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Abstract

Little is known about what features of AAC systems are regarded as more suitable by AAC professionals for children with different characteristics. A survey was conducted in which participants rated the suitability of hypothetical AAC systems on a Likert scale from 1 (very unsuitable) to 7 (very suitable) alongside a discrete choice experiment. The survey was administered online to 155 AAC professionals in the UK. Statistical modelling was used to estimate how suitable 274 hypothetical AAC systems were for each of 36 child vignettes. The proportion of AAC systems rated at least five out of seven for suitability varied from 51.1% to 98.5% for different child vignettes. Only 12 out of 36 child vignettes had any AAC systems rated at least six out of seven for suitability. The features of the most suitable AAC system depended on the characteristics of the child vignette. The results show that, while every child vignette had several systems which had a good suitability rating, there were variations, which could potentially lead to inequalities in provision.

Keywords: Clinical decision-making; Likert scale; Stated preferences; Discrete choice experiment; Children

Something for everybody? Assessing the suitability of AAC systems for children using stated preference methods

Augmentative and alternative communication (AAC) can improve the lives of many people with communication difficulties (Schlosser & Wendt, 2008; Ryan et al., 2015; Hajjar et al., 2016). For children, provision of AAC is especially important, as it can affect their social participation, as well as their development and learning, having an impact on the rest of their lives (Lund & Light, 2006; Ryan et al., 2015). In recent years, the expectations of people who use AAC to participate in all aspects of society has increased (Williams et al., 2008; Sundqvist & Rönnerberg, 2010; Williams et al., 2012; Hemsley & Murray, 2015; Hynan, Goldbart & Murray, 2015; Light, McNaughton, Beukelman, et al., 2019).

Many different AAC systems exist, with very different features. Children may benefit from AAC due to a wide range of reasons, and may have a variety of conditions such as cerebral palsy and autism spectrum condition. Children with the same diagnosis each have disparate needs, abilities, and personal circumstances. Selecting a suitable AAC system for a child is thus a highly complex task, requiring the balancing of many different competing concerns, and the process is unique to each child (Dietz et al., 2012; Lund et al., 2017; Lynch et al., 2019). For example, matching might involve assessing whether a child is more motivated by vocabulary represented by photos or text. This consideration would have to be balanced against which mode of graphical representation would better suit the child's future needs given their progress. For more details, see Beukelman & Light (2020).

Research has revealed some important factors in AAC professionals' decision-making (Enderby et al., 2013, Thistle & Wilkinson, 2015, Geytenbeek et al., 2015), such as a child's preferences and family circumstances. Assessing the cognitive demands a given AAC system places on a child is another important factor (Fried-Oken, Mooney & Kinsella, 2019). There are also guidelines for how AAC services should be organized (Choi & Pak, 2006; Royal

College of Speech and Language Therapists [RCSLT], 2009; National Health Service England [NHS England], 2016). Some research has been conducted on AAC professionals' decision-making. For example, it has been shown that professionals with different backgrounds (Dietz et al., 2012) and levels of experience (Sauerwein & Wegner, 2020) differ in their consideration of factors. Still, little is known about the details of how AAC professionals make decisions, or what features lead AAC professionals to judge AAC systems as a suitable match for children with different characteristics (McFadd & Wilkinson, 2010; Dietz et al., 2012; Ryan et al., 2015).

The context for this study is the UK, where it is estimated that 1 in 200 children could benefit from AAC (Gross, 2010; Enderby et al., 2013; Judge et al., 2017). There is some variation across the UK in how children are allocated AAC systems, but in general children's needs, abilities and circumstances are assessed by a multidisciplinary team of AAC professionals. Final recommendations are made with input from children and their support network about their preferences and opinions about the potential options. The composition of the multidisciplinary team varies, and can include speech and language therapists, occupational therapists, and teachers (NHS England, 2016; Lynch et al., 2019).

The current study is one of three linked studies which used online surveys to examine UK AAC professionals' judgement and decision-making for children, and what factors are most important in matching AAC systems to children (by AAC system we refer in this manuscript to aided systems which may be either high-tech or low tech). Examining AAC professionals' judgement and decision-making addresses a knowledge gap, identified above, and allows an examination of whether a gap exists between research and practice. The study also makes it possible to reflect on how improvements may be made to current practice and service structures. The three linked studies were part of a wider research project entitled Identifying Appropriate Symbol Communication aids for children who are non-speaking:

enhancing clinical decision-making (I-ASC) (Murray et al., 2021). The project used a variety of research methods (Lynch et al., 2019; Murray et al., 2019; Judge et al., 2020) to study AAC provision for children in the UK. The evidence produced by the project has been used in the creation of a suite of resources for AAC professionals and other stakeholders to support best practice, which is available for free at <https://iasc.mmu.ac.uk/>. See Figure 1 for a schematic overview of the relations between the current study and the different components of the I-ASC project.

The three linked I-ASC studies used different methods and addressed the topic from different angles. The principal research question for the first study (Webb, Meads et al. 2019) was: What is the relative importance of AAC system attributes and child characteristics in AAC professionals' decision-making in daily practice? The study revealed how important different factors were in AAC professionals' daily practice; in other words how important specific factors were averaged over the case-mix AAC professionals see. For example, it revealed that interface-related AAC system attributes were relatively more important than hardware attributes in professionals' daily practice. Averaged over the case-mix that they saw, participants also judged children's cognitive and learning abilities to be more important than their physical features. The second study (Webb, Lynch et al. 2019) had the principal research question: When choosing an AAC system, what trade-offs do AAC professionals make between system attributes, and how do such trade-offs change depending on the characteristics of the child? This study revealed how AAC professionals make decisions when choosing for an individual child. For example, it showed that children's motivation to communicate using AAC and predicted future abilities had a greater influence on how participants traded-off different AAC system attributes than their language ability and previous experience with AAC.

Finally, the current study has the principal research question: How do AAC professionals judge the suitability of different AAC systems to be for a child, and how do their judgements change depending on child characteristics? This study adds information about strength of preference, revealing not only what AAC system an AAC professional would choose for a child, but also how suitable they believe the system to be for that child. Such additional information is useful, as it allows comparisons between different children and to examine whether, in the opinion of survey participants, there is an AAC system which suits the needs of every individual child. In addition, AAC professionals may not necessarily choose what they believe to be the most suitable AAC system for a child, for example due to resource constraints such as cost or instruction time.

