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Liste des abréviations

ACP	Analyse des Composantes Phonologiques
APP	Aphasie primaire progressive
vlAPP	Variante logopénique de l’aphasie primaire progressive
vnf/aAPP	Variante non-fluente/agrammatique de l’aphasie primaire progressive
vsAPP	Variante sémantique de l’aphasie primaire progressive
ATS	Analyse des Traits Sémantiques
AVC	Accident vasculaire cérébral
BECLA	Batterie d’Évaluation Cognitive du Langage chez l’Adulte
BORB	Birmingham Object Recognition Battery
CVA	Cerebrovascular accident
DMS-48	Visual recognition memory test
LOE	Level of evidence
MPO	Months post-onset
MQA	Methodological quality assessment
MT-86	Protocole Montréal-Toulouse d’examen linguistique de l’aphasie
NA	Not available
ND	Not or partially done due to difficulties
NS	Not specified
PCA	Phonological Components Analysis
PPA	Primary progressive aphasia
lvPPA	Logopenic variant of primary progressive aphasia
nf/aPPA	Nonfluent/agrammatic variant of primary progressive aphasia
svPPA	Semantic variant of primary progressive aphasia
PPTT	Pyramids and Palm Trees Test
SFA	Semantic Feature Analysis
SLP	Speech-language pathology
SLT	Speech-language therapy
TBI	Traumatic brain injury
TDQ-60	Test de dénomination de Québec
UK	United Kingdom
USA	United States of America
VNeST	Verb Network Strengthening Treatment
WAIS	Wechsler Adult Intelligence Scale

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Avant-propos

Les résultats de la présente thèse sont constitués d'une recension systématique des écrits et de deux articles expérimentaux :

1) Lavoie, M., Macoir, J., & Bier, N. (2017). Effectiveness of technologies in the treatment of post-stroke anomia: A systematic review. *Journal of Communication Disorders, 65*, 43-53.

2) Lavoie, M., Bier, N., & Macoir, J. (en révision pour *International Journal of Language and Communication Disorders*). Efficacy of a self-administered treatment using a smart tablet to improve functional vocabulary in post-stroke aphasia: A case series study.

3) Lavoie, M., Bier, N., Laforce Jr, R., & Macoir, J. (en révision pour *Neuropsychological Rehabilitation*). Improvement in functional vocabulary and generalization to conversation following a self-administered treatment using a smart tablet in primary progressive aphasia.

Le premier article est inséré au Chapitre 3 de cette thèse et est présenté tel que publié dans la revue *Journal of Communication Disorders*. Monica Lavoie a été responsable de la recherche systématique des écrits ainsi que de la rédaction de l'article dans son intégralité. Les co-auteurs Joël Macoir et Nathalie Bier, directeur et co-directrice de la thèse, ont contribué à l'élaboration de la méthodologie, en plus de réviser, corriger et bonifier les différentes versions du manuscrit.

Le deuxième article est inséré au Chapitre 4 de cette thèse. Il est introduit tel que soumis à la revue *International Journal of Language and Communication Disorders*. Monica Lavoie a été responsable de l'élaboration de la méthodologie, de la collecte et de l'analyse des données ainsi que de la rédaction de l'article dans son intégralité. Les co-auteurs Nathalie Bier et Joël Macoir, co-directrice et directeur de la thèse, ont contribué activement à l'élaboration de la méthodologie, au déroulement du projet ainsi qu'à la révision, la correction et la bonification des différentes versions du manuscrit.

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Chapitre 1. Introduction générale

1.1 Problématique

L'aphasie est un trouble acquis du langage survenant à la suite d'une lésion au cerveau, la cause la plus fréquente étant l'accident vasculaire cérébral (AVC). L'aphasie acquise peut également survenir en contexte de maladie neurodégénérative, comme c'est le cas dans les aphasies primaires progressives (APP). Les profils reliés à l'aphasie acquise sont variés et peuvent entrainer des difficultés de compréhension ou de production du langage parlé ou écrit.

1.1.1 Aphasie secondaire à un accident vasculaire cérébral

L'AVC est la cause la plus commune de l'aphasie acquise. Au Québec, environ 20 000 cas d'AVC sont rapportés annuellement (Ministère de la Santé et des Services sociaux, 2018) alors qu'au Canada, ce nombre s'élève à 50 000 (Ontario Stroke Network, 2017). Dans les dernières années, les avancées médicales ont permis d'améliorer de façon importante le taux de survie après un AVC, ce qui implique cependant que de plus en plus de personnes doivent vivre quotidiennement avec les conséquences qu'il engendre. En effet, près de 426 000 Canadiens vivent actuellement avec les séquelles d'un AVC, ce qui en fait la première cause de handicap au Canada (Ontario Stroke Network, 2017). Les conséquences de l'AVC comprennent une variété de symptômes moteurs et cognitifs, incluant l'aphasie. Dans les premiers jours suivant un AVC, environ 1/3 des personnes souffriraient d'aphasie (Dickey et al., 2010; Mazaux, Pélissier, & Brun, 2000; Pedersen, Jørgensen, Nakayama, Raaschou, & Olsen, 1995). De ce nombre, 60% demeureraient avec une aphasie chronique un an après l'AVC (Engelter et al., 2006).

L'aphasie post-AVC peut altérer la compréhension ou la production du langage oral ou écrit, à des degrés de sévérité qui varient d'un individu à l'autre. Plus spécifiquement, les déficits de compréhension et de production peuvent survenir au niveau des mots isolés (noms ou verbes), des phrases (agrammatisme) ou du discours. De plus, il arrive fréquemment que des déficits soient observés en lecture ou en écriture. Selon l'approche neuroanatomique classique, les différents profils cliniques sont déterminés par la localisation de la lésion et les liens anatomiques que la région lésée entretient avec d'autres aires cérébrales (ex., une lésion à l'aire de Broca entraine une aphasie de Broca; Benson & Ardila, 1996; Geschwind, 1967). Depuis quelques années, ces tableaux cliniques classiques sont cependant de plus en plus laissés de côté, au profit d'une compréhension plus globale du langage, basée sur la neuropsychologie cognitive. Les données de la neuroimagerie démontrent d'ailleurs une distribution beaucoup plus large et étendue des aires cérébrales responsables des diverses fonctions linguistiques que ce qui était reconnu dans la conception classique (ex., Tremblay & Dick, 2016; Tremblay, Dick, & Small, 2011). Selon l'approche cognitive (Caramazza, 1997; Whitworth, Webster, & Howard, 2013), les manifestations cliniques observées chez un individu aphasique résultent de l'atteinte isolée ou combinée de différentes composantes de traitement cognitif ou de voies de traitement. Même si les manifestations de l'aphasie diffèrent pour chaque personne, l'impact sur les compétences communicationnelles est indéniable. Les écrits scientifiques ont clairement démontré que l'aphasie est associée à une qualité de vie plus faible (ex., Hilari, Needle, & Harrison, 2012; Ross & Wertz, 2003) ainsi qu'à moins d'interactions sociales (ex., Cruice, Worrall, & Hickson, 2006; Parr, 2007). Une récente recension systématique des écrits réalisée auprès d'adultes en âge de travailler et présentant une aphasie a mis en lumière une participation réduite dans les activités de la vie domestique ainsi que des limitations vécues dans la vie communautaire et sociale (Pike, Kritzinger, & Pillay, 2017).

Plusieurs facteurs peuvent influencer le pronostic langagier en contexte d'aphasie. Outre le site et l'étendue de la lésion, la prise en charge en orthophonie est un facteur de première importance. Une recension systématique des écrits réalisée récemment par le Groupe Cochrane a d'ailleurs démontré l'efficacité de l'intervention orthophonique en aphasie post-AVC (Brady, Kelly, Godwin, Enderby, & Campbell, 2016). Au Québec, lorsqu'un individu subit un AVC, il est d'abord pris en charge en soins aigus, en milieu hospitalier. À ce moment, une évaluation sommaire en orthophonie ainsi qu'un début d'intervention sont généralement offerts, selon la durée du séjour. Lorsque l'état de l'individu est stabilisé, il est transféré, au besoin, en centre de réadaptation où une période de réadaptation fonctionnelle intensive a lieu. Pendant cette période, qui peut durer de quelques semaines à quelques mois, l'individu reçoit des services de réadaptation variés (ex., ergothérapie, physiothérapie, neuropsychologie, orthophonie), en fonction de ses besoins. Malheureusement, la fin des services en centre de réadaptation rime souvent avec la fin du suivi orthophonique. En effet, au Québec, les services offerts aux personnes souffrant d'aphasie chronique, soit une aphasie qui persiste plus de 12 mois après l'AVC, sont très limités, en raison de contraintes humaines et financières. Ainsi, bien que d'importants besoins demeurent sur le plan communicationnel, la majorité des personnes qui présentent une aphasie chronique ne reçoit plus de services dans les années qui suivent la survenue de l'AVC, malgré que l'efficacité de l'intervention orthophonique soit bien démontrée pour cette population (Allen, Mehta, McClure, & Teasell, 2012).

1.1.2. Aphasie primaire progressive

Le vieillissement de la population est un des plus grands défis de notre société actuelle. En 2015, le Canada a connu un changement démographique sans précédent alors que, pour la première fois de l'histoire, les personnes âgées de 65 ans et plus étaient plus nombreuses que les enfants âgés de 14 ans et moins (Statistique Canada, 2015). Ce vieillissement de la population s'accompagne inévitablement d'une augmentation fulgurante de la prévalence des maladies neurodégénératives. Au Canada, 25 000 nouveaux cas sont diagnostiqués chaque année et, selon les projections, près d'un million de Canadiens vont en souffrir dans 15 ans (Société Alzheimer du Canada, 2017).

L'APP est une maladie neurodégénérative caractérisée par un déclin progressif et spécifique du langage. Rapportée pour la première fois dans les écrits scientifiques par Mesulam, en 1982, l'APP a depuis été décrite par de nombreux auteurs (ex., Grossman et al., 1996; Hodges, Patterson, Oxbury, & Funnell, 1992; Snowden, Goulding, & Neary, 1989). La classification la plus récente, élaborée par Gorno-Tempini et collaborateurs (2011), propose des critères diagnostiques pour trois variantes d'APP. De façon générale, l'APP est caractérisée par une atteinte prédominante et progressive du langage, sans atteinte d'autres domaines cognitifs, pendant au moins les deux premières années d'évolution de la maladie. Trois variantes principales sont décrites par Gorno-Tempini et collaborateurs: la variante non-fluente/agrammatique (vnf/aAPP), la variante sémantique (vsAPP) et la variante logopénique (vlAPP). En résumé, la vnf/aAPP est associée à une atrophie de la région fronto-insulaire postérieure gauche et se caractérise par la présence d'agrammatisme ou d'apraxie de la parole. La compréhension de phrases syntaxiquement complexes peut également être altérée. La vsAPP survient en contexte d'atrophie bilatérale du lobe temporal antérieur, souvent plus marquée à gauche. Elle est caractérisée par une atteinte de la mémoire sémantique, ce qui entraine des difficultés dans toutes les habiletés impliquant un traitement sémantique (ex., compréhension, accès lexical), et s'accompagne souvent d'une dyslexie et d'une dysorthographie de surface. La vnf/aAPP et la vsAPP sont toutes deux des sous-types de dégénérescences lobaires fronto-temporales et représenteraient, selon les estimés, entre 20 et 40% des cas (Grossman, 2010). La vlAPP correspond, quant à elle, à la variante langagière de la maladie d'Alzheimer et est associée à une atrophie de la région périsylvienne postérieure ou pariétale gauche. Elle est caractérisée par la présence d'anomie et de difficultés de répétition avec un effet délétère de la longueur sur la performance.

L'APP apparait généralement entre 55 et 65 ans (Mesulam, 2001), à un âge où les personnes sont en plein cœur d'une vie productive sur le plan personnel et professionnel. Ainsi, les difficultés langagières associées à cette condition sont susceptibles d'entrainer des conséquences importantes pour la personne qui en souffre et son entourage. Medina et Weintraub (2007) ont d'ailleurs démontré qu'une proportion importante d'individus souffrant d'APP présentait des symptômes dépressifs significatifs au plan clinique. Le nombre de symptômes dépressifs était associé à la sévérité des difficultés de dénomination. Tel que mentionné par les auteurs, la conscience des déficits pourrait expliquer, en partie, les sentiments dépressifs vécus par cette population.

Au Québec, le diagnostic d'APP est posé par un neurologue ou un gériatre à la suite d'une évaluation exhaustive, impliquant souvent d'autres professionnels de la santé (ex., neuropsychologues, orthophonistes, etc.). Un suivi annuel est ensuite réalisé en milieu hospitalier, mais aucune prise en charge orthophonique systématique n'est offerte. Ainsi, bien que le langage soit au cœur des difficultés, les services publics en orthophonie pour cette population sont quasi inexistants.

1.1.3 Anomie

Qu'elle survienne consécutivement à un AVC ou en contexte d'APP, l'aphasie peut entrainer une grande diversité de symptômes langagiers. Dans ces deux pathologies, la manifestation la plus fréquente de l'aphasie est l'anomie, qui consiste en la difficulté à retrouver un mot précis, au moment voulu (Goodglass, 2001). L'anomie peut survenir à l'oral ou à l'écrit, tant dans les tâches structurées (ex., dénomination d'images) qu'en conversation.

