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RESEARCH ARTICLE



Augmentative and alternative communication for Aboriginal Australians: Developing core vocabulary for Yolŋu speakers

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ABSTRACT

Yolŋu, Aboriginal people from Arnhem Land, Australia are at risk of Machado-Joseph disease, with progressive loss of speech. Yolŋu are interested in developing augmentative and alternative communication (AAC) systems in their own languages. This research aimed to develop a culturally responsive process to explore and create a core vocabulary word list for Yolŋu adults living with the disease for inclusion in AAC system prototypes. A list of 243 Yolŋu words and morphemes was created. In this highly collaborative, mixed methods, participatory action research, *Balanda* (the Yolŋu word for non-Aboriginal people) and Yolŋu researchers conducted cycles of transcription and analysis of a language sample, with oral group discussions to identify which words to include, omit, or add, based on Yolŋu perceptions of the structure and use of their languages. A Yolŋu metaphor, *Gulaka-buma* (“Harvesting yams”), was identified by Yolŋu researchers to represent and share the research process and findings. Three key themes were identified that summarize the main cultural and linguistic considerations related to changes made to the core vocabulary. Study findings emphasized the role of language as an expression of culture and identity for Indigenous peoples and the importance of considering cultural and linguistic factors in selecting vocabulary for AAC systems.

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Adults living with Machado-Joseph disease (MJD), otherwise known as spinocerebellar ataxia type 3 (SCA3), may greatly benefit from augmentative and alternative communication (AAC) systems. MJD is the most common type of spinocerebellar ataxia in the world (Martins et al., 2012). It is a neurodegenerative disease that results in dysarthria, and later anarthria, a complete loss of speech. Impaired vision, fine and gross motor skills, incontinence, and sleep are other symptoms associated with MJD (Saute & Jardim, 2015). Despite the gradual degradation of these functions, cognition remains unaffected. A phenomenon known as *anticipation*, associated with MJD and other triplet diseases, results in younger generations commonly inheriting a longer disordered gene sequence and earlier onset than their parents (Bettencourt & Lima, 2011). People can live for 20 years or more from the first onset of symptoms with access to appropriate medical care (Saute & Jardim, 2015). These factors suggest that AAC can and should be developed before the onset of debilitating symptoms.

The prevalence of MJD among Aboriginal Australians is approximately 100 times the global average (Carr et al., 2019). Most Aboriginal people living with the disease are located across 15 remote Aboriginal communities in the Northern Territory and Queensland (MJD Foundation, 2017). The communication strengths and needs experienced by Aboriginal people living with MJD “between ‘two worlds’” are complex (Amery et al., 2020, p. 507) and occur in the context of substantial disparities in health and living conditions between Indigenous and non-Indigenous Australians (Commonwealth of Australia & Department of Health & Ageing, 2013). Indigenous peoples have the right to communicate in their own Indigenous languages (United Nations, 1992). Communicating in their first languages connects Aboriginal Australian people to their culture, identity, and contributes to overall health and wellbeing (Commonwealth of Australia & Department of Health & Ageing, 2013). Therefore, advocating for, resourcing, and supporting Aboriginal people to maintain use of their languages,

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including through aided AAC, is an important and fertile ground for exploratory research.

Yolŋu are Aboriginal people from northeast Arnhem Land, Northern Territory. More than 250 Yolŋu are at risk of developing MJD, making them one of the largest cultural and linguistic groups at risk of the disease in Australia (MJD Foundation, 2017). There are approximately 12,000 speakers of Yolŋu languages, comprising more than 50 clan languages (Christie & Charles Darwin University, 2016). Most Yolŋu are multilingual, understanding and speaking several Yolŋu languages. *Djambarrpuyŋu*, a Yolŋu language and lingua franca of northeast Arnhem Land, is the strongest traditional Australian Aboriginal Language with a growing number of speakers (Simpson et al., 2018). Aboriginal languages in Australia have an oral history and are still learned and passed down through ceremony, song, and stories. Yolŋu ontology and epistemology are relational, performative, fundamentally narrative-based and incorporate multiple perspectives (Christie, 2006; van Gelderen & Guthadjaka, 2017). Many Yolŋu also know and use some Yolŋu Sign Language (Maypilama & Adone, 2013). Like most hunter-gatherer societies throughout the world, 80% of Australian Aboriginal languages, including Yolŋu languages, only have number words for 1, 2, 3 and sometimes 4 (Epps et al., 2012). The first systematic written accounts of Yolŋu languages were constructed by *Balanda* (non-Aboriginal) missionaries and linguists in the early 1960s (ARDS Inc, 2004); however, since this time government policies have not consistently supported bilingual education (Devlin et al., 2017) and not all Yolŋu feel confident reading and/or writing their own language.

Most Yolŋu live in remote and very remote communities and homelands. A significant number of Yolŋu also travel and live in urban contexts to access medical and rehabilitation services, education and visit family. While Standard Australian English has little relevance for Yolŋu interacting with other Yolŋu in most everyday contexts (Amery et al., 2020), Yolŋu are increasingly required to interact with *Balanda* services and systems. Yolŋu culture remains strong, and is practiced in daily community life as well as ceremony, hunting, and through raising their children according to Yolŋu *rom* (culture and law) (Amery et al., 2020). Key Yolŋu terms discussed throughout this paper are presented in a glossary in [Supplemental Table 5](#).