Method

This study uses data collected from the same participants and using the same procedures, as Webb, Lynch, et al. (2019).

Research Design

The study used a survey design. It received ethical approval from an NHS Research Ethics Committee (REC reference 6/NW/0165) and participants gave informed consent.

This study is one of three linked studies using data collected from two online surveys (see Figure 1). In Webb, Meads et al. (2019), lists of 18 AAC system attributes and 19 child characteristics were constructed using information from systematic reviews of the literature (Judge et al., 2020), input from an expert panel as well as focus groups and interviews with AAC professionals, people who use AAC, their families and other stakeholders (Murray et al., 2019; Lynch et al., 2019). These lists were then included in a survey which used a method called best-worst scaling case 1 (BWS) (Cheung et al. 2016) and which was administered to 93 AAC professionals. The study showed the relative importance participants ascribed to each attribute/characteristic in their daily practice.

The second and third studies use data from a single survey which combined a discrete choice experiment (DCE) and Likert scale ratings. DCEs are commonly used in healthcare (Soekhai et al. 2019), and survey participants make a series of choices between hypothetical objects, in this case AAC systems. The objects participants choose between are described in terms of a set of non-overlapping attributes, and the levels of the attributes vary from question to question. Statistical analysis of participants' choices can then quantify the trade-offs they make between different attributes. In our DCE study, the standard approach was modified by asking participants to choose between which AAC systems to provide for a child vignette. The vignette described a hypothetical child in terms of non-overlapping characteristics, the levels of which varied from question to question. This allowed us to analyze how trade-offs between AAC system attributes depend on the characteristics of the child vignette they were choosing for. The current study analyzes data from additional Likert scale tasks which were asked after each DCE task. After choosing each AAC system, participants rated how good a match their chosen system was for the child vignette on a scale from 1=very unsuitable to 7=very suitable. Thus, the current study is concerned with cardinal measures of an AAC system's suitability for a child, rather than trade-offs between different AAC system attributes.

Likert scale ratings allow us to address our research question of how suitable a match different AAC systems are for different children. The innovative method of combining a Likert scale with a DCE enables us to estimate suitability ratings for many more AAC system-child combinations than would be feasible for survey participants to rate individually.

Participants

The target population was AAC professionals working in the UK who contributed to AAC decision-making for children (including those who worked with both children and adults). Piloting revealed that some AAC professionals did not have enough input into

decision-making in their daily practice to meaningfully engage with the DCE/Likert scale tasks. To address this, at the beginning of the survey, participants answered the question “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 organization within AAC systems.” Those who responded no were directed to answer only demographic questions and were not shown the DCE or Likert scale tasks. A total of 172 people submitted complete responses, of which 155 completed the DCE and Likert scale tasks. Participant demographics are summarized in Table 2. For participants who completed the DCE/Likert scale exercise, most were female ($n=140$, 90.3%) and of white ethnicity ($n=137$, 88.4%). Most had a professional background as a speech and language therapist ($n=125$, 75.5%). They were 40 years old on average, with 11 years of professional experience. A majority reported physical conditions ($n=128$, 82.6%) intellectual disability/delay ($n=107$, 69.0%) and autism spectrum ($n=101$, 65.2%) as among the three most common diagnoses encountered in their practice.

The demographics of participants who did not complete the DCE or Likert scale tasks were largely similar to those who did. However, they were slightly older on average, at 46 years, and were more likely to have a professional background as an occupational therapist ($n=5$, 29.4% compared to $n=11$, 7%) and less likely to have a background in speech and language therapy ($n=8$, 47.1% compared to $n=117$, 75.5%).

Table A2 in the online supplementary material details where participants reported working. The sample of participants who completed the DCE/Likert scale included respondents from every area of the UK, although some areas were overrepresented and some under-represented. For example, Yorkshire and the Humber represented 14.2% of the sample compared to 8.2% of the UK population, and South West England represented 5.2% of the sample, compared to 8.4% of the UK population (Office for National Statistics [ONS], 2020).

Materials and Measures

Full details about survey development is reported in Webb, Lynch, et al. (2019) and Webb et al. (2021). The BWS survey (Webb, Meads et al., 2019) used lists of 18 AAC systems attributes and 19 child characteristics. From these, five AAC system attributes and four child attributes were selected by the research team for inclusion in the DCE/Likert scale survey. The selection criteria were that: (a) attributes formed coherent descriptions of AAC systems/children; (b) attributes reflected the specific aims of the I-ASC project; (c) most attributes were of high relative importance according to the BWS survey results; and (d) the number of attributes was not so large as to overburden DCE survey respondents. The final list of attributes and levels for the DCE is given in Table 1.

In each DCE task, participants were shown a child vignette formed from the set of child attributes. An example is:

Child A has receptive language exceeding expressive language. Child A is able to use AAC for a few communicative functions. Child A is motivated to communicate through symbol communication systems. Child A is predicted to plateau in skills and abilities.

In each task, participants were shown three hypothetical AAC systems described in terms of the attributes in Table 1, and asked which they would choose for the child vignette. An example choice task, including example AAC systems, is shown in Figure 2. After making their choice, participants were asked to rate how suitable their chosen AAC system was for the child vignette using a Likert scale which ranged from one (very unsuitable) to seven (very suitable). Participants were shown three randomly chosen child vignettes. For each child vignette they completed four DCE and Likert scale tasks, meaning a total of 12 DCE and Likert scale tasks.

The statistical design of the DCE was constructed using Ngene (ChoiceMetrics). This software package selected a design which maximized D-efficiency, which may be thought of

as a measure of how much information it is possible to extract from survey responses (Kuhfeld et al., 1994). The design had 60 tasks which were divided into five blocks of 12. Each participant was randomly allocated to answer a block of 12 questions, with random allocations of blocks and child vignettes independent of each other. It is possible to form 54 child vignettes and 432 AAC systems from the sets of attributes. A total of 18 child vignettes and 158 AAC systems were identified as representing unrealistic combinations and excluded from being used in the survey according to the judgements of authors with AAC expertise (an example is that it would be unrealistic to have a vocabulary set with staged progression with fewer than 50 vocabulary items).

Procedures

The survey was piloted with five AAC professionals. In response to feedback, small changes were made to wording and visual presentation to improve clarity. Before starting the survey, participants were given instructions, including attributes/characteristics and levels descriptions. An example survey is given as supplementary material. The survey was administered online by a market research company. Participants were recruited using the email lists of the I-ASC project and Communication Matters (a UK-wide AAC charity and chapter of the International Society for Augmentative and Alternative Communication), as well as project members' personal contacts. In addition, the survey was advertised on the I-ASC project's website and social media. The survey was open for responses from 20 October 2017 until 4 March 2018.