Selon les modèles d'architecture fonctionnelle de la production orale, les mots sont produits via l'activation de composantes cognitives spécialisées et interconnectées (Caramazza, 1997; Levelt, Roelofs, & Meyer, 1999). Pour nommer une image, un traitement gnosique est d'abord effectué afin d'associer l'image perçue à une forme pictographique encodée dans le *lexique des représentations structurales*. Une fois l'image reconnue, les traits sémantiques du concept correspondant sont activés dans la *mémoire sémantique* (Tulving, 1972). La mémoire sémantique est une mémoire à long terme où sont encodées les informations sensorielles, fonctionnelles et encyclopédiques qu'un individu possède sur les différents concepts (i.e. représentations mentales abstraites d'un objet, d'un mot). La représentation phonologique, c'est-à-dire la forme sonore du mot, est ensuite récupérée au sein du *lexique phonologique de sortie*, mémoire à long terme où sont stockées toutes les représentations phonologiques des mots connus par un individu. Finalement, cette représentation phonologique est maintenue en *mémoire tampon phonologique*, le temps de mettre en place les processus moteurs nécessaires à la production orale du mot.

Puisque les manifestations de l'anomie diffèrent selon la localisation fonctionnelle du déficit (Goodglass, 1993; Goodglass & Wingfield, 1997; Whitworth et al., 2013), une évaluation approfondie est essentielle pour déterminer les composantes cognitives en cause (Grima & Franklin, 2017). Cette évaluation de l'anomie se fait à la fois en contexte spontané (ex., conversation) et dans des tâches plus structurées, comme la dénomination orale d'images. En plus d'une analyse quantitative du score obtenu par l'individu aphasique, différents paramètres doivent être pris en compte lors de l'analyse qualitative des résultats. En effet, plusieurs facteurs psycholinguistiques peuvent influencer la production de mots isolés et renseigner le clinicien sur l'origine fonctionnelle de l'anomie (Whitworth et al., 2013). Un premier facteur à prendre en compte est le degré d'imageabilité, c'est-à-dire la facilité avec laquelle le mot évoque une image visuelle ou auditive. La performance de l'individu en fonction des différentes catégories sémantiques (ex., objets biologiques vs manufacturés) doit également être considérée. La présence d'un effet d'imageabilité (i.e. performance significativement supérieure pour les mots avec une imageabilité élevée) ou d'un effet de catégorie sémantique (i.e. performance qui diffère en fonction des catégories sémantiques) suggère un déficit de la mémoire sémantique ou de l'accès au lexique phonologique de sortie à partir de la mémoire sémantique. La fréquence ainsi que la familiarité des mots sont deux autres paramètres psycholinguistiques à prendre en considération. La fréquence est une variable objective qui réfère à l'occurrence d'un mot dans une langue donnée, alors que la familiarité est une variable subjective qui réfère à l'estimation du nombre de fois qu'un mot a été lu ou entendu par un sujet. Plus un mot est fréquent ou familier, plus il est facile d'accéder à sa forme sonore dans le lexique phonologique de sortie. Un effet de fréquence ou de familiarité (i.e. performance significativement supérieure pour les mots fréquents ou familiers) peut donc suggérer une atteinte de cette composante. Finalement, la longueur du mot (i.e. nombre de sons qu'il contient) est également un paramètre à considérer. Plus un mot est court, plus il est facile de le maintenir en mémoire tampon phonologique. Ainsi, un effet de longueur (i.e. performance qui dépend de la longueur des mots) peut suggérer un déficit de cette composante.

Lors de l'évaluation, l'efficacité de l'indiçage sémantique et phonologique peut également aider à préciser l'origine de l'anomie (Whitworth et al., 2013). En effet, si la dénomination est facilitée par un indiçage phonologique, c'est-à-dire la production par le clinicien du premier son ou de la première syllabe du mot cible, l'origine de l'anomie est fort probablement lexicale. Par contre, si un indiçage sémantique est efficace, c'est-à-dire la production par le clinicien de traits sémantiques reliés au mot cible, l'anomie est plus probablement d'origine sémantique.

En aphasie post-AVC, l'anomie peut découler d'une atteinte de la mémoire sémantique, du lexique phonologique de sortie ou, dans la plupart des cas, d'une atteinte de ces deux composantes (Nickels, 1997, 2002a). Dans tous les cas, l'anomie peut se manifester par l'absence de réponse ou la présence d'un délai avant la production du mot cible. Lorsque la mémoire sémantique est en cause, l'anomie se manifeste principalement par la production de circonlocutions vagues (i.e. définition générale du concept, ex. cuillère → on l'utilise dans la cuisine) ou de paraphasies sémantiques (i.e. substitution du mot cible par un mot qui lui est relié sémantiquement, ex. cuillère → fourchette). Lorsque l'atteinte est plutôt localisée dans le lexique phonologique de sortie, l'anomie se manifeste par la production de circonlocutions précises (i.e. définition détaillée du concept, ex. cuillère → c'est l'ustensile qu'on utilise pour manger de la soupe) ou d'erreurs phonologiques (i.e. omission, déplacement ou substitution d'un son dans le mot, ex. cuillère → cuillare). Lorsque les deux composantes sont à l'origine de l'anomie, toutes les manifestations nommées précédemment peuvent être observées.

En contexte neurodégénératif, l'origine fonctionnelle de l'anomie diffère selon la variante d'APP. Dans la vsAPP, l'anomie est secondaire à une altération de la mémoire sémantique et les manifestations sont donc similaires à celles mentionnées ci-dessus. Dans le cas de la vlAPP, c'est plutôt une atteinte du lexique phonologique de sortie et de la mémoire tampon phonologique qui explique la présence d'anomie. Ainsi, en plus de retrouver les erreurs reliées à une atteinte lexicale, l'anomie rencontrée dans la vlAPP peut se manifester par la présence de séquences d'approximations phonémiques, c'est-à-dire la production de tentatives successives pour articuler le mot cible (ex., cuillère → cu-cui-cuillère).

Finalement, l'impact des autres fonctions cognitives sur la production de mots doit aussi être considéré (Berthier, Dàvila, Garcia-Casares, & Moreno-Torres, 2014; Turgeon & Macoir, 2008). Par exemple, puisque la dénomination orale d'une image débute par un traitement gnosique, l'intégrité des gnosies visuelles est primordiale. De plus, l'intégrité des fonctions exécutives (ex., organisation de la recherche, inhibition des distracteurs) est également nécessaire pour permettre un accès lexical adéquat (ex., Yeung & Law, 2010).

L'identification de l'origine de l'anomie est non seulement essentielle à une compréhension juste du portrait aphasique, mais permet également de proposer une intervention adaptée à l'individu. Puisqu'il s'agit de la manifestation la plus prévalente en aphasie, l'anomie est sans contredit l'une des cibles du traitement les plus fréquentes en orthophonie. De nombreuses études ont été menées pour démontrer l'efficacité de diverses approches de traitement pour améliorer l'accès aux mots, tant chez des individus souffrant d'aphasie post-AVC que d'APP (voir Chapitre 2). Toutefois, la prise en charge de l'anomie est grandement compromise par le manque de services offerts à long terme à ces populations cliniques. Ainsi, l'essor des nouvelles technologies ouvre la porte à de nouvelles possibilités thérapeutiques, notamment au traitement auto-administré de l'anomie, permettant ainsi aux personnes aphasiques de maximiser leur potentiel de rééducation et d'améliorer leurs compétences communicationnelles.

1.2 Objectifs

L'objectif général de la présente thèse est d'évaluer l'efficacité des technologies pour la rééducation de l'anomie acquise. Les travaux qui y ont été menés se divisent en trois objectifs spécifiques, associés à trois études distinctes.

Le premier objectif (étude 1) vise à faire une recension systématique des écrits quant à l'efficacité des technologies pour la rééducation de l'anomie secondaire à un AVC. Plus spécifiquement, cette étude vise à faire le point sur l'efficacité des études menées via ordinateur et tablette électronique pour la rééducation de l'anomie post-AVC et à établir des conclusions quant à la généralisation et au maintien des acquis à la suite de ce type de traitement.

Les deuxième (étude 2) et troisième (étude 3) objectifs ont été formulés à la lumière des lacunes identifiées dans la recension systématique des écrits (étude 1). Globalement, ils visent à évaluer l'efficacité d'une thérapie fonctionnelle auto-administrée via tablette électronique pour la rééducation de l'anomie chez une population présentant une aphasie chronique post-AVC (étude 2) et une APP (étude 3). Plus spécifiquement, ces deux études visent à : 1) Mesurer l'efficacité d'une thérapie auto-administrée via tablette électronique pour améliorer l'accès à des mots fonctionnels pour le participant; 2) Mesurer la généralisation à des items non traités ainsi que dans une tâche écologique de conversation; et 3) Mesurer le maintien des acquis jusqu'à deux mois post-intervention. Finalement, les deux études ont également pour objectif de comparer les effets de ce traitement pour les mots fonctionnels choisis selon les besoins et intérêts des participants vs des mots sélectionnés dans une banque d'images, sans égard à leur valeur fonctionnelle, en termes d'efficacité, de généralisation et de maintien.

Dans le chapitre 2 est présentée une recension des écrits scientifiques existants concernant l'anomie et sa rééducation en aphasie post-AVC et en APP. Le chapitre 3 est consacré à la présentation des résultats d'une recension systématique des écrits sur l'efficacité des technologies pour la rééducation de l'anomie post-AVC (étude 1). Le chapitre 4 est consacré à la présentation de l'étude expérimentale portant sur la rééducation de l'anomie via tablette électronique en aphasie post-AVC (étude 2), alors que le chapitre 5 porte sur l'étude expérimentale menée en APP (étude 3). Finalement, le chapitre 6 présente une discussion et la conclusion générale de cette thèse.

Chapitre 2. Recension des écrits : Rééducation de l’anomie acquise

2.1. Approches générales de prise en charge de l’anomie

L’objectif global de la prise en charge de l’anomie acquise est l’amélioration des capacités communicationnelles de l’individu. Pour atteindre cet objectif, trois grands types d’approches peuvent être utilisés: l’approche de restauration (aussi appelée approche de rétablissement), l’approche de réorganisation et l’approche de compensation (Seron, 1982). L’approche de restauration est la plus utilisée et vise à restaurer la fonction cognitive altérée dans le but de revenir au mode de fonctionnement pré-lésionnel (De Partz, 1998; Seron, 1982). Cette approche, qui sera utilisée dans le cadre des études 2 et 3 de la présente thèse, vise donc un réapprentissage ou une réactivation des informations perdues. Dans l’approche de réorganisation, l’objectif est plutôt d’utiliser les capacités préservées pour arriver à un résultat final équivalent à celui précédemment obtenu avec la fonction altérée (De Partz, 1998; Seron, 1982; Seron, Linden, & De Partz, 1991). Finalement, l’approche de compensation vise à utiliser des aides externes ou à adapter l’environnement physique et social de l’individu aphasique, afin de diminuer les répercussions fonctionnelles de l’anomie (De Partz, 1998).

2.1.1 Approches cognitives de restauration de l’anomie

Tel que mentionné ci-dessus, la restauration de l’anomie implique un réapprentissage des mots pour lesquels la personne présente des difficultés. Dans les approches cognitives de rééducation, le rôle du clinicien est de fournir à la personne aphasique des indices afin de l’aider à réapprendre ou à réactiver les mots en mémoire. Selon l’origine fonctionnelle objectivée, les indices cibleront la restauration ou la réactivation des représentations au sein de la mémoire sémantique ou du lexique phonologique de sortie.

Dans les approches sémantiques de traitement, l'objectif est d'aider la personne à réactiver les connaissances qu'elle possède sur les concepts, dans le but de faciliter l'accès subséquent aux mots auxquels ils sont associés. Par exemple, le traitement par Analyse des Traits Sémantiques (ATS) a été proposé par Boyle et Coelho (1995) pour l'amélioration de l'anomie post-AVC. Cette intervention est basée sur la théorie de l'activation étendue pour le traitement sémantique (Collins & Loftus, 1975), selon laquelle l'activation du réseau sémantique associé à un mot cible est susceptible de faciliter l'accès subséquent à ce mot. Dans ce traitement, le rôle du clinicien consiste à guider le participant dans la production de caractéristiques sémantiques reliées au mot cible (i.e. catégorie, utilité, action, propriétés, endroit où on trouve l'objet correspondant, objet avec lequel il est associé). Le participant doit ensuite nommer l'objet. En cas d'échec, le clinicien produit alors le nom de l'objet et invite le participant à le répéter. L'efficacité de ce traitement a été démontrée dans une récente recension des écrits (Maddy, Capilouto, & McComas, 2014). Dans la présente thèse, une adaptation de l'ATS a été utilisée dans les deux études expérimentales. D'autres traitements sémantiques, reposant, par exemple, sur la distinction (i.e. explication concrète des différences entre le concept cible et un autre concept sémantiquement relié; Hillis, 1998) ou la typicalité sémantique (i.e. production d'exemples atypiques pour une catégorie sémantique donnée; Kiran, Shamapant, & DeLyria, 2006; Kiran & Thompson, 2003), ont également été démontrés efficaces.

Dans le cas d'une anomie secondaire à une atteinte du lexique phonologique de sortie, une approche phonologique est plutôt préconisée. L'objectif est alors de fournir à la personne aphasique des indices destinés à restaurer ou réactiver la forme sonore du mot. Par exemple, l'Analyse des Composantes Phonologiques (ACP; Leonard, Rochon, & Laird, 2008) est un traitement inspiré de l'ATS dans lequel le participant doit générer, seul ou avec l'aide du clinicien, cinq composantes phonologiques reliées à l'item cible (i.e. son initial, son final, nombre de syllabes, mot avec lequel il rime, autre mot commençant par le même son). Les auteurs ont obtenu une amélioration significative de la dénomination pour sept des 10 participants de l'étude qui présentaient une aphasie chronique post-AVC ainsi qu'un maintien des gains quatre semaines post-traitement. Dans les dernières années, d'autres études ont appuyé l'efficacité de l'ACP pour la rééducation de l'anomie (ex., Neumann, 2018; van Hees, Angwin, McMahon, & Copland, 2013). L'efficacité d'autres traitements phonologiques a également été démontrée dans les écrits scientifiques, par exemple le *Lindamood Phoneme Sequencing Program*, qui guide le participant dans l'exploration des sons, aux plans moteur et perceptuel, à travers différentes tâches (ex., Kendall et al., 2008; Lindamood & Lindamood, 1998).