The design, development, and implementation of AAC in multilingual and intercultural contexts is a growing area of AAC practice and research (Tönsing et al., 2018). Intercultural AAC is developing in both (a) high-income countries, where the majority of speech-language pathologists (SLPs) are members of the dominant or mainstream culture but the diversity of the population is increasing due to globalization and migration (Kulkarni & Parmar, 2017); and (b) low- and middle-income countries, where a greater proportion of people live with a disability and AAC services are increasing to respond to a largely unmet need (Muttiah et al., 2016).

While Australia is classified as a high-income country, many Aboriginal Australians, especially in very remote

locations, live with poor health and limited access to education, technology, and other resources. In the Northern Territory, there are no speech-language pathologists who share the same language and cultural background as the Aboriginal families with whom they work, and access to accredited interpreters is limited. Difficulty with recruitment and high staff turnover means many SLPs are new to the complex linguistic and intercultural context (Lowell et al., 2012). Most Yolŋu have never seen nor heard of aided AAC and have had limited exposure to AAC in English, let alone their primary languages (Amery et al., 2020).

Families from diverse cultural and linguistic backgrounds receiving AAC services experience language and cultural barriers the world over. One of the most significant barriers is the absence of comprehensive AAC systems in different languages (Tönsing et al., 2018). Limited linguistic knowledge and resources have also hindered the development of comprehensive AAC systems in some contexts (Bhattacharya & Basu, 2009). When partnerships with families and cultural advisors are lacking, decision-making and implementation are often based solely on practitioner views and cultural values (Kulkarni & Parmar, 2017). Practitioners often prescribe AAC systems that have culturally inappropriate symbols and messages and no access to vocabulary in the home language (Soto & Yu, 2014).

Families from diverse cultural and linguistic backgrounds want more access to contextual and culturally appropriate information, education, and training about AAC and to be involved with professionals in AAC decision making (Soto & Yu, 2014; Kulkarni & Parmar, 2017). Yolŋu too, want to develop respectful partnerships to explore the potential of aided AAC in Yolŋu languages to support the communication needs of their family members (Amery et al., 2020). For example, for people living with dysarthria associated with a degenerative disease like MJD, AAC may be introduced initially to enhance intelligibility by augmenting dysarthric speech, and later, to be used alongside residual speech as a primary means of communication (Ball, 2005).

AAC systems are typically designed based on the intuition, experiences, and beliefs of practitioners (Light et al., 2019); however, when practitioners do not share the language and/or cultural background of the people with whom they work, they must engage and partner with families and language/cultural advisors (Huer & Saenz, 2002). Working collaboratively increases the likelihood that appropriate AAC systems will be developed that reflect the cultural values, linguistic and communication practices of the family and community (Huer & Saenz, 2002; Soto & Yu, 2014).

Vocabulary selection is one of the first steps in AAC system design. Vocabulary is often gathered from various sources, including lists from family, therapists and educators, environmental inventories, and published vocabulary lists (Trembath et al., 2007). Core vocabulary is typically defined as words that occur frequently or are commonly used by many individuals (Laubscher & Light, 2020). Core vocabulary provides most of the vocabulary that an individual needs for effective communication between speakers and across contexts and can be easily supplemented and personalized with

fringe vocabulary over time (Robillard et al., 2014; van Tilborg & Deckers, 2016). Research to determine core vocabulary for use in AAC has recently been conducted for several languages, including French, Arabic, Korean, Mandarin, Urdu, and Zulu (Liu & Sloane, 2006; Mukati, 2013; Robillard et al., 2014; Draffan et al., 2015; Shin & Hill, 2016; Mngomezulu et al., 2019).

Most traditional core vocabulary studies have involved collecting and analyzing speech samples from participants and have used quantitative research methods to determine core vocabulary from percentages, frequency, and commonality scores (Balandin & Iacono, 1999; Trembath et al., 2007; Robillard et al., 2014; Shin & Hill, 2016; Mngomezulu et al., 2019). In some languages, core vocabulary has been developed from collated word lists (Draffan et al., 2015) or speech-data sets, modified and supplemented with relevant linguistic and cultural knowledge (Liu & Sloane, 2006). Researchers are often native speakers or possess a deep understanding of the study language, which is important because the structure of a language impacts the way vocabulary is represented and organized in AAC systems (e.g., Nakamura et al., 2006; Yong, 2006; Mngomezulu et al., 2019).

Researchers working across languages and cultures may need to adopt different theoretical frameworks and methodologies to acknowledge and reflect the socio-cultural context and diverse cultural views of all stakeholders (Ripat & Woodgate, 2011; Hyter, 2014). For core vocabulary research about Aboriginal languages to be ethical, it must be designed and carried out with Aboriginal people in ways that benefit and are meaningful to them and respect, protect, and maintain Aboriginal knowledge and cultural expression (Australian Institute of Aboriginal & Torres Strait Islander Studies, 2012). Yolŋu commonly share metaphors in everyday communication as an expression of Yolŋu epistemology and ontology, to demonstrate the interconnectedness of all things, including but not limited to aspects of the natural world, kinship and Yolŋu law (Marika-Mununggiritj & Christie, 1995; van Gelderen & Guthadjaka, 2019). Collaborative analysis processes with Yolŋu involve many intercultural bilingual conversations over time, with ongoing negotiation and renegotiation of meaning and agreement for the relevant purpose (Lowell et al., 2018).

Given the significance of language for communication, knowledge, and cultural expression for Indigenous peoples, and the lack of aided AAC research relevant to the needs of Indigenous language speakers, the goals of this study were to explore, with Yolŋu, the concept and development of core vocabulary inclusion in AAC system prototypes, and to do so within the framework of a culturally responsive research process.