Statistical analysis. Analysis of responses used a random utility theory framework (Louviere et al., 2000) which assumed individuals assigned a utility to each option. The utility of each option was modelled as depending partly on the attributes of AAC systems as well as having a random component, representing all aspects of decision-making not

explicitly captured by the model. Individuals were then assumed to choose the AAC system with the highest utility, and rated AAC systems higher if they had a higher utility.

Ratings and choices were analyzed jointly using choice-ordered logit models (Webb & Hess, 2019) which had a set of parameters representing how individuals made their decisions. Statistical techniques were used to find the parameters which maximized the probability of observing the choice and ratings participants made. The full model with parameters for every interaction between AAC system and child attributes had too many parameters to estimate robustly. Therefore, an iterative process was used in which a series of models with only one parameter were estimated. The parameter which contributed most to explaining how participants made their decision was selected for inclusion. A further series of models with two parameters were then estimated, and again the parameter which contributed most to explaining participants' decision-making was selected. This continued until all parameters were included. The final model was then selected using the Akaike information criterion (Akaike, 1974), a measure of how well a model fits a dataset. Technical details of the model estimation are given in the online supplementary material.

The final model was used to predict participants' ratings for every AAC system for every child vignette. It was then calculated for each child vignette what percentage of AAC systems had a rating of at least five out of seven, and what percentage had a rating of at least six out of seven. All model estimation was carried out using the Apollo choice modelling package for R (Hess & Palma, 2019).

Results

The raw results for model estimation are given in Table A1 in the online supplementary material.

Table 3 gives for each child vignette the percentage of all 274 AAC systems included in the survey which were rated above five and above six. All child vignettes had at least

51.1% of AAC systems rated above five, and for 19 out of 36 this percentage was above 90%. For 24 out of 36 child vignettes, no AAC system was rated at six or above. However, some child vignettes had a range of AAC systems rated at least six, for example five vignettes had over 10% of AAC systems rated at least six, and one vignette over 20%.

Eleven of the 24 child vignettes without an AAC system rated six or higher were predicted to regress in skills and abilities, whereas eight were predicted to plateau and four were predicted to progress. In contrast, out of the 12 vignettes with an AAC system rated at least six, seven were predicted to progress in skills and abilities, four to plateau and one was predicted to regress. All but one of the 12 child vignettes with at least one AAC system rated six or above for suitability were motivated to communicate using AAC.

Figure 3 shows how the most suitable AAC systems for each child vignette were rated. The vignette “delayed receptive and expressive language, no AAC experience, not motivated to communicate by any means, expected to regress in skills and abilities” had the lowest rated most suitable AAC system, at 5.62. The vignette “receptive language exceeding expressive language, experience of using AAC for a range of functions, motivated to communicate using AAC, expected to progress in skills and abilities” had the highest rated most suitable system, at 6.62. The difference of 1 between the ratings of the most suitable AAC system represents 14.3% of the available scale from one to seven.

Descriptions of what the most suitable AAC systems were for each vignette are given in Table A3 in the online supplementary material. The results are summarized in Figure 4 which illustrates how often a given AAC system feature was part of a child vignette’s most suitable system. Vocabulary sets with staged progression were a feature for 21 out of 36 child vignettes. Only a single child vignette had no pre-provided vocabulary set as a feature of a most suitable AAC system. Having fewer than 50 items was only seen as a feature of the most suitable AAC systems for two child vignettes.

For most child vignettes (20), the highest rated AAC system had pragmatic vocabulary organization, with the most suitable system having visual scene organization for only two child vignettes. When photos were a feature of a most suitable AAC system, this was associated with lower ratings for those systems, in contrast to text, which was associated with higher rated most suitable AAC systems. Ideographs were not a feature of the most suitable AAC system for any child vignette. An idiosyncratic layout was a feature of the most suitable AAC system for all child vignettes.

Discussion

The results show that participants rated the suitability of AAC systems differently depending on the characteristics of the child vignette they were presented with. There was considerable variation in the fraction of AAC systems which were highly rated, and the features of the most suitable AAC systems varied for different child vignettes. This is not surprising, as it is in line with the analysis of participants' choices (Webb, Lynch, et al., 2019) and with previous findings in the literature (Johnson et al., 2006; Light & McNaughton, 2014). However, it is an encouraging sign of the face validity of the current study's approach.

The current study's methods allowed the calculation of how participants rated the suitability of 274 AAC systems for each of 36 child vignettes. This in turn allows a comparison between child vignettes in terms of what fraction of AAC systems were rated above five and above six. However, the set of AAC systems used in this survey was not intended to be representative of the characteristics of AAC systems currently available on the market. There may be no available system matching a given description, or there may be several different models all having features matching the description. Thus, for example, if participants rated 50% of AAC systems in this survey at least five out of seven for suitability, it does not mean they would give 50% of currently available AAC systems a similar rating. It

follows that the proportion of AAC systems suitable for a given child vignette reported here may not reflect the range of suitable systems which AAC professionals would consider choosing between in daily practice. Yet despite this caveat, the AAC systems presented were considered to be feasible, whether or not they were available “off the shelf”, so the current study’s results do give an indication of the relative numbers of possible AAC systems which were regarded as acceptable or good for different children.

If an average rating of five or more out of seven is taken as good in terms of suitability, and six out of seven taken as excellent, then for all child vignettes at least half of AAC systems were a good fit (the reader may instead choose to interpret five as an acceptable rating and six as good, for example, but the meaning of our discussion is unchanged). However, there was still much variation in the number of AAC systems which were a good fit, from a low of 51.1% to a high of 98.5%. In addition, more variation is revealed in terms of excellent systems. Most child vignettes had no AAC systems which were an excellent fit, yet for one child vignette (which could in some ways be considered to have the strongest prognosis for improvement) 20.4% of AAC systems were considered excellent for suitability. For many child vignettes almost all AAC systems were a good fit, yet only a small fraction were an excellent fit.