Dans la plupart des cas d'aphasie post-AVC, l'anomie résulte d'une atteinte de la mémoire sémantique et du lexique phonologique de sortie. Une approche mixte est alors préconisée, combinant à la fois des indices sémantiques et phonologiques (ex., Raymer et al., 2007; Raymer & Gonzalez-Rothi, 2001).

2.2 Rééducation de l'anomie en contexte d'aphasie post-AVC

2.2.1 Efficacité du traitement cognitif de l'anomie: amélioration de la production des mots et généralisation

Dans une recension des écrits sur l'efficacité du traitement de l'anomie, Nickels (2002b) conclut qu'il est clairement démontré que les traitements cognitifs de l'anomie sont efficaces et peuvent résulter en une amélioration à long terme. Cependant, il est encore difficile de prédire l'efficacité d'un traitement spécifique pour un individu spécifique. L'auteure recommande donc de procéder à l'analyse fonctionnelle des déficits afin de guider le choix du traitement proposé. Elle mentionne cependant que, pour une majorité d'individus aphasiques, des tâches structurées multimodales (i.e. incluant l'oral et l'écrit) et multi-composantes (ex., indiçage sémantique et phonologique) seraient les plus prometteuses.

Selon le modèle cognitif de la production orale des mots (Caramazza, 1997; Levelt et al., 1999), un effet item-spécifique est attendu à la suite du traitement de l'anomie, c'est-à-dire que seuls les mots travaillés s'améliorent. La majorité des études portant sur la rééducation de l'anomie post-AVC ne rapporte effectivement pas ou peu de généralisation des effets du traitement aux items non travaillés (ex., Fillingham, Sage, & Lambon Ralph, 2006; Thompson, Kearns, & Edmonds, 2006). Cependant, dans divers cas, une généralisation peut malgré tout être observée pour des items non travaillés. Tout d'abord, lorsque des items sont présentés plusieurs fois au sujet sans être traités, une amélioration pourrait être observée et résulterait alors des tentatives répétées de production du mot cible (Howard, 2000; Nickels, 2002c). En effet, les habiletés de dénomination sont souvent inconsistantes chez les personnes aphasiques (i.e. un même mot peut être produit correctement à une occasion et ne pas être retrouvé à une occasion subséquente). Lorsqu'au cours des diverses tentatives de dénomination la personne parvient à trouver le mot cible, les représentations sémantique et phonologique de ce mot seraient activées, ce qui renforcerait son réseau et faciliterait ainsi l'accès ultérieur à ce même mot (Nickels, 2002b). De plus, tel qu'abordé précédemment, en raison de la théorie de l'activation étendue (Collins & Loftus, 1975), une généralisation pourrait également survenir pour des items sémantiquement reliés à un mot cible entrainé.

Jusqu'à maintenant, peu d'études ont porté sur la généralisation dans le discours des mots travaillés en thérapie. Certains auteurs ont utilisé une analyse conversationnelle générale pour documenter les changements dans le discours à la suite d'un traitement de l'anomie. Par exemple, Wambaugh et Ferguson (2007) ont obtenu une amélioration de la productivité et de l'efficience verbale en contexte de discours narratif (i.e. le sujet doit raconter ce qui se passe sur une image ou une séquence d'images ou doit raconter une histoire connue ou un évènement vécu) et procédural (i.e. le sujet doit expliquer comment réaliser une tâche spécifique) chez une participante aphasique post-AVC à la suite d'un traitement par ATS (Boyle & Coelho, 1995) de l'anomie pour les verbes. Best et al. (2011) ont également utilisé ce type d'approche pour mesurer les changements en conversation à la suite d'un traitement phonologique et orthographique de l'anomie chez 13 participants présentant une aphasie chronique. Plus spécifiquement, les auteurs ont utilisé le *Profile of Word Errors and Retrieval in Speech* (Herbert, Best, Hickin, Howard, & Osborne, 2008) pour quantifier le nombre et le type de tours de parole (i.e. minimal vs informatif), l'accès lexical, les comportements indicateurs de difficultés ainsi que les bris de communication et les tentatives de réparation. Pour l'ensemble du groupe, aucun changement significatif n'a été relevé post-traitement. Cependant, des améliorations à au moins une des mesures d'intérêt ont été rapportées chez neuf des participants.

D'autres auteurs ont plutôt évalué la généralisation dans le discours de l'utilisation de mots spécifiques travaillés en thérapie. Par exemple, Conroy, Sage et Lambon-Ralph (2009) ont traité des noms et des verbes, pouvant être utilisés spécifiquement dans la description d'une scène imagée (i.e. Cookie Theft) et la narration d'une histoire (i.e. Cendrillon), à l'aide d'une thérapie phonologique, orthographique et sémantique chez sept participants aphasiques post-AVC. Leurs résultats démontrent que les participants ont utilisé le vocabulaire entrainé en contexte spécifique de discours (i.e. description de la scène imagée et narration de Cendrillon). De plus, la performance en dénomination d'images était prédictive de la production de ces mêmes mots en contexte discursif. Peach et Reuter (2010) ont évalué l'efficacité de l'ATS (Boyle & Coelho, 1995) pour améliorer la dénomination de mots spécifiques utilisés dans la description d'images et la réponse à des questions procédurales chez deux participantes avec aphasie post-AVC. À la suite du traitement, ils ont obtenu une amélioration de la production verbale et de l'informativité du discours. Cependant, Rider, Wright, Marshall et Page (2008) ont obtenu peu de généralisation dans le discours narratif et procédural pour des items travaillés avec l'ATS, malgré une amélioration de la dénomination à la suite du traitement. À notre connaissance, une seule étude à ce jour a évalué le transfert des gains spécifiques de la thérapie en contexte conversationnel. En effet, Mason et collaborateurs (2011) ont évalué l'efficacité d'un traitement auto-administré par ordinateur (huit séances réparties sur deux semaines) pour la rééducation de mots fonctionnels auprès de trois participants aphasiques post-AVC. Ils ont également évalué le transfert des mots entrainés dans une tâche de conversation. À la suite du traitement, les auteurs ont obtenu une amélioration significative de la dénomination des mots traités chez deux participants et une amélioration de leur production en conversation pour un seul d'entre eux.

Ainsi, il semble qu'un transfert des gains du traitement de l'anomie en contexte de discours soit possible. Puisqu'un effet item-spécifique est généralement attendu, il apparait crucial de choisir judicieusement les mots à rééduquer. Or, dans la plupart des études, les mots travaillés proviennent plutôt de banques d'images (ex., Snodgrass & Vanderwart, 1980) et sont choisis sans égard à leur utilité pour le participant. Bien que cette approche permette une amélioration en dénomination pour les mots travaillés, elle limite de façon importante les bénéfices potentiels du traitement dans la vie quotidienne de l'individu aphasique. Dans quelques études, dont les résultats sont prometteurs, les auteurs ont ciblé un vocabulaire fonctionnel pour le participant (ex., Mason et al., 2011; Menke et al., 2009). Par exemple, Menke et collaborateurs (2009) ont évalué l'efficacité d'un traitement de l'anomie via ordinateur (trois heures/jour durant deux semaines) pour l'amélioration de mots choisis spécifiquement pour chacun des huit participants aphasiques à l'étude. Leurs résultats ont démontré qu'en moyenne, les participants sont passés de 0% à 64.4% de bonnes réponses en dénomination à la suite du traitement. De plus, cette performance est demeurée stable jusqu'à huit mois après l'arrêt du traitement. Cependant, à notre connaissance, aucune étude n'a, à ce jour, comparé les effets du traitement pour des items choisis selon l'approche classique, via des banques d'images, vs des items choisis pour leur valeur fonctionnelle.

2.2.2 Efficacité de la rééducation de l'anomie via les technologies

Dans les dernières années, l'essor considérable de l'utilisation des technologies en réadaptation a permis d'explorer de nouvelles possibilités pour la rééducation des troubles du langage. Dans le contexte actuel où les soins de santé sont limités par des contraintes humaines et financières, certains auteurs se sont intéressés à l'apport potentiel des technologies pour la prise en charge de l'aphasie post-AVC. Par exemple, Latimer, Dixon et Palmer (2013) ont démontré que l'ordinateur était une alternative gagnante en termes de coût-efficacité. Dans une récente recension systématique des écrits, Zheng, Lynch et Taylor (2016) ont montré que l'ordinateur était un moyen efficace pour la rééducation des troubles du langage dans l'aphasie post-AVC et ont trouvé des résultats préliminaires suggérant qu'il pourrait s'agir d'une approche aussi efficace que les traitements classiques administrés par le clinicien. Des Roches et Kiran (2017) ont également démontré l'efficacité d'interventions utilisant les technologies pour la rééducation des troubles du langage post-AVC.

Cependant, jusqu'à maintenant, aucune synthèse ou recension systématique des écrits n'a porté spécifiquement sur l'efficacité des technologies pour la rééducation de l'anomie, qui est pourtant la cible la plus fréquente du traitement en aphasie post-AVC. Les résultats d'une recension systématique des écrits portant sur l'efficacité de l'ordinateur et de la tablette électronique pour le traitement de l'anomie post-AVC sont donc présentés dans le chapitre suivant.

2.3 Rééducation de l'anomie en contexte d'aphasie primaire progressive

2.3.1 Efficacité des interventions cognitives de rééducation de l'anomie

Dans les dernières années, l'efficacité de la rééducation de l'anomie dans toutes les variantes de l'APP a été clairement démontrée dans les écrits scientifiques (Cadório, Lousada, Martins, & Figueiredo, 2017; Gravel-Laflamme, Routhier, & Macoir, 2012; Jokel, Graham, Rochon, & Leonard, 2014; Routhier, Gravel-Laflamme, & Macoir, 2013).

Dans une récente recension systématique des écrits, Cadório et collaborateurs (2017) se sont intéressés à l'efficacité de thérapies incluant un indiçage sémantique en APP. La majorité des études recensées portait sur le traitement de l'anomie et les auteurs ont rapporté des améliorations significatives après le traitement dans toutes les études, peu importe la variante d'APP. Les auteurs se sont également intéressés aux enjeux de la généralisation et du maintien dans chacune des variantes d'APP. La vsAPP est sans contredit la variante ayant fait l'objet du plus grand nombre d'études. De façon générale, Cadório et collaborateurs concluent que, pour cette population, la généralisation est grandement limitée puisque, en raison de l'atteinte prédominante de la mémoire sémantique, le réapprentissage est fortement soutenu par la mémoire épisodique. Ainsi, le réapprentissage est plus rigide et résulte davantage d'un apprentissage «par cœur» de l'association entre l'image travaillée et l'étiquette verbale correspondante que d'un réel réapprentissage du concept en mémoire sémantique. Dans un tel contexte, il est possible que le participant ne puisse généraliser l'utilisation de l'étiquette verbale réapprise au concept correspondant (ex., poire), mais seulement à l'image spécifique qui a été travaillée. Certaines études ont tout de même démontré une généralisation intra-concept (i.e. généralisation à différents exemplaires d'un même item; ex., Heredia, Sage, Lambon Ralph, & Berthier, 2009; Jokel, Rochon, & Anderson, 2010; Mayberry, Sage, Ehsan, & Lambon Ralph, 2011). Par exemple, à la suite d'un traitement auto-administré via ordinateur (sept jours/semaine durant un mois) mené auprès d'une participante souffrant de vsAPP, Heredia et collaborateurs (2009) ont obtenu une amélioration significative pour les mots travaillés, mais aussi pour des exemplaires visuellement similaires des mêmes items. Une généralisation inter-tâches (i.e. généralisation pour les mêmes items, mais dans une tâche différente que celle entrainée) a également été obtenue dans quelques études (ex., Jokel & Anderson, 2012; Savage, Piguet, & Hodges, 2014). Par exemple, Jokel et Anderson (2012) ont évalué l'efficacité d'un traitement de l'anomie auprès de sept participants souffrant de vsAPP et ont observé, à la suite du traitement (4-6 sessions de 30 minutes/semaine, pour un total de 96 sessions), une amélioration de la dénomination, mais également de la fluence sémantique. Les résultats relatifs à la généralisation inter-concepts (i.e. généralisation à des mots non travaillés) sont cependant plus mitigés. Bien que certains auteurs aient obtenu une amélioration de la dénomination pour des items contrôles (ex., Jokel, Rochon, & Leonard, 2006; Savage, Ballard, Piguet, & Hodges, 2013), la majorité des auteurs n'ont rapporté aucune généralisation aux items non traités (ex., Dressel et al., 2010; Jokel et al., 2010; Macoir et al., 2015). De plus, en raison de l'atteinte de la mémoire sémantique, les participants souffrant de vsAPP seraient plus fragiles à la sur-généralisation, c'est-à-dire à la production d'une étiquette verbale réapprise (ex., renard) pour le concept cible (i.e. renard), mais aussi pour d'autres concepts sémantiquement reliés à la cible (ex., chien, loup; Mayberry et al., 2011). Dans la très grande majorité des études recensées, les gains se sont maintenus de quatre semaines à six mois post-traitement (ex., Heredia et al., 2009; Macoir et al., 2015; Snowden & Neary, 2002). Dans une recension des écrits sur le traitement de l'anomie en vsAPP, Jokel et collaborateurs (2014) ont rapporté que, chez cette population, une connaissance préservée de certains traits sémantiques des items travaillés favoriserait le réapprentissage et le maintien des gains post-traitement.