Method

This is the second study in a broader program of communication research with Yolŋu living with MJD and their families. In Study 1 (Amery et al., 2020), constructivist grounded theory was used to explore the views of Yolŋu living with MJD

about communication, speech-language-pathology services, and AAC. Study 3 (Amery et al., 2022) involves the development of AAC system prototypes utilizing vocabulary from the current study. The same participants, family members, communication partners, recruitment process, research design, and researchers took part/were used in the current study and Studies 1 (Amery et al., 2020) and Study 3 (Amery et al., 2022).

Throughout this broader program of research, researchers aimed to enact the principles of the metaphor *Gon̄dhu* ("Building understanding by hand") identified in Study 1. The metaphor *Gulaka-buma* ("Harvesting yams"), an applied example of *Gon̄dhu*, was utilized in the current study and Study 3 (Amery et al., 2022) to represent and share the research process and findings in a culturally responsive way that centers Yolŋu voices and worldview.

Participants

A total of 15 Yolŋu adults provided written and oral consent to participate in this study: 10 Yolŋu adults living with MJD (P1, P2, etc.) and five of their close Yolŋu family members and communication partners (FM1, FM2, etc.), who informed the vocabulary selection. Participants and family members were aged between 18–56 years and were 11 females and four males. One participant with severe stage MJD used facial expression, gesture, sign language, and vocalizations to participate. All other participants with MJD presented with mild to moderate dysarthria associated with their stage of MJD and were still using their speech to communicate effectively. All participants spoke a Yolŋu language as their first language and were members of the same extended Yolŋu family.

The first author and principal Yolŋu researcher carried out purposeful sampling to invite all Yolŋu living with MJD to participate. Opportunistic sampling was used to invite family members and close communication partners living or staying with participants at the time of the research. Participant characteristics and their participation in research activities are presented in Table 1.

Setting

This study was conducted in remote and regional Northern Territory, Australia. Yolŋu researchers decided that the language sample would be recorded at the beach, where participants felt most relaxed and comfortable. Being connected to country and with each other facilitated more natural conversation among participants.

Research design

This study involved qualitative dominant, concurrent, transformative mixed methods research (Johnson et al., 2007; Creswell & Creswell, 2018). Quantitative data collection and analysis were used to provide contextual, baseline data to stimulate discussion, and to exemplify and inform Yolŋu researcher understandings about core vocabulary and

Table 1. Participant characteristics.

Participants: Individual (P) and family (FM)	Sex	Age range (years)	Stage of Machado–Joseph disease	Participated in language sample	# of group discussions attended
P1	F	40–50	Mild	Yes	6
P2	F	20–30	Mild	Yes	2
P3	F	30–40	Moderate	No	4
P4	F	50–60	Moderate	Yes	5
P5	F	50–60	Moderate	Yes	3
P6	F	18–20	Severe	No	6
P7	M	20–30	Moderate	No	4
P8	F	50–60	Moderate	No	5
P9	M	50–60	Moderate	No	6
P10	F	50–60	Moderate	No	3
FM1	M	30–40	NA	No	4
FM2	F	20–30	NA	No	5
FM3	F	18–20	NA	No	1
FM4	M	18–20	At risk	No	2
FMS	F	20–30	At risk	Yes	3

decisions in subsequent cycles of qualitative research. Qualitative data collection and analysis played an important role in grounding, clarifying, contextualizing, interpreting, and modifying the initial quantitative results (Creswell & Creswell, 2018). Incorporating mixed methods allowed the research team to consider the paradox of quantitative research methods typically used to determine core vocabulary, and the anumeric, oral narrative, performative, and multiperspective ontological views of Yolŋu. Mixed methods were used in this research to provide a deeper understanding, more meaningful and useful results, and to challenge existing power dynamics (Creswell & Creswell, 2018). Incorporating mixed methods also stimulated new ways of thinking and allowed for the development of an innovative research process (Johnson et al., 2007) for determining a culturally relevant and usable core vocabulary list for the development of Yolŋu AAC systems.

This culturally responsive research drew on the theoretical paradigms of critical theory and constructivism, focusing on relationships and recognizing that knowledge is socially constructed (Baum et al., 2006; Hyter, 2014). Indigenist and decolonizing research methodologies also informed this research (Rigney, 1999; Martin & Mirraboopa, 2003; Smith, 2012). Indigenist research is undertaken by Indigenous Australians, with Indigenous Australians, for the purposes of contributing to and informing the Indigenous struggle for self-determination (Rigney, 1999). The research team understood the inherent power imbalances at work from the historical and ongoing colonial practices of researchers and research institutions on Indigenous peoples, languages, and cultures in Australia; accordingly, Yolŋu voices, ways of being, and knowing were intentionally privileged through all stages of the research (Martin & Mirraboopa, 2003). Local Yolŋu research principles were implemented throughout this research, including employing Yolŋu researchers, working in Yolŋu languages as much as possible, incorporating Yolŋu approaches to research and being flexible (Yalu Marngithinyaraw, 2012).

Participatory action research was the overarching methodological framework that informed this research. This involved cycles of action, observation, reflection, and

planning, in iterative, empowering, collaborative, and reflective enquiry (Baum et al., 2006). Power was intentionally shared between researchers and participants, blurring the lines between them so that participants also became active, reflective researchers.