One possible interpretation of most systems being rated good for most child vignettes is that there is a weak underlying decision-making rationale. This interpretation would also be consistent with only a small number of vignettes having AAC systems rated over six: in most cases no stand-out system (and thus decision rationale) emerged. An alternative explanation for these observations is that participants rated the suitability of a given AAC system in the context of the alternative being no system. If they believed “some communication is better than none”, then this may have led to most AAC systems being rated as good. A further interpretation is that the AAC system attributes used in this study are relatively unimportant

compared to other attributes not included, although the extensive attribute development process weighs against this possibility. One additional reason behind the finding that many AAC systems were rated good, but relatively few were rated excellent, is participants' interpretation of a "suitable match" for a child vignette. It may be that participants interpreted suitable, especially on the upper half of the Likert scale, as meaning adequate. This could have led to participants rating many AAC systems similarly, rather than making distinctions between an adequate and optimal match. If participants did approach the Likert scale tasks in that way, it would lead to problems in interpreting the study's results as giving cardinal information about strength of preference. However, examining participants' responses reveals that they are consistent with them distinguishing between, say, 5 being an adequate match and 7 being an optimal match of AAC system to a child vignette. For child vignettes which may broadly be described as more motivated to communicate via AAC, and with a strong prognosis for improvement, participants tended to rate most AAC systems as at least good, but clearly distinguished some systems as being a better match for their needs, indicating participants saw a difference between adequate and optimal matching. In addition, suitability ratings of AAC systems with greater learning demands (large vocabulary, semantic-syntactic organization, etc.) for more challenging child vignettes were generally lower than the suitability ratings of basic AAC systems for children motivated to use AAC and with strong prognoses for improvement. This later observation is consistent with participants distinguishing between poor and adequate matches for child vignettes.

Motivation to communicate using AAC and prognosis

The vignettes where there were AAC systems ranked over 6 could broadly be described as those where the child was described as more motivated to communicate via AAC and with stronger prognoses for improvement, which implies that there is at least the potential for inequalities in AAC provision to arise. For some children, fewer AAC systems

are well suited to them, so that barriers to accessing some systems, such as cost or requiring a large amount of AAC practitioner input to set up, may disproportionately affect them, compared to children for whom many AAC systems are suitable. In light of this finding, it is encouraging that some dedicated funding for AAC systems is available, and Webb, Meads, et al. (2019) found that UK AAC professionals ascribed low importance to cost in their decision-making. However, other evidence suggests cost can play a significant role in AAC professionals' decision-making in other countries (Van Niekerk et al., 2018), and future research could usefully address the extent to which this leads to inequalities in AAC provision.

Previous evidence has shown a need for lower learning demands of AAC systems for some children (Light, McNaughton, & Caron, 2019; Light, Wilkinson, et al., 2019). This need may have led participants to rate only AAC systems with low learning demands highly for some children, explaining some of the observed variation in the number of systems with high suitability ratings. In particular, it is a plausible explanation as to why child vignettes predicted to regress in skills and abilities had fewer AAC systems with high suitability ratings.

In line with the above observation, graphic representation using photos, considered to have lower learning demands, were commonly a feature of the most suitable AAC system for child vignettes predicted to regress in skills and abilities and without motivation to communicate using AAC. Photos were associated with having a lower rated most suitable AAC system, and text, with greater learning demands, was associated with having a higher rated most suitable AAC system. The implication is that for children who require an AAC system with low learning demands, not only were there fewer systems which were a good match, even the most suitable systems were not an ideal match.

Another factor in how many AAC systems were given high suitability ratings was whether a child vignette included ‘was motivated to communicate using AAC’ or not. For vignettes in which the child was motivated to communicate using AAC, many more AAC systems tended to be rated as good or excellent for suitability. Such motivation was also an important factor in the DCE results, where it led participants to make what could be regarded as more ambitious choices, for example a large vocabulary, or graphic representation using ideographic symbols rather than photos. The current study has given context to this finding by suggesting that, although motivation to communicate using AAC was an important determinant of participants’ choices, the consequences of such choices were not necessarily large, as participants regarded many less preferred AAC systems as well suited for motivated children. These findings are in line with previous evidence that attitudes towards AAC, and valuing an AAC system are important factors in successfully adopting AAC (Johnson et al., 2006, Light & McNaughton, 2014), so that children motivated to use AAC are still likely to succeed, even with an AAC system which is not a perfect match.

Most suitable AAC systems

The analysis also reveals which AAC systems participants regarded as most suitable for each child vignette. A caveat is that, although combinations of attributes which were regarded as unrealistic were excluded by the research team, there is no guarantee that for each AAC system included in the current study, an AAC system exists in the real world which has similar characteristics. There were significant differences between child vignettes in terms of how highly rated the most suitable AAC systems were, up to 14.3% of the rating scale’s available range. This may reflect that, for some children the best available AAC system was not as suitable to their needs and abilities as for other children. However, previous findings have shown that personalizing an off-the-shelf AAC system is an important factor in whether a child successfully adopts it (King et al., 2008; Dietz et al., 2012; Light & McNaughton,

2013). Thus it may be that participants would have given similar ratings to the most suitable AAC system for all child vignettes if it was clear that they would be personalized to the individual child.

Figure 4 shows the number of times each AAC system level was part of a child vignette's most preferred system, and certain characteristics appeared much more often than others. For example, very few child vignettes had a highest rated AAC system with fewer than 50 vocabulary items. This is in line with findings from the DCE, which showed that participants were always more likely to choose AAC systems with more than 50 vocabulary items than systems with fewer than 50, regardless of the child vignette they were choosing for. The result is also consistent with few child vignettes having no pre-provided vocabulary sets and many having staged progression as a feature of their most suitable AAC system. A roughly even number of child vignettes had 50-1000 and over 1000 words as part of their most suitable AAC system, so it was not the case that participants believed that more vocabulary items were always better.

Visual scene was the most preferred mode of vocabulary organization for few child vignettes, yet visual scene displays are increasingly common (Wilkinson, Light & Drager, 2012; Beukelman, Thiessen & Fager, 2021). This is not necessarily a contradiction, as the child vignettes used in this study are intentionally not representative of the population of children who would benefit from AAC. Rather, they represent a wide range of characteristics. Thus it may be that AAC professionals encounter many children with characteristics similar to the vignettes where visual scene is most suitable, and fewer children similar to other vignettes.