Peu d'études ont porté sur la généralisation des acquis dans la vnf/aAPP. Dans une étude réalisée auprès de deux participants souffrant respectivement de la vnf/aAPP et de la vlAPP, Croot et collaborateurs (2015) ont évalué l'efficacité d'un traitement auto-administré de l'anomie via ordinateur (cinq jours/semaine durant deux semaines). Leurs résultats ont démontré une amélioration pour les mots travaillés, mais aussi une généralisation intra-concept, c'est-à-dire une amélioration pour des images différentes représentant les mêmes concepts que ceux entrainés. Cependant, ils n'ont obtenu aucune généralisation pour les items non traités. Aucune généralisation à des items non traités n'a également été obtenue par Marcotte et Ansaldo (2010) à la suite d'un traitement de l'anomie par ATS (Boyle & Coelho, 1995; trois sessions de 60 minutes/semaine durant trois semaines) administré chez un participant souffrant de vnf/aAPP. En ce qui concerne la généralisation à d'autres tâches, Jokel, Cupit, Rochon et Leonard

(2009) ont rapporté la généralisation du vocabulaire travaillé dans une tâche de production de phrases à partir d'images chez deux participantes souffrant de vnf/aAPP à la suite d'un traitement de l'anomie administré par ordinateur. En ce qui a trait à la durée des effets du traitement, les gains étaient maintenus d'un à six mois, selon les études (un mois; Croot et al., 2015; six mois; Jokel et al., 2009).

Finalement, un nombre limité d'études a également été relevé pour la vlAPP. Certaines études ont démontré une généralisation à des items non traités. Par exemple, Beeson et collaborateurs (2011) ont observé une amélioration pour les mots travaillés, mais aussi pour des mots non traités, à la suite d'un traitement sémantique de l'anomie (six sessions de deux heures/semaine durant deux semaines) administré chez un participant souffrant de vlAPP. Pour cette population, un maintien des gains a été rapporté jusqu'à six mois post-traitement (ex., Beeson et al., 2011; Henry et al., 2013).

Jusqu'à maintenant, seules quelques études ont investigué la généralisation des effets du traitement en contexte de discours et les résultats sont mitigés. Beeson et collaborateurs (2011) ont observé une amélioration de l'accès lexical, se manifestant par une augmentation du débit et du nombre d'unités d'informations produites, à la suite d'un traitement de l'anomie inspiré de l'ATS (Boyle & Coelho, 1995) et administré à raison de six séances de deux heures par semaine, pendant deux semaines, chez un participant présentant une vlAPP. Savage et collaborateurs (2014) ont observé une amélioration de l'accès lexical pour les mots traités via ordinateur (cinq jours/semaine pendant huit semaines) dans une tâche de description de vidéos chez quatre des cinq participants souffrant de vsAPP à l'étude. Toutefois, Jokel et collaborateurs (2010) ont rapporté une absence de généralisation dans une tâche de description d'images chez un individu souffrant de vsAPP à la suite d'un traitement informatisé de l'anomie (30 sessions d'une heure sur une période de quatre mois). Finalement, Croot et collaborateurs (2015) n'ont obtenu aucune généralisation dans une interview structurée reprenant les mots travaillés en thérapie chez deux individus présentant une vlAPP et une vnf/aAPP à la suite d'un traitement de l'anomie administré de façon intensive (10-15 minutes, cinq jours/semaine pendant deux semaines).

Comme c'est le cas dans la rééducation de l'anomie en aphasie post-AVC, la plupart des études menées en APP visent l'amélioration de mots provenant de banques d'images (ex., Peabody Picture Collection; Snodgrass & Vanderwart, 1980). Dans quelques études, le vocabulaire a toutefois été ciblé en fonction des besoins du sujet (ex., Croot et al., 2015; Evans, Quimby, Dickey, & Dickerson, 2016; Savage et al., 2014). Dans une synthèse des écrits sur le traitement de l'anomie en APP, Jokel et collaborateurs (2014) concluent que l'implication du client dans le choix des cibles du traitement pourrait contribuer au succès de ce dernier. Selon ces mêmes auteurs, seuls les mots qui sont significatifs pour les participants devraient être travaillés.

2.3.2 Efficacité de la rééducation de l'anomie via les technologies

En contexte d'APP, le nombre d'études exploitant les technologies pour la rééducation de l'anomie a aussi augmenté de façon importante dans les dernières années. En effet, plusieurs auteurs ont obtenu une amélioration significative de l'accès lexical à la suite d'un traitement par ordinateur dans toutes les variantes d'APP (ex., Croot et al., 2015; Henry et al., 2013; Heredia et al., 2009; Jokel et al., 2009; Jokel et al., 2010; Savage et al., 2014).

Dans quelques études, l'ordinateur a été utilisé en télé-traitement, dans lequel le clinicien administrait à distance les séances thérapeutiques. Par exemple, Henry et collaborateurs (2013) ont utilisé le logiciel Skype© pour l'administration d'un traitement de l'anomie basé sur le *Lexical Retrieval Cascade* chez un participant présentant une vlAPP, à raison d'une fois par semaine pour un total de six sessions. Les résultats ont démontré une amélioration de la dénomination pour les mots entrainés, qui s'est maintenue jusqu'à trois mois après l'arrêt du traitement, ainsi qu'une généralisation des stratégies enseignées à des items non traités. De plus, bien que la performance se soit dégradée durant l'intervalle de trois à six mois post-traitement, la performance à six mois post-traitement était équivalente à la performance initiale en ligne de base, malgré la progression apparente de la maladie.

Dans d'autres études, le traitement par ordinateur était auto-administré, le participant réalisant les séances de thérapie à la maison, en l'absence du clinicien. Par exemple, le logiciel MossTalk Words®, un traitement informatisé de l'anomie intégrant une variété de tâches (ex., dénomination indicée), a été utilisé auprès d'un participant souffrant de vsAPP (Jokel et al., 2010) et de deux participants souffrant de vnf/aAPP (Jokel et al., 2009). Dans les deux cas, les auteurs ont rapporté une amélioration significative de la dénomination pour les items travaillés. Une généralisation des effets du traitement a également été observée pour différents exemplaires des items travaillés (Jokel et al., 2010) ainsi que dans une tâche de production de phrases à partir d'une image (Jokel et al., 2009). Croot et collaborateurs (2015) ont évalué l'efficacité d'un traitement intensif (10-15 minutes, cinq jours/semaine pendant deux semaines) auto-administré par ordinateur auprès de deux individus souffrant respectivement de vnf/aAPP et de vlAPP et ont obtenu une amélioration significative de la dénomination pour les mots entrainés ainsi qu'une généralisation à d'autres exemplaires de ces mêmes mots.

En somme, les études dans lesquelles l'ordinateur est utilisé pour la rééducation de l'anomie en APP semblent produire des résultats similaires aux interventions cognitives classiques menées en présence d'un clinicien.

2.4 Synthèse et limites des études

Globalement, les études réalisées à ce jour sur le traitement de l'anomie en aphasie post-AVC et en APP démontrent l'efficacité de différentes approches (i.e. sémantiques et phonologiques) pour améliorer l'accès aux mots travaillés. Les écrits scientifiques démontrent que les gains peuvent se maintenir à court et moyen terme, même en contexte neurodégénératif. De plus, il semble que les traitements administrés via les technologies puissent produire des résultats similaires et donc constituer une alternative plus qu'intéressante dans le contexte actuel des soins de santé où les services à long terme sont grandement limités, tant en aphasie post-AVC qu'en APP. L'étude 1 de cette thèse a permis de faire une recension systématique des écrits existants sur le traitement de l'anomie via les technologies en aphasie post-AVC, afin de mettre en lumière les forces, mais aussi les limites des études actuelles. Dans l'APP, les résultats obtenus par Cadório et collaborateurs (2017) ont également permis de démontrer des forces et des limites similaires. Les limites identifiées dans ces recensions des écrits permettent d'appuyer le traitement proposé dans les études 2 et 3 de la présente thèse.

Dans un premier temps, si la généralisation intra-concept, inter-concepts et inter-tâches a été mesurée dans plusieurs études, la généralisation en contexte de discours doit être davantage investiguée. Alors que les résultats d'études menées en aphasie post-AVC sont encourageants (ex., Best et al., 2011; Conroy et al., 2009; Mason et al., 2011; Peach & Reuter, 2010), les résultats obtenus en APP sont plutôt mitigés quant à la généralisation dans le discours (ex., Beeson et al., 2011; Croot et al., 2015; Jokel et al., 2010). Dans certaines études, une analyse conversationnelle générale a été réalisée, sans évaluer spécifiquement le réinvestissement des mots travaillés en thérapie (ex., Best et al., 2011). Dans les études ayant porté sur le transfert de mots spécifiques dans le discours, diverses tâches plus ou moins structurées ont été utilisées (ex., description d'images ou de vidéos, Jokel et al., 2010, Peach & Reuter, 2010; discours narratif, Conroy et al., 2009; interview structurée, Croot et al., 2015). À notre connaissance, une seule étude a porté sur la généralisation des mots spécifiques travaillés en thérapie dans un contexte aussi écologique que la conversation (Mason et al., 2011).

Dans le but d'atteindre cette généralisation en contexte écologique, le choix des cibles du traitement est d'une importance cruciale. En effet, puisqu'il est généralement attendu que seuls les items travaillés s'améliorent, les cibles du traitement devraient porter sur des mots utiles pour le participant dans sa vie de tous les jours. Or, dans la majorité des études menées en aphasie post-AVC et en APP, le vocabulaire est choisi dans des banques d'images, sans égard à sa valeur fonctionnelle pour le participant. Même si ce type d'approche permet une amélioration de la production de ces mots à la suite du traitement, le réinvestissement possible au quotidien est largement questionnable, bien qu'il s'agisse de l'objectif ultime du traitement de l'anomie. Jusqu'à maintenant, une minorité d'études menées en APP et en aphasie post-AVC a ciblé un vocabulaire utile pour chaque participant (ex., Evans et al., 2016; Mason et al., 2011; Menke et al., 2009; Savage et al., 2014). Dans leur étude menée en aphasie post-AVC, Mason et collaborateurs (2011) ont obtenu une généralisation en conversation pour les mots fonctionnels travaillés chez un des trois participants à l'étude. De plus, dans une recension des écrits sur le traitement de l'anomie en APP, Jokel et collaborateurs (2014) ont conclu que seuls les mots qui sont significatifs pour la personne aphasique devraient être travaillés en thérapie.

Ainsi, les études 2 et 3 de cette thèse portent sur l'évaluation d'un traitement auto-administré de l'anomie via tablette électronique pour la rééducation de mots fonctionnels en aphasie post-AVC et en APP. De plus, elles proposent l'évaluation du transfert des gains du traitement dans un contexte écologique de conversation.

Chapitre 3. Recension systématique des écrits: Utilisation des technologies pour le traitement de l'anomie post-AVC

Étude 1. Effectiveness of technologies in the treatment of post-stroke anomia: A systematic review

Lavoie, M., Macoir, J., & Bier, N. (2017). Effectiveness of technologies in the treatment of post-stroke anomia: A systematic review. *Journal of Communication Disorders, 65*, 43-53.

Résumé

INTRODUCTION: La popularité croissante de l'utilisation des technologies pour le traitement des troubles du langage offre de nombreuses opportunités, mais leur efficacité ainsi que leurs limites demeurent peu connues. L'objectif de cette recension systématique des écrits est donc d'évaluer l'efficacité de traitements administrés via les technologies pour la rééducation de l'anomie post-AVC.

MÉTHODE: Les lignes directrices de la déclaration PRISMA pour la rédaction de recensions systématiques et de méta-analyses d'études évaluant l'efficacité d'interventions en santé ont été utilisées. Une recherche systématique a été effectuée dans les bases de données PubMed, PsycInfo et Current Contents ainsi que dans Google Scholar. Sans limites quant à la date de publication, les études visant à évaluer l'efficacité d'une intervention administrée via une technologie, soit l'ordinateur ou la tablette électronique, pour l'amélioration de l'anomie chez des participants post-AVC ont été sélectionnées. Les principaux effets mesurés étaient l'amélioration des capacités de dénomination ainsi que la généralisation à des items non traités et à la communication en contexte de vie quotidienne.

RÉSULTATS: Vingt-trois études ont été incluses dans la présente recension. À ce jour, la majorité des études ont été menées avec l'ordinateur et seules quelques études ont exploré l'efficacité de la tablette électronique. Dans certaines études, la technologie était utilisée comme outil de thérapie, en présence du clinicien, alors que dans d'autres, la thérapie via la technologie était auto-administrée à la maison, en l'absence du clinicien. Toutes les études ont démontré l'efficacité des thérapies administrées via les technologies pour l'amélioration des mots entrainés. La généralisation à des items non traités est cependant mitigée et peu d'études ont évalué la généralisation à la communication en contexte de vie quotidienne.

DISCUSSION: Les résultats de cette recension systématique confirment que la technologie est une approche efficace dans la rééducation de l'anomie post-AVC. Les études futures devraient inclure des tâches permettant d'évaluer la généralisation des gains du traitement dans des contextes écologiques, l'objectif ultime de la rééducation de l'anomie étant de permettre une meilleure communication au quotidien.

Abstract

BACKGROUND: Technologies are becoming increasingly popular in the treatment of language disorders and offer numerous possibilities, but little is known about their effectiveness and limitations. The aim of this systematic review was to investigate the effectiveness of treatments delivered by technology in the management of post-stroke anomia.

METHODS: As a guideline for conducting this review, we used the PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions. We conducted a systematic search of publications in PubMed, PsycInfo and Current Contents. We also consulted Google Scholar. Without any limitations as to publication date, we selected studies designed to assess the effectiveness of an intervention delivered by a technology, namely computer or smart tablet, to specifically improve anomia in post-stroke participants. The main outcomes studied were improvement in naming skills and generalisation to untreated items and daily communication.