Ethical approval for this study was received from Menzies School of Health Research with reciprocal ethics approval from Charles Darwin University.¹

Research team

This project involved high levels of collaboration between (a) the first author, a Balanda speech-language pathologist with a family history of living in Arnhem Land; and (b) five Yolŋu researchers with culturally appropriate kin relationships to Yolŋu with MJD. The research team also purposefully sought cultural and linguistic advice from a linguist, Yolŋu language teachers, and a language researcher for input into the transcription and analysis of both quantitative and qualitative data. Researchers welcomed input from other Yolŋu elders and cultural advisors who contributed to analytical discussions in an opportunistic and convenient way. A software programmer was also approached and volunteered to code a script for quantitative analysis.

Materials

A SmartLav+² lapel microphone with an extension cord was used to record the language sample and passed between speakers through the conversation. An iPad³ mounted on a tripod was used to video record the interaction and capture use of Yolŋu Sign Language and other non-verbal communication in the conversation. The software programmer coded a Unix shell script to calculate word frequencies in consultation with the research team.⁴

Procedures

This study involved integrated concurrent cycles of quantitative and qualitative data collection and analysis that have been separated below for clarity. Data was collected and

analyzed in reflective cycles, and decisions were made regarding what action to take. The next action was taken, observed, and collaboratively analyzed, which generated more data and analysis, which informed planning of the next cycle.

Conversation sampling

First, a 60-min naturalistic language sample was video recorded. A total of four participants and two family members were available and provided consent to participate in the language sample. This was the maximum length of time participants who took part in this process were able to engage in conversation before some started to experience fatigue. This short recording was considered adequate for an initial cycle of quantitative data collection and analysis and was used to stimulate discussion and inform the collaborative group discussions and analysis that followed.

Group discussions

Collaborative, reflective, and analytical oral group discussions were carried out between Yolŋu researchers, participants, and advisors. Through these discussions, the concept of core vocabulary was explored from a Yolŋu worldview and cultural understanding. Transcripts from the language sample and emerging wordlists were considered, among other issues related to determining core vocabulary for Yolŋu speakers. Yolŋu discussed their views and understandings of the structure and use of Yolŋu languages compared to non-Aboriginal meta-linguistic understandings of suffixes and irregular forms of words. Yolŋu participated in one to six oral group discussions over a period of 5 months. The research team collectively considered which words from the language sample should be omitted from or added to the core vocabulary, as well as other issues related to transcription, interpretation, and determining a Yolŋu core vocabulary. Summary notes were recorded from each of these discussions. The first author also wrote memos and field notes and kept a reflective research journal.

Data analysis

Conversation sampling: Transcription, frequency and commonality scores

Two Yolŋu researchers watched the video recording of the conversation sample and provided an oral transcription of the first 300 utterances (approximately 30-min) by orally repeating verbatim what participants had said, but at a slower speed. This was transcribed by the first author in Microsoft Word. This process evolved to respond to the Yolŋu researchers' preferences for oral communication despite some confidence in English and Yolŋu language literacy. The conversation sample was transcribed following pre-determined transcription rules (Appendix A, Supplemental file) per Trembath et al. (2007). Yolŋu researchers provided an oral meaning-based interpretation of the Yolŋu conversation into English. A Yolŋu and English gloss translation was also transcribed by the first author in which morphemes were marked separately.

Frequency counts were conducted for whole-word transcription (e.g., *dhawaṯthundja* as one word) and gloss transcription, in which morphemes were marked separately (e.g., *dhawaṯthun/-dja* as two morphemes). In successive cycles of data analysis (informed by group discussions with Yolŋu researchers and participants), frequency counts were carried out on the gloss transcription, with compound suffixes marked as single suffixes (e.g., *Djuwit/-kunhamirr* rather than *Djuwit/-kunha/-mirr*), and irregular forms of Yolŋu verbs and pronouns counted as unique words (e.g., *waŋa* and *waŋi*, primary and secondary forms of the verb "to talk").

The final modified gloss transcription was analyzed for total number of words, total number of unique words, Yolŋu words, English words, and a frequency count of words. Words that were spoken with a frequency of > 0.5 per 1000 words were considered in the possible initial core vocabulary from the quantitative data analysis. This criterion has been used consistently in various core vocabulary studies (e.g., Trembath et al., 2007; Robillard et al., 2014; Mngomezulu et al., 2019). For the small sample in the current study, this included words spoken with a frequency greater than or equal to two, by two or more speakers, calculated using the Unix shell script. The overall percentage of core words retained in the final Yolŋu core vocabulary list, compared to the total language sample corpus, was calculated.

Group discussions: Coding and key themes

NVivo 12 software (QSR International Pty Ltd, 2019) was used to manage qualitative data sources and codes. Initial cycles of simultaneous coding were carried out on qualitative data sources, applying multiple codes to relevant sections of memos, field notes, discussion notes, and journal entries related to the considerations and views expressed by participants, researchers, and advisors. Initial coding involved tagging data with in-vivo codes, using the words of participants to privilege Yolŋu voices; descriptive codes, labeling or summarizing the primary topic; and process codes, or gerunds and verbs to identify collaborative processes and highlight the cultural and linguistic considerations in determining the core vocabulary (Saldaña, 2009; Charmaz, 2014). Initial codes were discussed by the research team and codes were confirmed, modified, or removed if redundant or irrelevant to the study aim. Through a second cycle of analysis data were recoded as necessary. Codes were then grouped into themes through a collaborative process of discussion and checking with Yolŋu researchers. The following example, taken from a field note documenting part of a conversation with a Yolŋu researcher, illustrates the coding process.