All most preferred systems featured an idiosyncratic layout. This uniformity of opinion is surprising. One possible explanation is a form of measurement error. The statistical model had a limited number of parameters to avoid overfitting, and it may be that this

resulted in some child vignettes appearing to have idiosyncratic as their most suitable layout, whereas in fact participants would have rated an alternative more highly. An alternative explanation is that in the context of the survey, any degree of layout customization was classed as idiosyncratic, whereas in practice most AAC professionals wouldn't necessarily think of them that way. In any case, this unusual finding should be investigated further.

Comparison with other findings

Although DCEs are common in healthcare (Soekhai et al., 2019), this is the first study we are aware of that combines choices with ratings. An advantage of this approach is that it gives more information and makes it possible to answer other research questions than with a standard DCE with low extra participant burden and minimal additional resources to gather the data. The current study's novel methods gave quantitative insight into current practice around UK AAC professionals' decision-making. Particularly, it and the two linked survey studies address the concept of feature matching, i.e. matching the characteristics of the child with the most relevant AAC system attributes. Their findings can be linked to evidence from the wider project: Participants included in other elements of the I-ASC study (e.g. Lynch et al., 2019; Murray et al., 2019) described how they considered and made trade-offs across the decision-making process. At a feature matching level this included consideration of particular child characteristics, for example the child's motivation to communicate, their abilities to learn or their likely decline in learning capacity. Regarding AAC system attributes, we found consideration of the child's physical and cognitive characteristics. This included communication aid size and weight, which were important for very small children or for children who were ambulatory. Communication aid appearance, voice quality, and reliability were also salient features. The software attributes prioritized reflected both the needs of the child and those providing support.

The different components of research resulted in a general explanatory model of decision-making in AAC for children. Full details are given in Murray et al. (2021), and a schematic representation is given in Figure 5. The I-ASC explanatory model will aid and inform practice by providing a conceptual overview of the linked aspects of decision-making and the different components of AAC provision for children. It will also stimulate future research by highlighting areas where we currently lack understanding and empirical evidence.

In summary, the I-ASC exploration concluded that those charged with the responsibility for proposing specific communication aids face a complex task that includes identifying the particular child characteristics, access features, and communication aid attributes. A key lesson for practice is that these must be considered in the recommendations for each child. The challenge is that these are not separate, fixed components of the decision-making process, but are constantly moving, with some being more fluid and others more stable depending on context as teams reach their decisions.

Limitations and Future Directions

It is possible to calculate a numerical rating for each AAC system and to test whether any differences are statistically significant. However, it is not possible to know how meaningful participants considered the difference between, for example, an AAC system rated five out of seven and one rated six out of seven to be. It may be that they considered two such AAC systems to be very similar, or they could have believed that the higher rated system would have a significantly positive effect on a child's future for many years. Future studies using a similar method may wish to investigate giving participants guidance as to how to interpret a unit difference in the rating scale.

The ratings for AAC systems are derived from statistical modelling of a limited number of choices for each individual, and so participants may have given different responses if the context was changed to rating an AAC system directly. However, with 36 child

vignettes and 274 AAC systems, rating every system for every vignette would have required participants to complete 864 rating tasks, which is unfeasible. In addition, DCE choices and ratings were gathered at the same time and participants' ratings may have been influenced by the previous choice task. However, incorporating the Likert scale as part of a DCE had many practical advantages, as discussed above. In addition, recruiting participants to both the BWS and DCE surveys was difficult given the low numbers of AAC professionals in the UK, estimated at around 800 (Communication Matters, private correspondence). Thus it was uncertain whether recruiting participants for a third survey would be practical.

In common with all stated preference studies, there is concern about the ecological validity of the survey instrument, and whether it captures the relevant aspects of the decision-making situation. However, the survey went through an extensive development process (Webb et al., 2021) to help create as realistic a scenario as possible, and which captured the most important aspects of decision-making. A related limitation is that we could include only a subset of the many characteristics which influence how suitable a match an AAC system is for a child. Thus, for example, while we provide information on systematic organization and representation, we did not include features related to access. Also, the survey measures what AAC system attributes participants believed would match well with children. It does not necessarily capture the effectiveness of the sort of AAC systems suggested here to be a suitable match for children, and empirical research into whether AAC professionals' beliefs match up with real-world effectiveness would be useful to investigate in future.

It was mentioned above that the set of AAC systems used in the survey was not necessarily reflective of AAC systems available on the market. Although all systems were feasible, many would not be available off the shelf, and in practice would require practitioners to adapt an existing AAC vocabulary set. The skills, willingness and culture of doing this is likely to vary across practice settings. Additionally the availability of AAC

systems will vary from place to place (particularly across countries) and the AAC systems and vocabularies placed on the market will change over time.

This study has a relatively low sample size compared to many similar studies in healthcare (Soekhai et al., 2019). However, as noted above, the number of AAC professionals in the UK is small, so that the sample size represents a sizeable fraction of the target population.

There was probably some heterogeneity in participants' opinions and preferences depending on their individual experiences and familiarity with different AAC systems and children. It is a limitation of our study that we did not collect data on what AAC system participants' were familiar with, and only broad information about what diagnoses they commonly encountered. However, it is difficult to collect such detailed information in a short web survey where the focus was on preference elicitation tasks. There may also be decision-making differences between more experienced AAC professionals, as in Sauerwein & Wegner (2020) (though note that in that study, novices were defined as first-year masters students, some of which had not taken an AAC course, whereas here 93% of participants had at least one year of professional AAC experience). Future work could examine heterogeneity in AAC professionals' decision-making more closely. This includes how decision-making varies among different specialties, which is not possible to explore in the current study due to 75% of participants having a speech and language therapy background. For example, speech and language therapists may have interpreted regression as a loss of language skills, whereas occupational therapists interpreted it as a loss of physical abilities or vision, and made different decision accordingly.

There is much scope for future research to build on the current study. For example, it would be useful to examine whether the findings about the suitability of hypothetical AAC systems concur with AAC professionals' opinions about the suitability of real life systems. In

addition, the current study highlighted areas in which inequalities in provision could occur, and in future, it could be examined whether such inequalities are found. Finally, it would be fruitful to explore whether AAC professionals' opinions about the suitability of AAC systems are in agreement with other stakeholders such as people who use AAC and their families. This latter issue is of particular importance given the likely impact on how motivated a child is to use an AAC system, and on how motivated a family is to provide support.

Conclusion

This study complements the earlier BWS and DCE studies, with all three studies examining the decision-making of AAC professionals choosing AAC systems for children from a different perspective. There have also been synergies from performing the studies together in a single research project. The results, together with the findings of the wider research project have been used to help create practical resources to help AAC professionals working with children in their everyday practice. The suite of resources is freely available at <https://iasc.mmu.ac.uk/>.