RESULTS: We examined 23 studies in this review. To date, computers constitute the most popular technology by far; only a few studies explored the effectiveness of smart tablets. In some studies, technology was used as a therapy tool in a clinical setting, in the presence of the clinician, while in others, therapy with technology was self-administered at home, without the clinician. All studies confirmed the effectiveness of therapy provided by technology to improve naming of trained items. However, generalisation to untrained items is unclear and assessment of generalisation to daily communication is rare.

DISCUSSION: The results of this systematic review confirm that technology is an efficient approach in the management of post-stroke anomia. In future studies, ecological tasks aimed at evaluating therapy's effectiveness with word retrieval in real-life situations should be added since the ultimate goal of improving anomia is to increase the ability to retrieve words more easily in everyday life.

INTRODUCTION

The aim of this article was to review the effectiveness of technologies in the treatment of post-stroke anomia. In this introduction, we discuss the limitations of the management of aphasia in health services today, along with results of recent studies related to the potential of technologies to overcome these limitations. Then we define anomia, which is the focus of this article, and review its traditional treatment.

Aphasia is an acquired language disorder following brain injury, its most common cause being stroke. Aphasia causes difficulties in comprehension and/or production of language, thus compromising the communication skills of people with aphasia. In Canada, about 50,000 new cases of strokes are reported annually (Heart & Stroke Foundation, 2014) and approximately 315,000 people are currently living with the consequences of stroke (Public Health Agency of Canada, 2011), including aphasia. In the United States, nearly 800,000 people have a stroke every year, making it the leading cause of long-term disability (American Stroke Association, 2016). It is estimated that among people with cerebrovascular disease, one in three suffers from aphasia (Mazaux, Pélissier, & Brun, 2000; Pedersen, Jørgensen, Nakayama, Raaschou, & Olsen, 1995). Thus, aphasia affects many people and has significant repercussions, not only for the person with aphasia, but also for that person’s family and society. For example, researchers have documented decreased quality of life (e.g., Hilari, Wiggins, Roy, Byng, & Smith, 2003; Ross & Wertz, 2003) and less social interactions (e.g., Cruice, Worrall, & Hickson, 2006; Parr, 2007).

The prognosis of aphasia depends on several factors, including its etiology and the impact of speech-language therapy (SLT). In post-stroke aphasia, therapy is based on a collaborative care approach that usually begins at the hospital in the acute phase, continues in intensive rehabilitation programmes, and ends at home or during weekly visits to an outpatient clinic. There is evidence of the effectiveness of SLT for people with aphasia following stroke, as determined by a review conducted by the Cochrane Collaboration (Brady, Kelly, Godwin, & Enderby, 2012). However, for many patients, getting to an outpatient clinic can be difficult or impossible because of mobility problems, the need for support from a family member, the distance between home and clinic, and so on. Home therapy could be an interesting option for these people, allowing them to reach their maximum rehabilitation potential. Moreover, although clinicians usually assume that the greatest amount of recovery from aphasia primarily takes place during a spontaneous recovery period, occurring in the immediate period after stroke and lasting as long as one year, some studies provide evidence that people with aphasia can make significant improvements in response to treatment well over one year post-onset (e.g., Basso, Capitani, & Vignolo, 1979; Kertesz and McCabe, 1977; Routhier, Bier, & Macoir, 2015). Indeed, some researchers found that time post-onset was not related to response to treatment in chronic aphasia (Allen, Mehta, McClure, & Teasell, 2012; Moss & Nicholas, 2006).

However, in many countries, SLT for people with chronic aphasia is often limited, even non-existent. For example, although increasing accessibility to rehabilitation services is a clear priority of Canada's home support policy (Council of the Federation, 2012), home services cannot currently meet demand due to personnel and financial constraints, particularly in speech-language pathology. In this context, it is essential to develop new service delivery options, without burdening professional resources. The accelerated development of new technologies offers clinicians the opportunity to propose innovative and intensive treatments in which the person with aphasia is autonomous or needs less support.

Use of technology (i.e. computer, smart tablet) in language rehabilitation has grown significantly in recent years and become a topic of interest in the aphasia literature. First, there is increasing evidence of the effectiveness of technologies in the treatment of post-stroke aphasia. Recently, Zheng, Lynch, and Taylor (2016) conducted a systematic review of the effect of computer therapy in aphasia. They found seven studies assessing the effectiveness of computer programmes targeting different areas of language (i.e. comprehension and production of complex sentence structures, word-finding, reading comprehension and production of simple, grammatical sentences) and concluded that computer therapy was effective in comparison to no therapy. Zheng et al. (2016) also found three studies to support preliminary evidence that computer-delivered therapy could be as effective as clinician-delivered therapy for individuals with chronic aphasia. However, given the small number of studies investigating this aspect, more research is needed. In a review by Allen et al. (2012), computer-assisted treatment was also cited as an effective intervention for chronic aphasia.

Because of financial and institutional considerations, some studies investigated the cost-utility of these technologies in the management of post-stroke aphasia. In a recent study, Latimer, Dixon, and Palmer (2013) studied the cost-utility of self-managed computer therapy for people with aphasia. They concluded that computer therapy is a cost-effective use of resources for people with aphasia, even if more research is needed, particularly with respect to the quality of life gain achieved following computer therapy. Wenke et al. (2014) also performed a cost analysis of implementing computer therapy in a sub-acute setting and found computer therapy to be approximately 30% cheaper per hour per client than the usual therapy. However, for a technology to be useful, it must not only be cost-effective but also be accepted by the target population. In this regard, Palmer, Enderby, and Paterson (2013) studied the factors associated with the acceptability of independent home-computerised practice from the perspective of both participants with aphasia and carers. Independence, flexibility, repetition and personalised exercises were seen as benefits, while fatigue and interference with other commitments were the major barriers.

There is little evidence regarding the effectiveness of treatments of aphasia delivered with technologies compared to traditional face-to-face treatments. Other aspects of technology in language rehabilitation must also be considered. When used in isolation, technological approaches to aphasia treatment can be questioned in relation to the principles of neuroplasticity in rehabilitation (Kleim & Jones, 2008). Indeed, rehabilitation via technology could differ from face-to-face treatment in terms of saliency (i.e. "the training experience must be sufficiently salient to induce plasticity") and transference (i.e. "plasticity in response to one training experience can enhance the acquisition of similar behaviours"). On the other hand, technology has the potential to promote other principles of neuroplasticity such as intensity and repetition by allowing people with aphasia to improve their skills without the constant presence of the clinician. In this regard, optimal treatment intensity (Bhogal, Teasell, & Speechley, 2003) is rarely observed in face-to-face treatment.

This systematic review focuses specifically on the use of technologies for the treatment of post-stroke anomia. Anomia, which is the most common manifestation of aphasia, is described as the difficulty of finding a specific word at the right time (Goodglass, 2001). People experiencing anomia may have difficulty retrieving specific words during conversation or in structured tasks involving naming objects or pictures, in oral or written production. Anomia can have several origins (Nickels, 1997, 2002a) and identifying the impaired component plays a crucial role in choosing the right treatment. In many cases, anomia results from a deficit of the semantic system (i.e. long-term memory encoding conceptual knowledge about words, objects, etc.), of the output lexicon (i.e. long-term memory encoding information about the phonological/orthographic forms of words) or of both components. Overall, the literature shows that treatment for anomia is effective. In a literature review, Nickels (2002b) concluded that therapies for word-finding difficulties can be highly successful and result in long-term improvement. Some researchers proposed effective treatments based specifically on restoration of the semantic system in which semantic cues are used, such as category, use of the object, synonyms, etc. (e.g., Semantic Feature Analysis; Boyle & Coelho, 1995). When impairment is located in the phonological/orthographic output lexicon, treatment aims to restore access to the phonological/orthographic representation of the words by phonological (e.g., first sound, rhymes with, phonological sequences) or orthographic (e.g., first letter, number of letters) cues (e.g., Phonological Components Analysis; Leonard, Rochon, & Laird, 2008). However, while some treatments focused specifically on semantic or phonological/orthographic cueing, most addressed both at the same time (Raymer & Gonzalez-Rothi, 2001; Raymer et al., 2007). In traditional treatments, generalisation to untreated items remains a major concern. Most researchers found little or no generalisation (e.g., Fillingham, Sage, & Lambon Ralph, 2006; Raymer et al., 2007; Thompson, Kearns, & Edmonds, 2006). Thus, more research is needed to determine the factors associated with successful generalisation to untreated items. Moreover, very few studies examined generalisation effects to daily life communication, most probably because of methodological challenges. However, some researchers found positive outcomes in conversation following anomia treatment (e.g., Best et al., 2011; Conroy, Sage, & Lambon Ralph, 2009). These challenges are also found in treatment delivered by technologies, which is the subject of this review.

In summary, there is mounting evidence of the effectiveness of technologies in the management of post-stroke aphasia, but many questions remain unanswered. No systematic review has been conducted on the effectiveness of technologies in the treatment of anomia, which is the most frequent manifestation of aphasia. Moreover, no review on aphasia has included smart tablets, an increasingly popular new technology. Most reviews have been conducted with one technology and none has gathered information about all available technologies taken together. Therefore, the aim of this literature review was to examine the effectiveness of specific intervention programmes delivered by technologies (i.e. computer and smart tablet) in the management of post-stroke anomia, in terms of improving naming capacities and generalisation to untreated items and daily communication.

METHODS

Review protocol

As a guideline for conducting this review, we used the PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions (Liberati et al., 2009). The PRISMA statement consists of a 27-item checklist and a four-phase flow diagram aimed at helping authors improve the reporting of systematic reviews and meta-analyses.

Eligibility criteria

To be included in this review, studies had to: 1) be randomised or non-randomised trials or case studies, with or without control groups (e.g., healthy participants or usual care); 2) be conducted with participants with post-stroke aphasia; 3) assess the effectiveness of an intervention delivered by a technology, namely computer, smartphone, or smart tablet, to specifically improve anomia, whether administered in the presence of the clinician or self-administered; and 4) measure improvement in naming skills. We excluded studies if they: 1) had less than 50% of the participants with aphasia secondary to stroke; 2) targeted general language skills; and 3) were not in French or English. We did not set any limitations as to publication date.

Information sources and search strategy

We identified studies by searching the PubMed, PsychInfo and Current Contents electronic databases, with the following keywords used in combination: aphasia, anomia, naming, computer, technology, tablet, phone, software. We also did a general search in Google Scholar. We reviewed the bibliographies of all identified articles for additional References

Study selection

Two people (ML and a student in speech and language pathology) screened titles and abstracts of studies for potential eligibility. Full texts of potentially eligible studies were then retrieved to ensure they met the inclusion criteria and could be included in this review. The agreement on excluded and included studies was 100%. The reasons for excluding studies are given in the Results section.

Data collection process

The goal of this review was to describe the studies examined and evaluate their methodological strength in order to make clinical recommendations. Two members of the research team extracted study characteristics and main outcomes using a standardised form. The main outcomes studied were: 1) improvement in naming abilities; 2) generalisation to untrained items; and 3) functional impact of the therapy in everyday life (e.g., impact of treatment on communication quality, transfer to conversational speech). For each participant in the studies examined, we also retrieved data for variables that typically influence treatment outcomes (i.e. aphasia severity, time post-onset, training intensity, target, type of administration and co-occurring limitations) along with measures of magnitude of change, namely effect size and/or percentage change. For studies in which the magnitude of change was not available, we calculated the percentage change ([V2-V1]/V1 * 100) based on raw data when these data were explicitly presented in the results.

Two reviewers (ML and JM) independently conducted the methodological quality assessment and disagreements were resolved by discussion. They used a modified version of the Downs and Black checklist for randomised and non-randomised studies of health care interventions (Downs & Black, 1998). This checklist contains 27 items used to assess quality of reporting, external validity, internal validity and study power. Notation includes yes (1) and no or unable to determine (both coded 0) responses and only question 5, related to the description of principal confounders, is worth 2 points (no = 0; partially = 1; yes = 2). In the original checklist, the final question regarding statistical power is awarded between 0 and 5 points. However, we found the scoring criteria to be unclear and, as was done in other studies (e.g. Richardson, Brooks, Bramley, & Coleman, 2014; Samoocha, Bruinvels, Elbers, Anema, & van der Beek, 2010), we limited our score to 0 (if the study did not include a discussion of statistical power) or 1 (if the study included a discussion of statistical power). Therefore, the maximum score on this modified checklist was 28 points, with a higher score meaning better methodological quality. We calculated interrater agreement using Cohen's k to establish the validity of the methodological quality assessment.