Dayawurukthun, that's the new way of saying it. Just check with someone about the spelling and pronunciation because it's new to me. It's the new way of saying "someone is asking for you" like if they are on the phone and they pass it to you. I haven't used it myself. I heard that being used when we were back (home) for the first time, because of that funeral. (Dikul, Yolŋu researcher)

This data was initially tagged with the codes "modifying core vocabulary," "borrowing words," "mixing languages," "checking with family," "new way of saying it," and "when

someone passes away.” The first four of these codes were included in the key theme, Being Respectful, and the final two were better represented by existing codes. Successive cycles of analysis involved discussion of key themes, with an emphasis on identifying a Yolŋu metaphor to share findings of the research through a Yolŋu lens to respond to Yolŋu ways of knowing and sharing knowledge.

Trustworthiness and rigor

This research implemented numerous strategies to ensure reliability in quantitative data collection and analysis; trustworthiness in qualitative data collection and analysis; and integration of qualitative and quantitative procedures to address the aims of the research through a rigorous and culturally responsive process.

For quantitative components, Yolŋu researchers worked together to reach consensus on the English interpretation of each word. The transcript was checked by a Yolŋu-speaking language researcher from the MJD Foundation and a team of Yolŋu Studies lecturers at Charles Darwin University. Inter-transcriber agreement (number of agreed words between transcribers divided by number of agreed words plus disagreed words multiplied by 100) between three transcribers ranged from 92%–95%, providing an average agreement rating of 94%.

The research team also reached consensus on words omitted and added to the final Yolŋu core vocabulary list. When consensus was not possible (which rarely occurred), words were included when more than half of the researchers thought that the word should be included. The research team acknowledged that wordlists could continue to be modified as the AAC system prototypes were developed and vocabulary was socially validated (Amery et al. 2022).

To ensure the research was also respectful and useful to Yolŋu, the research team worked together and maintained strong, mutual relationships with appropriate Yolŋu kin through every stage of the research. The team followed Yolŋu cultural protocols, prioritizing working in Yolŋu languages as much as possible, and were guided by the trusted cultural advisors and elders. The final wordlists, key themes, and the Yolŋu metaphor were shared, checked, and confirmed with participants before sharing with relevant stakeholders.

Results

Findings from this research are presented in three subsections related to (a) the Yolŋu metaphor identified by Yolŋu researchers as a culturally relevant way to represent the research processes and findings; (b) a core vocabulary list of Yolŋu words and morphemes (quantitative findings); and (c) key themes that present cultural and linguistic considerations and justifications for additions, omissions, and modifications to the word list by Yolŋu researchers to reflect Yolŋu understandings of core vocabulary.

A Yolŋu metaphor for the research

Gulaka-buma (“Harvesting yams”) is a Yolŋu metaphor that was identified by Yolŋu researchers toward the end of the study as a culturally relevant representation of the emergent research process and findings. This metaphor was not applied as a predetermined process that the research team followed to carry out the research. Rather, *Gulaka-buma* emerged and was identified to encapsulate and emphasize key aspects of the research to demonstrate (or perform) from a Yolŋu worldview the respect, credibility, and trustworthiness of the findings.

The first key component of the metaphor related to the composition of the research team and the ways that we worked together, each sharing different knowledge, listening, learning, and reflecting with each other through research action. Yolŋu family members living with MJD, elders, cultural advisors, linguists, and a speech pathologist – all of whom brought their experience and knowledge about living with MJD, Yolŋu language, and core vocabulary – followed both Yolŋu and Balandra ways of doing research so that the words that were included would suit Yolŋu living with MJD. This resonates with the Yolŋu wisdom and practices involved in harvesting yams, learning with experienced people, together as a family:

That knowledgeable person knows where there are yams, and if it’s the right season, looking at the color of the leaves and where the sand is soft to dig. That wise person knows where to go, how far, what to bring, what to look for. They already know where the yams are. They go there to get yams. (Julie, Yolŋu researcher)

Another key tenet of the metaphor was to not cut or break the vine as you clear the forest before you get to the yam. Don’t lose the thread or forget your purpose. This concept is reflective of the systematic process of working with vocabulary from the language sample, talking about Yolŋu language, and how Yolŋu understand the structure of their own languages. The team had to always keep the purpose of developing AAC systems in mind:

When you are digging, you have to keep following that vine. You follow that vine right to the end where you see the head (of the yam) and start digging. If you cut the vine, you won’t be able to find the yam. If you cut it half-way, then you are lost, the vine will go away, and you won’t be able to see where the yam is. (Julie, Yolŋu researcher)

A third principle of the metaphor was to dig to the full extent. Don’t dig in haste and damage the yam. Rather, dig carefully so that the yam remains intact, and you can extract the whole yam. The research team carefully considered each word, so that the core vocabulary would be useful and relevant to Yolŋu adults with MJD, to tell any Yolŋu story. The team considered many factors so that other Yolŋu could see that a rigorous and respectful process had been followed. The research team talked with many people and worked the right Yolŋu way to come up with a list of words that would suit Yolŋu preferences and achieve the desired outcomes for Yolŋu families living with MJD. Successful yam hunting, and useful research requires careful consideration and respect:

She had a solid, heavy duty and pointy yam stick that she used with tenderness. She got it through careful digging. She put it on the paperbark sheets (it was too big for a dilly bag), and then

Table 2. Sample of 20 Yolŋu Words Retained as Core Vocabulary.