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Table 1

Attributes and Levels

Attribute	Levels
	Children
Receptive and expressive language	Delayed/ Receptive language exceeding expressive language
Communication ability with AAC	No previous AAC experience/ Able to use AAC for a few communicative functions/ Able to use AAC for a range of communicative functions
Child's determination and persistence	Does not appear motivated to communicate through any methods and means/ Motivated to communicate through symbol communication systems/ Only motivated to communicate through methods other than symbol communication
Predicted future skills and abilities	Regression/ Plateau/ Progression
	AAC systems
Vocabulary sets	No vocabulary set*/ Fixed vocabulary set/ Vocabulary set with staged progression/
Size of vocabulary	Up to 50 vocabulary items*/50-1000 vocabulary items/ More than 1000 vocabulary items
Consistency of layout	Consistency of some aspects of layout*/ Consistency of all aspects of layout/ Idiosyncratic layout
Type of vocabulary organization	Visual scene*/ Taxonomic/ Semantic-syntactic/ Pragmatic
Graphic representation	Photos*/ Pictographic symbol set/ Ideographic symbol system (with rules or encoding)/ Text

Note. * indicates baseline level.

Table 2

Participant Demographics

Characteristic	<u>Completed DCE</u>		<u>Did not complete DCE</u>	
	N	%	N	%
Mean age (sd)	40.2	10.9	46.1	10.9
Mean years of experience (sd)	11.4	9.15	11.6	9.87
Female	140	90.3	15	88.2
White ethnicity	137	88.4	12	70.6
Professional background - speech and language therapist	117	75.5	8	47.1
Professional background - occupational therapist	11	7.1	5	29.4
Professional background - assistive technology specialist	5	3.23	0	0
Professional background - teacher	11	7.1	3	17.6
Professional background - other	12	7.74	0	0
Common diagnoses - autism spectrum	101	65.2	12	70.6
Common diagnoses – physical	128	82.6	12	70.6
Common diagnoses - dyspraxia	12	7.74	2	11.8
Common diagnoses - intellectual disability/delay	107	69	11	64.7
Common diagnoses - neurological	39	25.2	6	35.3
Common diagnoses - speech/language disorder	19	12.3	3	17.6
Common diagnoses - syndromes	56	36.1	5	29.4
N	155		17	

Note. DCE = discrete choice experiment; sd = standard deviation

Table 3

For each Child Vignette, the Proportions of Systems Rated at Least Five and at Least Six

<u>Child vignette</u>				<u>Percentage of systems rated over</u>	
Language	AAC Experience	Motivation	Trajectory	5	6
Delayed	No experience	Motivated (non-AAC)	Regress	51.1	0
R>E	No experience	Motivated (non-AAC)	Regress	53.6	0
Delayed	No experience	Not motivated	Regress	70.8	0
Delayed	No experience	Motivated (non-AAC)	Plateau	71.2	0
Delayed	Few functions	Not motivated	Regress	71.9	0
R>E	No experience	Not motivated	Regress	73	0
Delayed	No experience	Motivated (non-AAC)	Progress	73.7	0
R>E	No experience	Motivated (non-AAC)	Plateau	73.7	0
R>E	No experience	Motivated (non-AAC)	Progress	75.2	0
R>E	Few functions	Not motivated	Regress	75.5	0
Delayed	No experience	Not motivated	Plateau	82.5	0
Delayed	Few functions	Not motivated	Plateau	83.6	0
Delayed	No experience	Not motivated	Progress	86.1	0
R>E	No experience	Not motivated	Plateau	86.1	0
Delayed	Few functions	Not motivated	Progress	87.6	0
R>E	Few functions	Not motivated	Plateau	88	0
R>E	Few functions	Not motivated	Progress	88.7	0
R>E	Few functions	Motivated (AAC)	Regress	93.4	0
R>E	No experience	Motivated (AAC)	Regress	94.2	0
Delayed	No experience	Motivated (AAC)	Regress	95.6	0
Delayed	Few functions	Motivated (AAC)	Regress	95.6	0
Delayed	Many functions	Motivated (AAC)	Regress	95.6	0
Delayed	No experience	Motivated (AAC)	Plateau	98.5	0
Delayed	Few functions	Motivated (AAC)	Plateau	98.5	0
R>E	No experience	Not motivated	Progress	86.5	0.36
					5
R>E	Few functions	Motivated (AAC)	Plateau	97.1	2.19
R>E	No experience	Motivated (AAC)	Plateau	97.1	3.28
Delayed	Many functions	Motivated (AAC)	Plateau	98.5	3.28
R>E	Many functions	Motivated (AAC)	Regress	93.4	4.38
Delayed	Few functions	Motivated (AAC)	Progress	95.6	8.76
Delayed	No experience	Motivated (AAC)	Progress	96.7	9.12
R>E	Many functions	Motivated (AAC)	Plateau	97.1	12
R>E	Few functions	Motivated (AAC)	Progress	94.5	12.8
R>E	No experience	Motivated (AAC)	Progress	94.5	13.1
Delayed	Many functions	Motivated (AAC)	Progress	96.7	15
R>E	Many functions	Motivated (AAC)	Progress	95.6	20.4