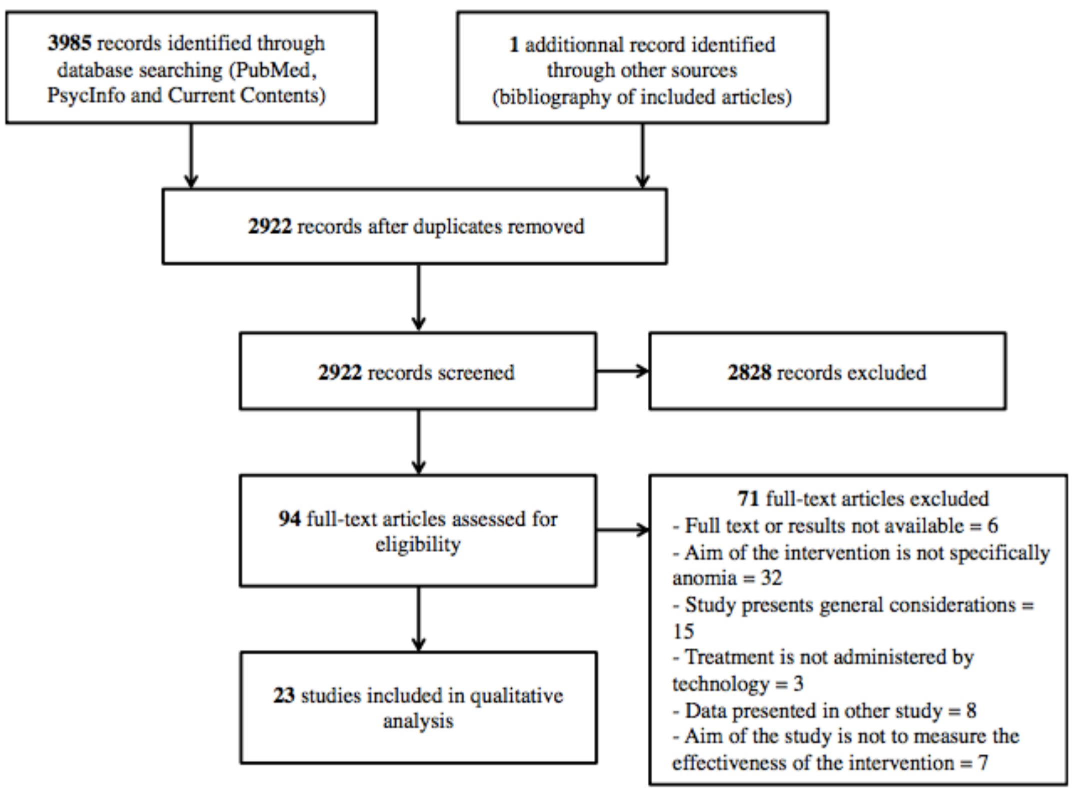
Moreover, the two reviewers also independently determined the level of evidence for each study based on the criteria of Cicerone et al. (2000, 2005, 2011) for the development of evidence-based clinical practice parameters. Briefly, Class I evidence refers to well-designed, prospective, randomised controlled trials. Class II evidence refers to prospective, non-randomised cohort studies, retrospective, non-randomised case-control studies or clinical series with well-designed controls that permitted between-subject comparisons of treatment conditions. Finally, Class III refers to clinical series without concurrent controls and single-subject designs with appropriate quantification and analysis. Clinical recommendations can also be derived from considering the relative strengths of the evidence (Cicerone et al., 2000, 2005, 2011). First, practice standards are based on at least one well-designed Class I study or overwhelming Class II evidence directly addressing the effectiveness of the treatment in question. It provides good evidence to support the recommendation concerning whether the treatment should be specifically considered for people with acquired neurocognitive impairments and disability. Second, practice guidelines are based on well-designed Class II studies that directly address the effectiveness of the targeted treatment and provide fair evidence to support the treatment recommendation. Finally, practice options are based on Class II or Class III studies with additional grounds to support the recommendation pertaining to whether the treatment should be specifically considered, but with unclear clinical certainty.

RESULTS

Study selection

A total of 3985 studies were identified through the systematic literature search. After excluding duplicates (n = 1063), the titles and abstracts of 2922 studies were screened for eligibility. Ultimately, 23 studies were included in this review. Figure 1 shows the flow chart of the selection process.

Figure 1. Flow chart of the selection procedure



Study characteristics

Table 1 (see Annex) summarises the main characteristics of the studies included in this review. Two randomised controlled trials (Doesborgh et al., 2004; Palmer et al., 2012), one group study (Deloche et al., 1992) and 20 single-subject studies (e.g., Adrian, Gonzalez, & Buiza, 2003; Choe, Azuma, Mathy, Liss, & Edgar, 2007; Laganaro, Di Pietro, & Schnider, 2006; Lavoie, Routhier, Légaré, & Macoir, 2016; Ramsberger & Marie, 2007) were included in this review, for a total of 170 participants with aphasia. In all but two studies (Laganaro et al., 2003; Laganaro et al., 2006), all participants had aphasia following stroke, the other cause being traumatic brain injury. Time post-onset ranged from one month to 348 months, with four studies including participants with acute aphasia (<6 months post-onset; Deloche et al., 1992; Laganaro et al., 2003, 2006; Raymer, Kohen, & Saffell, 2006).

In regard to technology, most studies were conducted using computers (e.g., Adrian et al., 2003; Choe et al., 2007; Deloche, Dordain, & Kremin, 1993; Furnas & Edmonds, 2014; Mortley, Wade, & Enderby, 2004) with only three using smart tablets (Kurland et al., 2014; Lavoie et al., 2016; Routhier et al., 2016). No study with a smartphone was found. In nine studies, computers or smart tablets were used as a therapy tool in the presence of the clinician (e.g., Choe et al., 2007; Deloche et al., 1993; Doesborgh et al., 2004; Fink et al., 2002; Raymer et al., 2006), while in 14 studies, therapy with technology was self-administered, without the clinician (e.g., Fridriksson et al., 2009; Herbert et al., 2012; Kurland et al., 2014; Lavoie et al., 2016; Routhier et al., 2016).

Intervention and protocol varied widely across the studies we examined. However, most studies targeted nouns, with some exceptions including verbs (e.g., Adrian et al., 2011; Furnas & Edmonds, 2014; Kurland et al., 2014; Lavoie et al., 2016; Routhier et al., 2016). Also, most studies used at least two types of cues, mostly semantic, phonological and orthographic (e.g., Adrian et al., 2011; Choe et al., 2007; Kurland et al., 2014; Palmer et al., 2012).

Concerning the main results, all studies confirmed the effectiveness of therapy delivered by technology in improving naming of trained items, whether administered in the presence of the clinician or self-administered. Two studies were conducted to determine the effectiveness of therapy delivered by technology in comparison to no therapy (Doesborgh et al., 2004; Palmer et al., 2012). In both of them, participants with therapy improved significantly more than those without therapy. Generalisation to untrained items is unclear, with some studies showing a significant improvement for at least one participant (e.g., Adrian et al., 2003; Bruce & Howard, 1987; Fink et al., 2002; Mortley et al., 2004; Weill-Chounlamountry et al., 2013), while others do not (e.g., Choe et al., 2007; Laganaro et al., 2003; Lavoie et al., 2016; Routhier et al., 2016).

Maintenance of the gains was measured in 17 of the 23 studies. In all of those studies, the gains were maintained, from a few weeks (Routhier et al., 2016; Weill-Chounlamountry et al., 2013) to 1 year of follow-up (Deloche et al., 1993). In seven of these 17 studies, no decrease was found between post-treatment assessment and maintenance (Deloche et al., 1993; Furnas & Edmonds, 2014; Herbert et al., 2012; Laganaro et al., 2006; Lavoie et al., 2016; Routhier et al., 2016; Weill-Chounlamountry et al., 2013). In four studies, a decrease from post-treatment measures to maintenance was found for at least one participant (Laganaro et al., 2003; Palmer et al., 2012; Pedersen et al., 2001; Ramsberger and Marie, 2007). Finally, in the remaining six studies, no statistical analysis was done between post-treatment and maintenance so that no conclusions could be drawn (Adrian et al., 2003; Choe & Stanton, 2011; Choe et al., 2007; Fink et al., 2002; Mortley et al., 2004; Raymer et al., 2006). Generalisation to discourse/conversation was measured in four of the 23 studies and found in three of them (Furnas & Edmonds, 2014; Mortley et al., 2004; Weill-Chounlamountry et al., 2013) but not the other (Doesborgh et al., 2004).

Some of the studies specifically examined the influence of intervention parameters such as intensity, number of treated items and type of administration. Ramsberger and Marie (2007) compared an intensive (5x/week) to a non-intensive (2x/week) self-administered treatment and found no difference in the level of evidence for 3 of the 4 participants. The remaining participant showed an advantage for intensive treatment. Raymer et al. (2006) also studied the effect of intensity by comparing treatments administered by a clinician 1–2x/week to 3–4x/week, both for a total of 12 sessions. They obtained greater improvements for sets trained during the most intensive training schedule. Laganaro et al. (2006) studied the effect of training size by comparing outcomes using a single list of 48 items to a double list of 96 items in a self-administered treatment. Their results showed superior overall gains for the double list, despite fewer item repetitions. Fink et al. (2002) compared clinician-guided treatment to partially self-guided treatment and obtained a significant improvement in both conditions. However, they found greater acquisition and maintenance effects in the clinician-guided group. Finally, Choe et al. (2007) compared outcomes for words trained with a computer vs. with a clinician. For words trained with a computer, they obtained a significant improvement for two of the four participants and the gains were maintained 5 weeks post-treatment. For words trained with a clinician, they found a significant improvement for one participant only, with no maintenance of gains.

Our analyses also highlighted great heterogeneity in the way variables known to influence treatment outcomes and measures of the magnitude of change were reported across the studies. Thus, only time post-onset and type of treatment administration could be accurately compared between the studies. Moreover, in most of them, no measure of the magnitude of change was reported. Effect size was reported in only seven studies (Furnas & Edmonds, 2014; Herbert et al., 2012; Kurland et al., 2014; Lavoie et al., 2016; Ramsberger & Marie, 2007; Raymer et al., 2006; Routhier et al., 2016). Fink et al. (2002) also reported effect sizes but for changes in level and slope, estimators that are not directly linked to standard deviation and thus cannot be compared to effect sizes reported in other studies.

Percentage change was reported in two studies only (Kurland et al., 2014; Ramsberger & Marie, 2007). However, raw data were also available in four more studies (Adrian et al., 2011, 2003; Mortley et al., 2004; Pedersen et al., 2001) so we were able to calculate percentage change for participants in these studies. Mean and standard deviations for magnitude of change in relation to time post-onset and type of treatment administration are reported in Table 2. Overall, these analyses showed extremely high standard deviations for both variables, indicating great variability in effect size and percentage change between participants, which limits the interpretation of the results. For time post-onset, no clear tendency emerged from the results, which suggests that treatment by computer or smart tablet is effective, regardless of the time post-onset.

Table 2. Magnitude of change in relation to time post-onset and type of treatment administration

	Time post-onset Effect size ≤12 mpo	13–24 mpo	25–36 mpo	37–48 mpo	49–60 mpo	>60 mpo
n	4	6	6	3	1	5
Range	0.71–14.68	0.12–5.53	4.95–47.38	2.91–5.39	2.59	2.08–30
Mean	8.56	3.26	12.91	4.02	2.59	12.38
SD	5.93	1.9	16.89	1.26	ND	10.62
	% of change ≤12 mpo	13–24 mpo	25–36 mpo	37–48 mpo	49–60 mpo	>60 mpo
n	5	16	5	2	1	6
Range	13.1–519	17.4–409.1	46.1–154.5	35.9–1037.5	54.7	26–1633
Mean	148.9	115.46	88.52	536.7	54.7	344.22
SD	213.96	98.67	48.53	708.24	ND	635.5

	Type of administration Effect size Clinician	Self
n	7	18
Range	0.12–11	0.71–47.38
Mean	5.37	9.46
SD	3.89	11.58
	% of change Clinician	Self
n	16	19
Range	17.4–1037.5	13.1–1633
Mean	164.16	189.54
SD	253.87	367.6

mpo = months post-onset, n = number of participants.

Methodological assessment

The 23 studies were screened with the 27 items of the revised Downs and Black checklist described above (Downs & Black, 1998). The two reviewers had different scores on 65 of 621 items, which corresponds to a Cohen's k of 0.788. The reviewers understood two questions (question 7, related to random variability, and question 26, related to losses to follow-up) differently. After a discussion to resolve this misunderstanding, they reached a consensus concerning the scoring of these questions, and Cohen's k rose to 0.939.

Scores ranged from 10 to 22 out of 28, with the randomised controlled trial of Palmer et al. (2012) receiving the highest methodological score and the single-subject studies of Kurland et al. (2014) and Pedersen et al. (2001) the lowest. Reporting was generally adequate in most studies, with some items being less frequent: description of confounders, reporting of adverse events and reporting of actual probabilities. Since most studies had single-subject designs, items concerning the representativeness of the population, participants and facilities, blinding and randomisation scored particularly low.

Concerning the level of evidence (Cicerone et al., 2000, 2005, 2011), the two randomised controlled trials were classified as Class I studies and the other 21 studies were classified as Class III. Treatment delivered by computer had the strongest level of evidence, with two studies classified as Class I. For smart tablets, only Class III studies were conducted.

DISCUSSION

The main objective of this study was to investigate the effectiveness of treatments delivered by technologies, namely computer and smart tablet, in the management of post-stroke anomia. Based on specific selection criteria and inter-rater agreement, 23 studies retrieved from PubMed, PsychInfo and Current

Contents were included in this literature review. To reduce the possibility of publication bias, Google Scholar was also screened for grey literature. All studies showed a significant improvement with trained words, regardless of the technology used (computer or smart tablet) and administration method (administered in the presence of the clinician versus self-administered). These results are in line with those of other reviews conducted recently that confirmed the effectiveness of computer in aphasia treatment (Allen et al., 2012; Zheng et al., 2016). However, our study is the first to focus specifically on anomia, the most frequent manifestation of aphasia, to include studies using smart tablets, and to gather information about all available technologies.

Among the 23 studies examined, two compared the effectiveness of therapy delivered by computer to no therapy (Doesborgh et al., 2004; Palmer et al., 2012), and the researchers concluded that participants with therapy improved significantly more than participants without therapy. These results are in line with those reported by Zheng et al. (2016) in their review of computer therapy for aphasia, which also included the studies of Doesborgh et al. (2004; treatment administered in the presence of the clinician) and Palmer et al. (2012; self-administered treatment).