Frequency	Commonality score	Words and suffixes	English translation
69	5	Ga	and / continuous action
62	5	ƀayɪ	he, she, it
57	5	-ny	focus
36	5	Dhuwal	this / here
30	4	ƀunhi	that / there (unseen)
29	3	Wanha	where?
27	5	Nhă	what?
27	4	Way	hey!
26	5	ƀarra	!
21	5	-nydja	Focus
21	5	Yol	who?
21	4	Nhe	you (singular)
19	5	-nha	object of transitive verb/focus
19	5	Bala	then / away from speaker
19	5	Dhu	future marker / probably will
19	5	Nhawi	um, er, you know
19	4	-a	Emphasis
19	4	ƀe	Yes
19	4	Waŋa	talk, say, ask
18	4	Yaka	no / don't

tied it up in a bundle and carried it that way. (Gurimaŋu, Yolŋu researcher)

You have to be careful... keep digging through to the end, then you get it. You pull the yam with the roots on it, then they know you've gone right down. Sometimes that hole is as big as my son. (Julie, Yolŋu researcher)

A Yolŋu core vocabulary

A total of 1641 words were transcribed from the language sample. Of these, 464 unique words were identified, including 369 Yolŋu words and 95 English words. There were 176 words spoken with a frequency greater than or equal to two, by two or more speakers. These 176 words were considered for initial inclusion in the possible Yolŋu core vocabulary. Of these, 86% or 152 words were Yolŋu words, and 14% or 24 words were English words. Participants and the research team decided that 101 Yolŋu words would remain in the Yolŋu core vocabulary list. These 101 Yolŋu words made up 63% of the total language sample corpus. A sample of 20 of these words is presented in Table 2. All 101 Yolŋu words are presented in Supplemental Table 1.

There were 46 words that were deleted from the possible core vocabulary list and not included in Yolŋu AAC system prototypes. These included people's names, contractions of Yolŋu words, Yolŋu slang, Yolŋu interjections, duplications from other Yolŋu languages, less common forms of verbs, and English words. Deleted words are available in Supplemental Table 2. A total of 29 words were omitted from the core vocabulary but included in Yolŋu AAC system prototypes as fringe vocabulary (Amery et al., 2022). These words were topic specific and or spoken only some of the time, including Yolŋu and English nouns, Yolŋu and English verbs, Yolŋu adjectives, Yolŋu adverbs and English interjections. Fringe vocabulary is presented in Supplemental Table 3.

An additional 142 Yolŋu words were added to the core vocabulary by participants and Yolŋu researchers. These

additional Yolŋu words included all remaining concepts in the Yolŋu closed classes (i.e., consisting of a fixed number of items) for relational kin terms, skin names, clan names and Yolŋu pronouns (see supplementary material for examples). The most common suffixes were also added, along with a small number of additional Yolŋu verbs, adverbs, interrogatives, and interjections that were considered to be used with very high frequency in general conversation. The full list of additional Yolŋu words is available in Supplemental Table 4.

A final Yolŋu core vocabulary list of 243 words and suffixes was agreed upon for the development of AAC system prototypes (Amery et al., 2022). The final vocabulary list incorporated 101 words from the original language sample and 142 additional words and suffixes from group discussions (Supplemental Table 1 and 4).

Key themes representing cultural and linguistic considerations

Three key themes were identified through the analysis of qualitative data to represent the main cultural and linguistic considerations in determining the Yolŋu core vocabulary: Keeping Relationships Central, Being Respectful, and Learning Yolŋu Languages and Literacy. Changes made to the core vocabulary were based on these cultural and linguistic considerations. The key themes are briefly summarized in the sections that follow, with further details (associated codes, related changes to the core vocabulary, implications for AAC systems, and illustrative quotes) presented in Table 3.

The first key theme was Keeping Relationships Central. Through discussions, a Yolŋu interpretation of core vocabulary emerged as *ŋaraka-dăl dhärük* (the structural core, or foundational words of Yolŋu languages). This interpretation incorporates concepts that are core or foundational to Yolŋu identity and culture, as well as words that occur with high frequency in conversations across contexts. The first key theme and associated codes reflect decisions to add all vocabulary items from the closed classes kinship terms, skin names, clan groups and Yolŋu pronouns to the Yolŋu core vocabulary. Inclusion of these words ensured that the vocabulary was suitable and responsive to Yolŋu ways of thinking, knowing and being.

The second key theme, Being Respectful, relates to the Yolŋu custom of *rum'rumdhunawuy rom* (observing taboos required by Yolŋu law or kin avoidance rules). Multiple Yolŋu languages were present in the language sample. This reflects a cultural and linguistic practice of not speaking aloud a person's name after they have died or words that sound like that name, as a way of showing respect to that person and their family. During this period, usually lasting one or more years, a similar word, or a word from another Yolŋu language is substituted for use. This theme identified an important role for Yolŋu communication partners to update AAC system vocabulary, including selecting substitute words and dynamically modifying words in response to cultural restrictions.

Table 3. Key Themes highlighting the main cultural and linguistic considerations in determining Yolŋu core vocabulary.