Note. R>E=Receptive language exceeding descriptive language

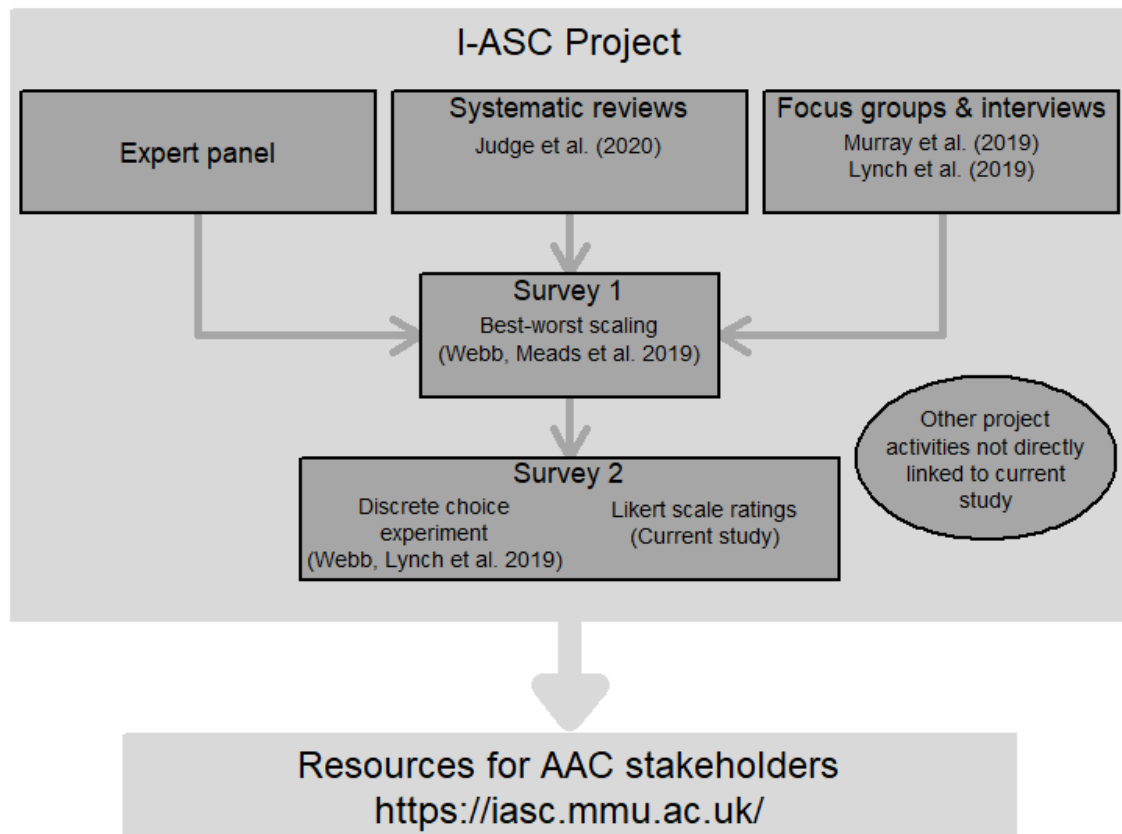


Figure 1. Schematic representation of the relationship between the current study and the wider I-ASC project

Child B has delayed expressive and receptive language and able to use aided AAC for a few communicative functions. Child B is only motivated to communicate through methods other than symbol communication systems. Child B is predicted to maintain current skills and abilities (plateau).

	System 1	System 2	System 3
Graphic Representation Primary type of graphic symbol used	Ideographic symbols	Photo symbols	Pictographic symbols
Consistency of layout Consistency of layout of symbols on pages, including when navigating through pages to select desired output.	Highly consistent layout	Somewhat consistent layout	Inconsistent layout
Vocabulary sets Pre-determined vocabulary or language package provided	Commercially provided sets without language progression	Commercially provided sets with language progression	Commercially provided sets without language progression
Size of vocabulary The size of the output vocabulary available within the aided AAC system.	More than 1000 vocabulary items	50-1000 vocabulary items	Up to 50 vocabulary items
Type of vocabulary organisation Primary format used to organise the vocabulary within the aided AAC system	Pragmatic organisation	Semantic syntactic organisation	Visual scene display

For this child I would choose:

On a scale from 1 to 7, how good a match is your chosen device for this child? (1=very unsuitable, 7=very suitable)