Most studies reported in the present review were conducted with participants more than one year post-stroke, which is in line with results of other studies confirming that improvement is still possible well over one year post-onset (e.g., Basso et al., 1979; Kertesz & McCabe, 1977; Routhier et al., 2015). Moreover, even though the protocols for the 23 studies examined varied greatly, some general conclusions can be drawn. First, most treatments delivered by the different technologies proposed a combination of two or more types of cues (semantic, phonological, orthographic, syntactic, morphological), which is similar to the cueing used in traditional treatments. Moreover, as in traditional treatment, therapies delivered by technologies focused mostly on noun retrieval, with only 8 of 23 studies including verbs. This finding is of concern considering the pivotal role of verbs in speech production, as pointed out by Conroy, Sage, and Lambon Ralph (2006).

Some researchers studied the maintenance of gains over time and their results tend to confirm that the improvement was maintained from a few weeks for smart tablet, up to 1 year after the end of the therapy for computer, regardless of whether the treatment was administered in the presence of the clinician or not. However, more research is needed to determine if some characteristics of the participants or the treatments could be associated with better maintenance. Generalisation to untrained items was measured in the great majority of studies in this review but mixed results are reported, a finding that is also true in traditional treatment (e.g., Fillingham et al., 2006; Raymer et al., 2007; Thompson et al., 2006). Since generalisation to untreated items is not assured, it is essential to choose significant target items in order to lead to positive outcomes in daily communication (Conroy et al., 2009; Raymer et al., 2007). In this regard, generalisation to daily communication was assessed in only four studies conducted with computer (Doesborgh et al., 2004; Furnas & Edmonds, 2014; Mortley et al., 2004; Weill-Chounlamountry et al., 2013), and positive outcomes were found in three of them (Furnas and Edmonds, 2014; Mortley et al., 2004; Weill-Chounlamountry et al., 2013). Doesborgh et al. (2004) suggested that the absence of generalisation in conversation could be explained by deficits in executive functioning. Since the ultimate goal of improving anomia is for individuals to retrieve words more easily in their everyday lives, further therapy studies should focus on assessing word retrieval in real-life situations. However, this is a major challenge since few clinical and ecological tools exist to assess everyday life communication.

Results of our preliminary analysis of magnitude of change are consistent with the conclusions of previous studies that time post-onset was not related to response to treatment in chronic aphasia (Allen et al., 2012; Moss & Nicholas, 2006). Independently of time post-onset, effect sizes varied broadly across participants, ranging from 0.12 to 47.38. These values correspond to very small to very large effect sizes according to Beeson and Robey's benchmarks for face-to-face lexical treatment whereby 4, 7 and 10 correspond to small, medium and large effect sizes (2006). With respect to treatment administration type, results suggest that both clinician and self-administered treatment are effective. Indeed, mean effect size was 5.37 for clinician-administered treatment, which corresponds to a small to medium effect, and 9.46 for self-administered treatment, which corresponds to a large effect (Beeson & Robey, 2006). However, given the high standard deviations, our analysis does not allow us to determine whether or not the two types of treatment are equivalent. Our systematic review also included a study by Furnas and Edmonds (2014) investigating the effectiveness of computer-delivered Verb Network Strengthening Treatment (VNeST-C), a treatment originally used in traditional therapy (VNeST; Edmonds, Nadeau, & Kiran, 2009). Results of this study showed that the treatment delivered by computer led to a significant improvement in lexical retrieval for both trained and untrained items, as well as maintenance of the gains 3 months post-treatment. However, generalisation to discourse was limited. In the traditional treatment, results also showed a significant improvement in lexical retrieval for both trained and untrained items with maintenance of the gains 1 month post- treatment. However, effect sizes were only provided in the study with the computer so the magnitude of change between the two studies could not be compared. In the traditional treatment, generalisation to connected speech was observed in 3 of 4 participants, which was not the case in the study with the computer. More studies are needed to determine optimal treatment conditions and their relationship to participants' characteristics.

In studies we examined, many researchers highlighted the benefits of therapy delivered by technology in post-stroke aphasia. One of the advantages cited most often is the fact that treatment delivered by computer or smart tablet can be very pleasant and motivating for participants, whether administered in the presence of the clinician (Adrian et al., 2003; Bruce & Howard, 1987; Fink et al., 2002) or self-administered (Kurland et al., 2014; Laganaro et al., 2003; Routhier et al., 2016). Researchers also noted that treatment self-administered by computer (Fink et al., 2002; Laganaro et al., 2003; Ramsberger & Marie, 2007) or smart tablet (Kurland et al., 2014; Lavoie et al., 2016) enables more intensive and extended treatment to be offered. This advantage is particularly relevant in today's reality where clinical resources are limited and insufficient to meet the needs of people with aphasia, which compromises their rehabilitation potential. Moreover, therapy self-administered by computer (Ramsberger & Marie, 2007) or smart tablet (Kurland et al., 2014; Lavoie et al., 2016; Routhier et al., 2016) can expand access to treatment for patients who cannot get to a clinic because of physical, geographical or financial constraints. For self-administered treatments, the increased autonomy allowing individuals to choose when, where and for how long they practice is also cited as an advantage for smart tablet (Kurland et al., 2014; Routhier et al., 2016) and computer (Mortley et al., 2004). And last but not least, Ramsberger and Marie (2007) also report increased self-esteem arising from pride in being able to work independently on the computer.

However, some limitations and disadvantages are linked to the use of technology in rehabilitation. First, although technologies have evolved tremendously in recent years, the presence of non aphasia-friendly features (e.g., small print, complex language) on the devices or applications can frustrate users (Kurland et al., 2014). Moreover, even though autonomy is cited as an advantage for self-administered treatments, Kurland et al. (2014) noted that this is also associated with less control over what clients are doing (e.g., errors, time of practice) and difficulty controlling the influence of other sources of language stimulation (e.g., Google), which can compromise the effectiveness and specificity of the treatment. Finally, although many researchers see the use of technology as a source of motivation, Ramsberger and Marie (2007) mentioned that for some, self-administered treatment delivered by computer could be associated with difficulty maintaining their motivation because of less clinician contact. In this regard, Kurland et al. (2014) suggested that the weekly presence of the clinician was a factor associated with success for self-administered treatment by smart tablet, and Palmer et al. (2012) proposed volunteer support to promote continued practice of self-administered treatment by computer.

In this systematic review, the level of evidence was generally low, with only two studies relating to therapy with computers being classified as Cicerone et al.'s Class I (2000, 2005, 2011), one with treatment administered in the presence of the clinician (Doesborgh et al., 2004) and one with self-administered treatment (Palmer et al., 2012). The remaining 21 studies involved Class III evidence. At this time, therefore, computer has the highest level of evidence. However, as there is considerable variation in the protocols used, more research is needed to determine if treatment for anomia delivered by computer should be classified as "practice standard" or "practice guideline". For smart tablet, studies are weaker in terms of methodology and therefore this treatment approach can only be considered as a practice option for now. In fact, this review highlighted general methodological weaknesses that should be addressed in future studies. The main aspect that influenced the scores on the methodological assessment was the lack of randomisation. However, most studies had either a control group (e.g. Adrian et al., 2011; Doesborgh et al., 2004; Palmer et al., 2012) or a control condition (e.g. Choe & Stanton, 2011; Kurland et al., 2014; Lavoie et al., 2016; Routhier et al., 2016). In future studies, the addition of a control group and randomisation would allow more accurate interpretation of the results and stronger evidence.

While smart tablet is a relatively new technology, the computer has existed for many years and it is not surprising that it has been the subject of more studies. The computer is an interesting clinical tool that offers numerous possibilities, including that of allowing the patient to perform therapy independently, without the presence of the clinician. However, in recent years, the smart tablet has become increasingly popular. It offers the same advantages as the computer but is easier to transport and more user-friendly (i.e. integrated keyboard, selection by touch, quick opening and closing). Thus, more studies should investigate the effectiveness of this technology in language rehabilitation.

To conclude, the results of this systematic review confirm that technology is an original and efficient approach to the management of post-stroke anomia. Although more studies are needed to confirm these results, intensive treatment (more than 2x/week) and a high number of treated items seem to be associated with better treatment outcomes. With the data currently available, it is not possible to confirm that self-administered therapy is as effective as traditional face-to-face therapy. Results from the studies included in this review are not consistent on this point and more research is needed. In any event, the role of speech-language pathologists remains crucial in self-administered therapy. Technologies cannot replace clinical expertise with respect to, for example, the therapy target, tailoring cueing to the client's profile, measures of progress and achievement of the treatment objectives. Nevertheless, self-administered therapies, when guided by a skilled clinician, are especially relevant in the current economic context, where human and financial resources for clinical practice are limited (Katz, 2010), since they have proven to be cost-effective (Latimer et al., 2013; Wenke et al., 2014). Thus, rehabilitation via self- administered therapy delivered by computer and smart tablet gives patients the opportunity to be more independent in their rehabilitation. This could maximise their potential for therapeutic success by increasing the frequency of therapeutic activities, a factor that has been explicitly recognised as a positive determinant of the efficacy of language treatment (Bhogal et al., 2003; Hoover & Carney, 2014).

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Chapitre 4. Étude expérimentale: Rééducation de mots fonctionnels en aphasie post-AVC

Étude 2. Efficacy of a self-administered treatment using a smart tablet to improve functional vocabulary in post-stroke aphasia: A case series study

Lavoie, M., Bier, N., & Macoir, J. (2018). Efficacy of a self-administered treatment using a smart tablet to improve functional vocabulary in post-stroke aphasia: A case series study (en révision pour *International Journal of Language & Communication Disorders*)

Résumé

INTRODUCTION: L'aphasie est un trouble acquis du langage secondaire à une lésion cérébrale, la cause la plus commune étant l'AVC. Elle entraine des difficultés de communication qui ont des répercussions significatives sur la qualité de vie et les relations sociales de la personne qui en souffre. Même si l'efficacité de l'intervention orthophonique a été clairement démontrée pour cette population, les services à long terme sont actuellement limités, en raison de contraintes logistiques et financières. Dans ce contexte, la contribution potentielle des nouvelles technologies pour soutenir les traitements auto-administrés doit être mesurée, particulièrement pour l'amélioration de mots significatifs pour la personne dans sa vie quotidienne. L'objectif de cette étude est donc d'évaluer l'efficacité d'un traitement auto-administré via tablette électronique pour l'amélioration de la production de mots fonctionnels en anomie post-AVC.

MÉTHODE: Quatre adultes présentant une aphasie chronique ont participé à l'étude. Un devis de type ABA avec lignes de base multiples a été utilisé pour comparer la performance en dénomination pour quatre listes équivalentes: 1) traitée, comprenant des mots fonctionnels choisis avec le participant; 2) traitée,

comprenant des mots choisis selon une approche classique « non fonctionnelle »; 3) exposée, mais non traitée; 4) non exposée (contrôle). Le traitement a été auto-administré à la maison, à raison de quatre fois par semaine durant quatre semaines.

RÉSULTATS: Pour tous les participants, une amélioration significative a été obtenue à la suite du traitement pour les mots entrainés et les gains se sont maintenus deux mois après son arrêt. De plus, une généralisation des gains du traitement en conversation a été observée chez deux des quatre participants.

DISCUSSION: Cette étude appuie l'efficacité de la tablette électronique pour l'amélioration de la dénomination en aphasie post-AVC. Même si davantage d'études sont nécessaires, l'utilisation des nouvelles technologies est sans contredit une approche prometteuse pour améliorer les habiletés communicationnelles chez les personnes aphasiques, particulièrement en ciblant un vocabulaire utile dans la vie de tous les jours.

Abstract

BACKGROUND: Aphasia is an acquired language disorder that occurs secondary to brain injury, such as stroke. It causes communication difficulties that have a significant impact on quality of life and social relationships. Although the efficacy of speech-language therapy has been clearly demonstrated in this population, long-term services are currently limited due to logistical and financial constraints. In this context, the potential contribution of technology, like smart tablets, is worth exploring, especially to improve vocabulary that is relevant in daily life. The main aim of this study was to investigate the efficacy of a self-administered treatment using a smart tablet to improve naming of functional words in post-stroke anomia.

METHODS: Four adults with post-stroke aphasia took part in the study. An ABA design with multiple baselines was used to compare naming performances for four equivalent lists: 1) trained with functional words chosen with the participant; 2) trained with words chosen using the traditional approach; 3) exposed but not trained; and 4) not exposed (control).

RESULTS: For all participants, the treatment self-administered at home (four times/week for four weeks) resulted in a significant improvement for both sets of trained words that was maintained two months after the end of treatment. Moreover, in two participants, evidence of generalisation to conversation was found.

DISCUSSION: This study confirms the efficacy of using smart tablets to improve naming in post-stroke aphasia. Although more studies are needed, the use of new technologies is unquestionably a promising approach to improve communication skills in people with aphasia, especially by targeting vocabulary that is relevant to them in their daily lives.

INTRODUCTION

In recent decades, the mortality rate following a stroke has fallen dramatically due to medical advances, resulting in more people surviving and living with consequences. Following a stroke, approximately one third of people suffer from aphasia at onset (e.g., Dickey et al., 2010; Mazaux, Pélissier, & Brun, 2000), and 60% still have chronic aphasia 12 months post-onset (Engelter et al., 2006). Aphasia can affect communication skills and has also been associated with decreased quality of life (e.g., Hilari, Needle, & Harrison, 2012), fewer social interactions (e.g., Cruice, Worrall, & Hickson, 2006) and reduced participation in domestic life (Pike, Kritzinger, & Pillay, 2017).

Anomia is the most common manifestation of aphasia. It is defined as difficulty retrieving a specific word at the right time (Goodglass, 2001) and can occur in structured tasks (e.g. picture naming) as well as in conversation. Anomia leads to non-responses, delays, production of semantic paraphasias or phonological paraphasias, etc. According to cognitive models of spoken production (Caramazza, 1997; Levelt, Roelofs, & Meyer, 1999), words are retrieved through activating specialised and interconnected components (i.e. semantic memory, phonological output lexicon, phonological buffer) and anomia results from a functional deficit in one or more of these components. In post-stroke aphasia, it often results from a deficit in both the semantic memory and the phonological output lexicon (Nickels, 1997, 2002a).