Key themes	Codes	Changes to core vocabulary and implications for AAC systems	Quotes
Keeping Relationships Central	Knowing identity Establishing connection Reinforcing relationships Discussing core Yolŋu categories Using Yolŋu definitions <i>Daraka-däl dhäruk</i> ("structural core or foundational words") and <i>gali'puy dhäruk</i> ("peripheral words")	Added all items from closed classes: kinships terms, skin names, clan names, pronouns, possessive pronouns	"It's all about connection, establishing connection. That's always the first thing you have to know - who you are and what's your clan" (Elah, Yolŋu researcher). "Add all <i>gurrugu</i> ("kinship"), <i>mälk</i> ("skin names") and <i>bäpuru</i> ("clan names") as core groups. <i>Gurrugu</i> , <i>mälk</i> and <i>bäpuru</i> are all connected. It's all the information you need to know about who you are and how you are connected" (Farrah, Yolŋu researcher).
Being Respectful	Borrowing words Mixing languages Modifying core vocabulary Using language in dynamic oral conversations Producing and publishing a static wordlist and AAC systems Checking with family Knowing why and how the core list was developed	Deleted all names from core vocabulary and generic AAC systems. Communication partner's role in AAC to dynamically modify words not in spoken use; update vocabulary in AAC systems	"At the moment we're not saying <i>walal</i> ("they"), it's close to someone's name. We're saying <i>dhanal</i> ("they"), a <i>Gälpu</i> ("clan nation") word. We're mixing <i>Djambarrpuyŋu</i> ("clan nation/language") and <i>Gälpu</i> ("clan nation/language") so that we don't say that word, borrowing from other Yolŋu languages" (Farrah, Yolŋu researcher).
Learning Yolŋu Languages and Literacy	Choosing proper Yolŋu words Writing with correct spelling Limiting duplication of words Modifying Yolŋu language or dialect for individuals Changing the form of the verb	Yolŋu words (mostly <i>Djambarrpuyŋu</i> clan nation) were considered core vocabulary. Added suffixes and style markers to support full Yolŋu grammar. One form of verb included as core vocabulary. Less common forms considered fringe vocabulary. High frequency and relevant English words considered fringe vocabulary.	"It's slang. We say it, but it's not correct. It's like baby talk ... not proper words. Better to use the proper words because you're making a communication tool (AAC system), you know" (Dikul, Yolŋu researcher). "(They'll) think of the longer version, the straight/proper way of talking. That word is made up, it's a short version, it's not really a word" (Julie, Yolŋu researcher).

The third key theme, Learning Yolŋu Languages and Literacy, reflects a strong desire for *Yolŋu matha ga marŋgithirr dhunupa ga däl yaka yalŋgi matha* (learning the deeper aspects of Yolŋu language and knowledge, keeping it strong and correct, rather than using immature or imperfect forms of language). Using the correct form, grammar, and spelling of words supports Yolŋu knowledge, the maintenance and teaching of Yolŋu languages, and demonstrates respect to older people. This priority resulted in only Yolŋu words, mostly from *Djambarrpuyŋu* clan nation (the lingua-franca for Yolŋu and most of the Yolŋu families living with MJD) being included in the core vocabulary. Additional suffixes and style markers were added to support full Yolŋu grammar. High frequency and relevant English words were considered fringe vocabulary.

Discussion

This study explored the concept of core vocabulary through a culturally responsive research process and determined a culturally relevant wordlist for Yolŋu adults living with MJD. This was achieved through cycles of participatory action research, incorporating quantitative analysis of word and morpheme frequency and commonality scores, and qualitative analysis of oral discussions with Yolŋu researchers, participants, and advisors. The research team collectively agreed

on a Yolŋu core vocabulary of 243 words and identified key themes related to linguistic and cultural considerations involved in determining Yolŋu core vocabulary. Yolŋu researchers also identified a Yolŋu metaphor to represent and share the research process and findings that emerged.

Core vocabulary can have different meanings when interpreted across different languages and cultural contexts, and this impacts the ways that core vocabulary is defined and determined in AAC. For Yolŋu, discussions about core vocabulary resulted in a shift in emphasis to align with their culture and worldview. A Yolŋu interpretation of core vocabulary, *ŋaraka-däl dhäruk* (the structural core, or foundational words) encompasses the concepts that are core or foundational to Yolŋu identity and culture, in addition to words that occur with high frequency in conversations across contexts. This resulted in many additional terms, predominantly from Yolŋu closed classes about identity and relationships being added to core vocabulary. Kinship and moiety relations are of such prominence in Aboriginal languages, that they are reflected in syntax as well as semantics and pragmatics—a phenomenon referred to as "kintax" in some Aboriginal languages (Evans, 2003).

Despite significant differences in methods to determine core vocabulary, this study confirmed that semantic similarities exist between Yolŋu core vocabulary and English core vocabulary lists. Van Tilborg and Deckers (2016) found 51 terms consistent across 15 vocabulary studies from diverse

groups of English speakers. Though not all English words can be directly translated in Yolŋu languages, many of the semantic concepts are present in the Yolŋu vocabulary. For example, the English concept “to make, made” is present in the Yolŋu core vocabulary as *djāma* (noun and intransitive verb, meaning “work”), and/or as a suffix *-kum/-gum* (“make” or “cause” added to transitive verbs in group 7) (Guyula & Greatorex, 2016). There were eight concepts from English core vocabulary lists (van Tilborg & Deckers, 2016) that were absent in the Yolŋu core vocabulary. These predominantly relate to grammatical differences. For example, there are no articles “a”, “an” or “the” in Yolŋu languages.

Semantic differences were also noted between English and Yolŋu core vocabulary lists. Some concepts, although translatable, were not considered to be core concepts for Yolŋu speakers. For example, the English word “time”, translated as *walu*, was not considered to be core vocabulary or of high cultural importance for Yolŋu. The inclusion of large numbers of culturally specific kin terms, skin, and clan names are other obvious differences.

This study supports the understanding that grammatical or syntactic differences between languages impact AAC system design (Mngomezulu et al., 2019). The research team identified aspects of Yolŋu core vocabulary that require ongoing consideration and user testing in the development of Yolŋu AAC systems, including whether so many suffixes are practically required, the non-linear morphology of Yolŋu languages, phonemic variation in suffix use and the changing forms of Yolŋu verbs. These grammatical considerations differ considerably from the structure of other languages like Zulu, Mandarin or Arabic (Baker & Chang, 2006; Draffan et al., 2015; Mngomezulu et al., 2019), and have implications for the layout, navigation paths and other features of AAC system design.