1 = very unsuitable

2

3

4

5

6

7 = very suitable



35%

Figure 2. Screenshot of example discrete choice experiment task

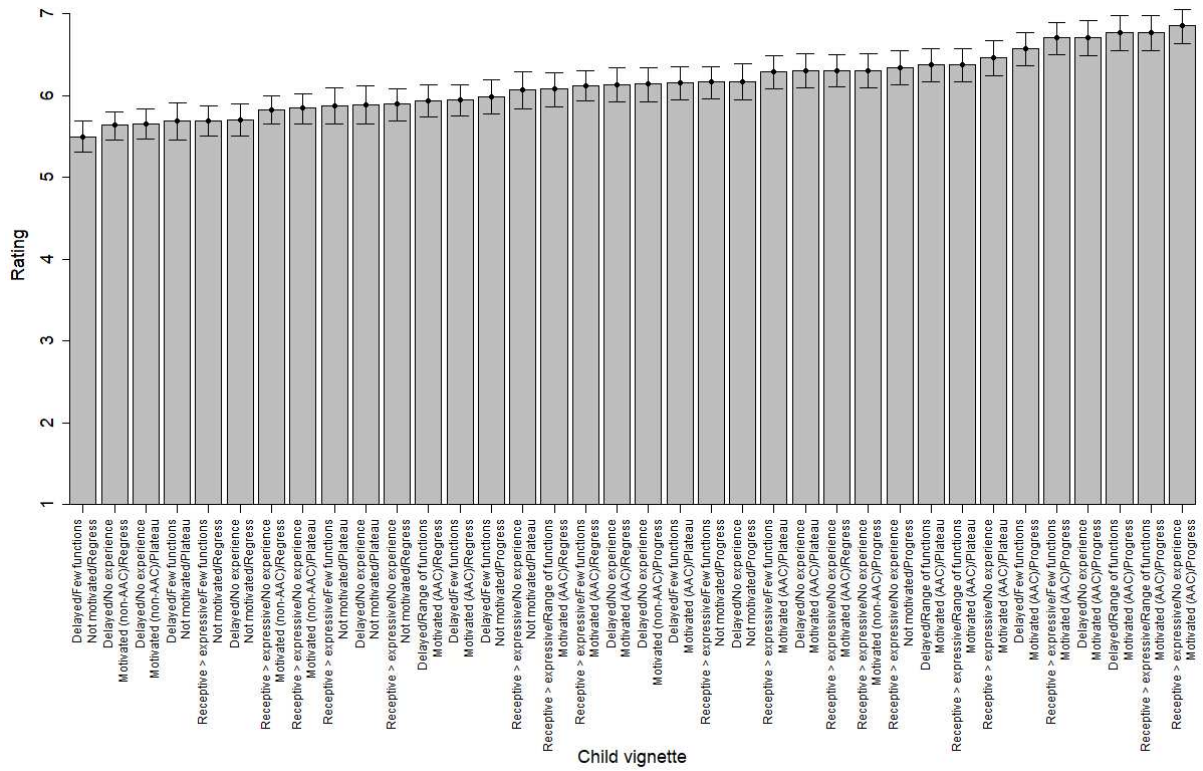


Figure 3. Ratings of the most suitable AAC system for each child vignette

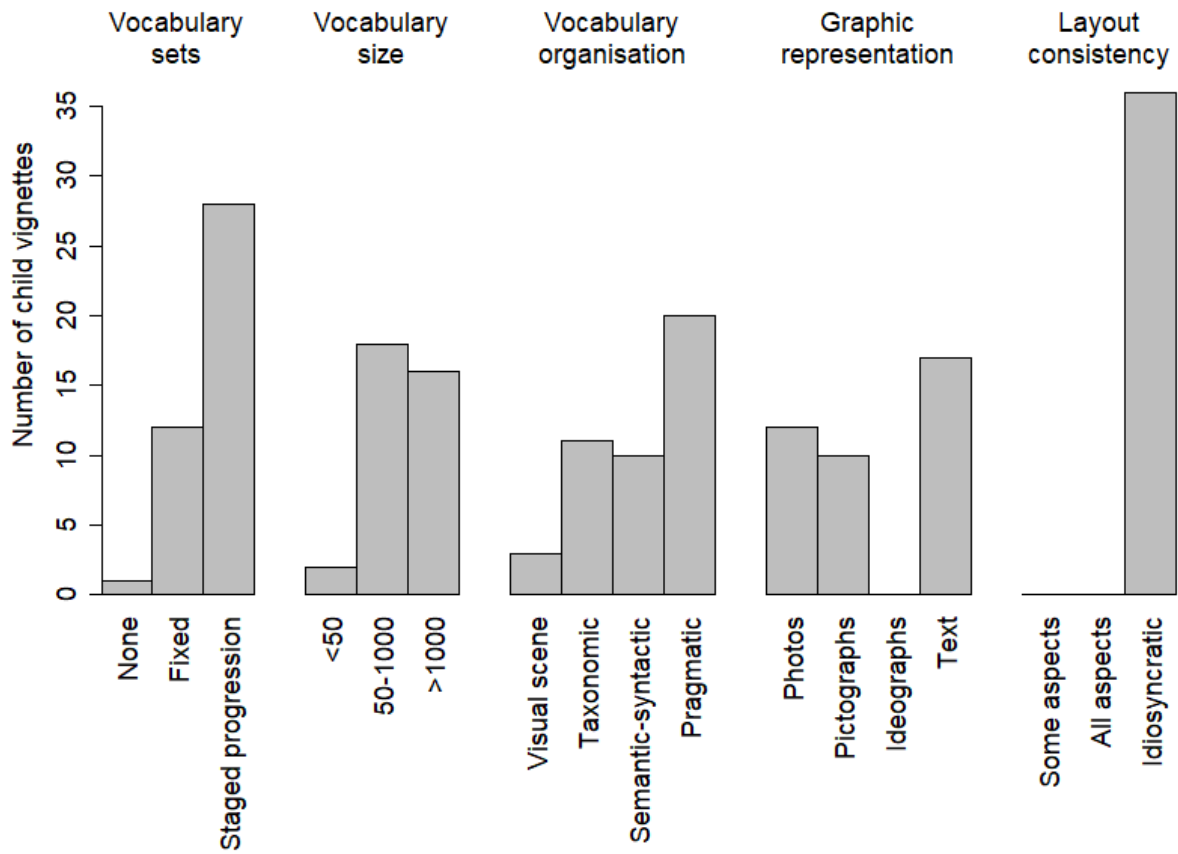


Figure 4. Number of times each AAC system level was part of a child vignette’s most preferred system

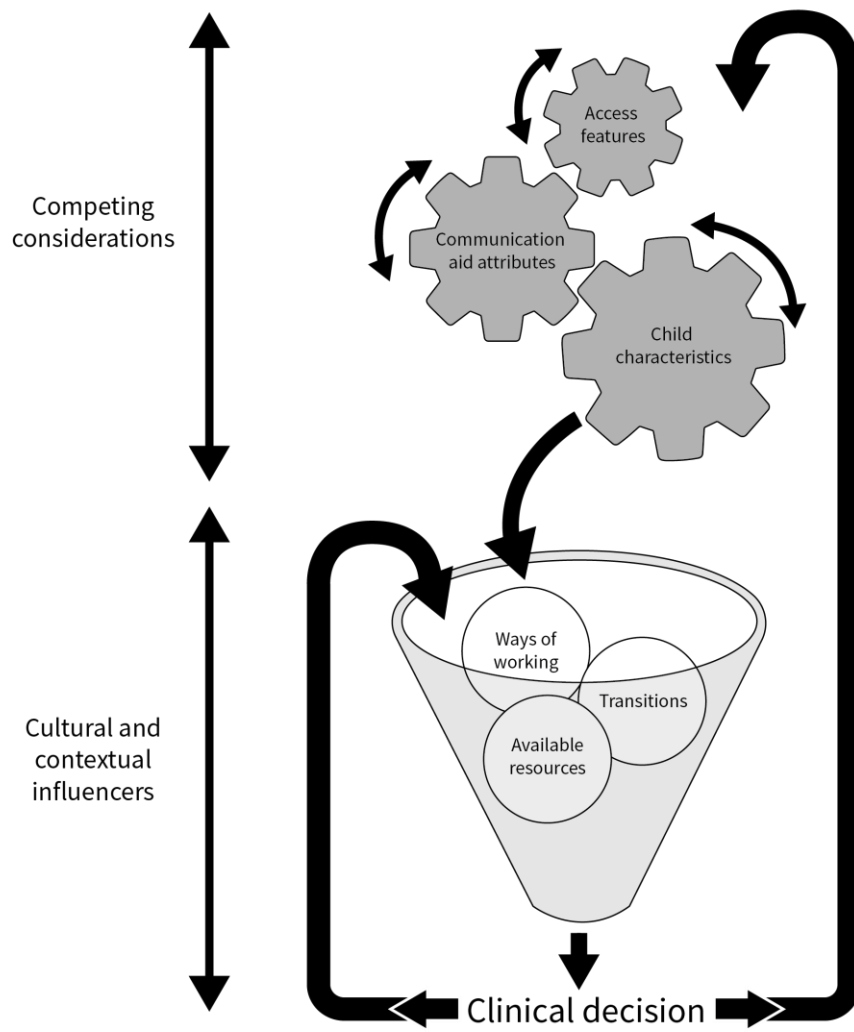


Figure 5. The I-ASC Explanatory Model of Decision Making (Murray et al, 2019)