td>Constant</td>
<td>0.131</td>
<td>0.143</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motivated to communicate through symbol communication systems</td>
<td>1.01*</td>
<td>0.232</td>
<td>-0.731</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than 1000 items</td>
<td>Constant</td>
<td>-0.929*</td>
<td>0.213</td>
<td>1.02*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Receptive language exceeding expressive language</td>
<td>0.692*</td>
<td>0.186</td>
<td>0.489</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Able to use AAC for a range of communicative functions</td>
<td>1.14*</td>
<td>0.319</td>
<td>-0.419</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motivated to communicate through symbol communication systems</td>
<td>1.31*</td>
<td>0.272</td>
<td>-0.751</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Predicted to progress</td>
<td>0.902*</td>
<td>0.233</td>
<td>0.981</td>
</tr>
<tr>
<td>Graphic representation (baseline photos)</td>
<td>Pictographic symbol set</td>
<td>Constant</td>
<td>-0.41</td>
<td>0.183</td>
<td>0.0722</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motivated to communicate through symbol communication systems</td>
<td>1.36*</td>
<td>0.24</td>
<td>-0.363</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Predicted to progress</td>
<td>-0.814*</td>
<td>0.217</td>
<td>1.12</td>
</tr>
<tr>
<td></td>
<td>Ideographic symbol system</td>
<td>Constant</td>
<td>-1.25*</td>
<td>0.207</td>
<td>0.823*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motivated to communicate through symbol communication systems</td>
<td>1.67*</td>
<td>0.268</td>
<td>0.069</td>
</tr>
<tr>
<td></td>
<td>Text</td>
<td>Constant</td>
<td>-0.709*</td>
<td>0.159</td>
<td>0.615*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motivated to communicate through symbol communication systems</td>
<td>1.39*</td>
<td>0.231</td>
<td>-1.12*</td>
</tr>
</tbody>
</table>

Note. σ indicates standard deviation. Parameter variance for level l of AAC system attribute a when choosing for child c is given by \( \sigma_{alc}^2 = (\sigma_{alc} + \sigma_{ac}Z_c)^2 \).