Clinical implications

Study findings identified important considerations for practitioners supporting vocabulary selection in AAC with Aboriginal Australians whose first language is an Aboriginal language. Vocabulary in AAC systems for Aboriginal Australians should be oriented to holistic well-being and serve to create and reinforce a strong sense of cultural identity, relationships and belonging; maintain and promote the learning and speaking of traditional Indigenous languages, and uphold cultural protocols.

The communication contexts and topics of conversation of other studies exploring the vocabularies of adults using AAC vary considerably from this study. The vocabulary needs, communication contexts and participation goals for Yolŋu adults living with MJD in very remote Arnhem Land, Australia (Amery et al., 2020) are substantially different, for example, from those of adults with disabilities working in a restaurant in metropolitan Sydney, Australia (Balandin & Iacono, 1999), or older Caucasian adults from retirement organizations in Lincoln, Nebraska, US (Stuart et al., 1997).

Proper nouns may be considered fringe vocabulary for Australian adult speakers of English (Balandin & Iacono,

1999) but for Yolŋu, nouns relating to identity and relationships are foundational to communication across contexts. Similarly, slang words can be an important consideration in vocabulary selection for some people because of their capacity to indicate group belonging (Balandin & Iacono, 1999); however, for Yolŋu in this study, including grammatically correct words and suffixes was more important for maintaining and learning Yolŋu languages and literacy. These are tangible examples of how an AAC practitioner working in collaborative partnership with individuals, families, and linguistic and cultural advisors can ensure that vocabulary increases a person’s sense of belonging and reflects the cultural values and linguistic practices of their family and community (Soto & Yu, 2014).

AAC practitioners must recognize that developing aided AAC systems for Aboriginal people involves transforming dynamic oral languages into a static print-based system. This requires practitioners to consider the who, when, and how of particular words spoken in different contexts. It was paramount for Yolŋu in this study that people who use AAC and their communication partners maintain and uphold linguistic patterns and cultural practices of respect, particularly around funerals. Stone (2019) also reported the importance of demonstrating respect for language, cultural knowledge and seeking approval from Māori elders in AAC. While many findings from this study are specific to Yolŋu language and culture, they may be applicable to other Aboriginal Australian and Indigenous languages, populations, and cultural contexts. Additionally, the research team hopes that these findings might encourage all AAC practitioners to consider the cultural and linguistic considerations relevant to their own contexts.

Limitations and future directions

One limitation of this research was that all participants were from the same extended Yolŋu family living with MJD and there were more women than men. This was in response to Yolŋu researcher preferences and was considered appropriate for the aims of this study but resulted in a less representative and generalizable sample. Additionally, most core vocabulary studies have included large samples and used software to assist in statistical analysis (Balandin & Iacono, 1999; Trembath et al., 2007). In core vocabulary studies in languages other than English, the first author is often a fluent speaker and literate in the language of the study (Mngomezulu et al., 2019) and researchers have accessed existing wordlists, large databases of language materials and/or transcription software (Draffan et al., 2015; Hattingh & Tönsing, 2020; Liu & Sloane, 2006). In the current study, the first author did not speak a Yolŋu language and Yolŋu researchers had varying capacities and confidence in their Yolŋu and English literacy as well as computer literacy required for translation, transcription, and analysis of the language sample. There are limited written and recorded oral language resources in Yolŋu languages. Collecting larger language samples from different conversations would result in more vocabulary for quantitative analysis and a more

representative language sample; however, there would be substantial logistical challenges to obtain these.

Future user testing and implementation research of AAC system prototypes that incorporate this initial core vocabulary will be required to assess the usability and social validity of the vocabulary for Yolŋu adults with MJD. To generate more representative Yolŋu core vocabularies, longer language samples from a larger number of Yolŋu of different age groups, gender, and clan groups could be conducted for future studies. Further research conversations with these subgroups would be useful in identifying similarities and differences for Yolŋu with MJD of different ages, gender, and family groups, as well as Yolŋu with complex communication needs resulting from other etiologies.

Conclusion

For this second study, a Yolŋu core vocabulary of 243 words and morphemes from Yolŋu languages was developed for incorporation into Yolŋu AAC system prototypes for Yolŋu adults living with MJD. Working collaboratively with Yolŋu on core vocabulary research demanded a unique, culturally and linguistically responsive research process represented through a Yolŋu metaphor *Gulaka-buma* ("Harvesting yams"). The core vocabulary reflects important aspects of Yolŋu languages and culture – relationships, respect, and learning for future generations. This research confirmed the role of language as an expression of culture and identity, not only as a device for communication. Differences in culture and worldview shape the very nature of AAC systems and such differences must be considered when determining vocabulary for aided AAC in languages and contexts where there has been no previous AAC development.

Notes

1. Traditional knowledge and Aboriginal cultural heritage shared and presented in this research, including Yolŋu language and the Yolŋu metaphor, are corporately owned and retained by each participant and other members of their Clan Nation (National Health and Medical Research Council, 2018).
2. The SmartLav+ is a broadcast-grade wearable microphone product of Rode, Silverwater, NSW, Australia, <http://www.rote.com/microphones/smartlav-plus>
3. The iPad© is a product of Apple Inc. www.apple.com
4. The purpose-built Unix shell script was written by volunteer software programmer Kris Gesling, Director of Developer Relations, Mycroft AI, Inc., <https://mycroft.ai/team/>. The script is available at: shorturl.at/syMS3

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