In interventions for anomia based on language processing theories, the clinician provides cues to help the person with aphasia retrieve or reactivate specific words. When the impairment arises from the semantic memory, the treatment focuses on the semantic knowledge associated with the target word (e.g., category, use, location). For example, Semantic Feature Analysis (SFA; Boyle & Coelho, 1995) is a semantic treatment, which efficacy has been repeatedly demonstrated in the literature (see Maddy, Capilouto, & McComas, 2014 for a review). When anomia is caused by impairment in the phonological output lexicon, the cues given relate to the phonological form of the word (e.g., first and final sounds, number of syllables). For example, Leonard, Rochon and Laird (2008) investigated the efficacy of the Phonological Components Analysis (PCA) and reported a significant improvement in naming for seven out of 10 participants following this treatment. Most treatments, however, are rarely exclusively semantic or phonological but combine both types of cues (e.g., Raymer & Gonzalez-Rothi, 2001). Overall, the literature shows that treatment for anomia can be very successful and result in long-term improvement (Nickels, 2002b).

To date, only a few studies investigated generalisation of the treatment effects to discourse. Some studies addressed this issue by performing a general analysis of descriptive, narrative and/or procedural discourse (e.g., Herbert, Webster, & Dyson, 2012; Wambaugh & Ferguson, 2007) and positive changes were generally reported. Some studies also investigated general changes in conversation. For example, Best et al. (2011) investigated general changes in conversational speech following a phonological and orthographic therapy in 13 participants with chronic post-stroke anomia. While no significant change was found for the group, individual analysis showed significant changes in at least one of the measured variables (e.g., number of minimal turns/total turns) in seven participants. Some studies also investigated generalisation of the treatment effects to connected speech for specific words (e.g. Conroy, Sage, & Lambon-Ralph, 2009; Rider, Wright, Marshall, & Page, 2008). To our knowledge, only one study investigated the reinvestment of specific therapy targets in conversation. Following a treatment self-administered using a computer, Mason et al. (2011) reported a significant improvement in naming for the trained words in two of the three participants with post-stroke aphasia, as well as an increase in the production of the target words in conversation for one participant. Generalisation to conversation is highly dependent on the choice of therapy targets. In most studies, however, treated words are chosen from picture databases (e.g., Snodgrass & Vanderwart, 1980), regardless of their relevance to the participant. In only a few studies, researchers specifically targeted words that were functional for participants (e.g., Mason et al., 2011, Menke et al., 2009).

Several factors can influence the prognosis of language recovery in aphasia; one of the most important being the availability of speech-language therapy (SLT). However, in many countries such as Canada, SLT is often limited for people with chronic aphasia due to financial and human constraints or other factors such as living in a remote area or having mobility problems. In this context, the use of technology for aphasia rehabilitation has received increasing attention over the past few years. In a recent systematic review, Zheng, Lynch and Taylor (2016) confirmed the efficacy of computer therapy for language deficits in post-stroke aphasia and found preliminary evidence that it could be as effective as clinician-delivered therapy. Recently, our research team conducted a systematic review of the efficacy of computers and smart tablets for the specific treatment of post-stroke anomia (Lavoie, Macoir, & Bier, 2017). Twenty-three studies were included in the review, with only three being conducted with smart tablets. All studies showed a significant improvement in naming for the trained words, regardless of whether the therapy was administered in the presence of the clinician or self-administered.

The main aim of this study was to investigate the efficacy of a self-administered treatment using a smart tablet to improve naming of functional words in post-stroke aphasia. The first specific objective was to compare treatment outcomes for functionality-oriented vocabulary vs non functionality-oriented vocabulary in terms of efficacy and maintenance, and generalisation to untrained items. The second specific objective was to investigate generalisation of the trained words to an ecologically valid measure such as conversation.

MATERIALS AND METHODS

Design

This study involved a multiple baseline single-case series using an ABA design across four lists of words. The procedure included three phases, which are described below: 1) Baselines (A^1), including measures of naming and conversation before starting the intervention; 2) Treatment (B), comprising training with the smart tablet and self-administered treatment; and 3) Post-intervention (A^2) and maintenance (A^3) measures. All phases were conducted in the participants' homes.

Participants

Four adults with post-stroke aphasia took part in the study. Their sociodemographic characteristics are presented in Table 3. Participants were recruited through speech-language pathologists in Quebec City (Quebec, Canada) or through advertising in associations for people with aphasia. To take part in the study, participants had to: 1) suffer from chronic aphasia (> one year post-stroke) secondary to a first left hemisphere stroke, 2) present moderate to severe anomia for nouns (z score ≤ -2 at the TDQ-60, Macoir et al., 2017), 3) live at home, and 4) be right-handed. Exclusion criteria were to present: 1) impaired comprehension severe enough to affect comprehension of the experimental tasks, 2) moderate to severe apraxia of speech or dysarthria, 3) non-corrected visual or hearing impairment, 4) moderate to severe visual agnosia, 5) psychiatric disorders, and 6) illiteracy. All participants underwent an exhaustive neuropsychological and language assessment (see Table 3 for results) to verify compliance with the inclusion/exclusion criteria and establish a comprehensive portrait of their cognitive profile prior to treatment. None of the participants was enrolled in concurrent SLT during the study.

Table 3. Participants' sociodemographic characteristics and summary of neuropsychological and language assessment

	P.R.	S.T.	L.M.	C.G.
1) Sociodemographic characteristics				
- Age (years)	73	72	59	63
- Gender	F	M	M	M
- Handedness	R	R	R	R
- Education (years)	14	4	12	11
- Time post-onset (months)	17	90	17	13
- Etiology	IS	IS	IS	IS
2) Language and semantic knowledge tests				
Comprehension				
- Words - BECLA (/20)	20	20	19	20
- Words and sentences - MT-86 (/47)	45	37*	32*	42
- Instructions- MT-86 (/8)	7	5*	6*	7
Lexical decision - BECLA				
- Spoken modality (/20)	20	13*	16*	16*
- Written modality (/20)	18*	12*	16*	20
Oral expression				
Spoken picture naming				
- TDQ-60 (/60)	25*	42*	23*	46*
- BECLA (/20)	7*	14*	12*	18
Repetition - BECLA				
- Words (/15)	15	13*	10*	7*
- Nonwords (/10)	9	6*	6*	5*
Reading aloud - BECLA				
- Words (/10)	10	3*	4*	9
- Nonwords (/10)	9	ND	5*	7*
Written expression				
Written spelling to dictation - BECLA				
- Words (/20)	16*	ND	ND	ND
- Nonwords (/10)	10	ND	ND	ND
Written picture naming – BECLA (/20)	12*	ND	ND	9*
Semantic knowledge				
Semantic picture matching				
- Pyramids and Palm Trees Test (/52)	38*	46	47	49
- BECLA (/20)	17*	19	20	19
Written word semantic matching - BECLA (/20)	15*	11*	18	18
3) Neuropsychological tests				
Episodic/working memory				
DMS-48 (/48)				
- Immediate recognition	45	46	40	46
- Delayed recognition	44	47	47	46
Digit span - WAIS				

- Forward span	4*	4*	4*	3*
- Backward span	3*	2*	2*	3*
Corsi block-taping test				
- Forward span	4	4	6	5
- Backward span	4	4	5	4
Executive functions				
Trail Making Test (time, seconds)				
- A	99	74	34	34
- B	256*	ND	119	104
Visuo-perceptual abilities				
BORB				
- Length match task (/30)	25	24*	24*	29
- Object decision B - Easy (/32)	27*	31	31	31
Praxis				
Brief praxis evaluation battery				
- Symbolic gestures (/5)	2*	2*	4	4
- Mimes of actions (/10)	8*	7*	10	10
- Abstract gestures (/8)	4*	ND	7	7

Note. * Indicates a score below the norm (≥ 2 SD) or below the 5th percentile; IS: Ischemic; ND: Not or partially done due to difficulties; BECLA: Batterie d'Évaluation Cognitive du Langage chez l'Adulte; MT-86: Protocole Montréal-Toulouse d'examen linguistique de l'aphasie; TDQ-60: Test de dénomination de Québec; DMS-48: Visual recognition memory test; WAIS: Wechsler Adult Intelligence Scale; BORB: Birmingham Object Recognition Battery.

Case 1: P.R.

P.R. is a 73-year-old right-handed woman with 14 years of education, retired from a job as a special education teacher in a psychiatric hospital. Seventeen months prior to the study, she suffered a left temporal-parietal-occipital stroke. She received SLT in a rehabilitation centre for five months, ending in March 2015. At the time of the study, P.R. lived alone at home and was independent for most daily living activities.

The neuropsychological and language assessment was conducted in January 2016 (see Table 3). As shown in Table 3, P.R. presented mild deficits of verbal working memory and mental flexibility, mild associative agnosia and limb apraxia. P.R. presented a right homonymous hemianopsia secondary to stroke, which reduced her speed of information processing in visual tasks, but without having a significant effect on her performance. Regarding language, a mild to moderate semantic impairment was observed. P.R.'s discourse was fluent; she produced well-formed sentences, but suffered from a significant lexical-semantic anomia.

Case 2: S.T.

S.T. is a 72-year-old right-handed man with four years of education. Before his retirement, he worked as a carpenter. In 2008, he suffered a left hemisphere stroke for which he received SLT in a rehabilitation center for four months. When S.T. enrolled in the study, he lived with his wife who helped him with daily activities, mostly because of a right hemiparesis secondary to the stroke.

The neuropsychological and language assessment was conducted in June 2016 (see Table 3). Verbal working memory, executive functions, visuoperceptual abilities as well as praxis were mildly impaired. With respect to language, S.T. showed a mild deficit in oral sentence comprehension. His speech was non fluent as he was able to produce only a few words and short sentences, with the presence of mild apraxia of speech. A significant lexical anomia and agrammatism were also observed.

Case 3: L.M.

L.M. is a 59-year-old right-handed man with 12 years of education. At the time of the study, he still worked as a school bus driver. Seventeen months prior to the study, he suffered a left hemisphere stroke and was referred to a rehabilitation centre where he received SLT for 14 months. He also received six SLT sessions at an outpatient clinic. At the time he enrolled in the study, L.M. lived with his wife and was independent in his activities of daily living and hobbies. Since his stroke, he and his wife engaged in weekly language exercises at home.

In March 2017, a neuropsychological and language assessment was conducted (see Table 3). As shown in Table 3, L.M. presented a mild impairment of visuoperceptual skills. For language, a mild to moderate deficit was observed for oral sentence comprehension. L.M.'s speech was non fluent, mostly because of a lexical anomia, and agrammatism was also observed.

Case 4: C.G.

C.G. is a 63-year-old right-handed man with 11 years of education. Before his retirement following his stroke, he worked as an industrial painter. In May 2016, he suffered a left hemisphere stroke. He received SLT at a rehabilitation centre for seven months. When he enrolled in the study in June 2017, he lived alone in his apartment and was independent for all his activities of daily living.

In June 2017, a neuropsychological and language assessment was conducted (see Table 3). Concerning language, C.G.'s speech was fluent but marked by a lexical anomia and the production of phonological errors.

Materials and procedure

Materials

The treatment was administered using an application developed for an Android© tablet via a collaboration between our research team and the Software Engineering Department at Université Laval. The application, named iTSA, is a semantic-phonological treatment inspired from the Semantic Feature Analysis (Boyle & Coelho, 1995), and the participant answers questions about semantic features rather than evoking them as in the classical form of the treatment. The specific procedure for the treatment is described in more detail below. Answers to the yes/no semantic questions are recorded in iTSA and compiled in an Excel file, while audio-records of the participant's attempts to name each object are stored in a file directly on the tablet.

The first author held a meeting with each participant to determine potential targets for the treatment of functionality-oriented vocabulary. Topics were chosen based on the participant's interests and activities of daily living (e.g., cooking, gardening, carpentry), and a list of approximately 120 functional words relating to those topics were created for each participant. When possible, pictures were taken directly in the participant's home with the application. When it was not possible because of the nature of the target (e.g., airplane), pictures were found in copyright-free digital image sets (e.g., Pixabay). For the non functionality-oriented vocabulary, 60 words related to topics that were not significant for the participant (e.g., camping, animals from the zoo) were chosen from a picture database (Brodeur, Guérard, & Bouras, 2014).

Phase 1: Baselines (A^1)

Baselines consisted of a naming task and a conversation task administered three and two times, respectively, to assess the stability of performance before beginning the treatment, using the list of 180 words (120 functional words and 60 words from the picture database). In the first session, the participant first had to rate the degree of usefulness of each of the words on a scale of 1 (not useful) to 5 (very useful) to ensure that words in the functionality-oriented treatment were relevant (score ≥ 3). In the naming task, administered by the first author, the participant had to name the 180 pictures presented in random order. A research assistant, blind to the 180 words chosen for each participant, carried out the conversation task. This research assistant was a speech-language pathologist who was used to discussing with people with aphasia. Four topics, two relating to the functional words and two relating to the non-functional words, were given to the research assistant with instructions to talk with the participant for approximately five minutes about each topic, for a total of 20 minutes per session. All conversations were audio-recorded with a computer.

Planning the treatment: After the baselines, three lists of 30 functional words were created for each participant: 1) List A: words trained with the application, 2) List C: words exposed but not trained, and 3) List D: words not exposed (control). These three lists were equivalent in terms of performance on the naming task (total score), syllable length, lexical frequency (New, Pallier, Brysbaert, & Ferrand, 2004) and degree of usefulness. For the non functionality-oriented vocabulary treatment, a fourth list, list B, composed of 30 words chosen from the picture database, was created and paired with the other three lists with respect to performance on the naming task, syllable length and lexical frequency. This list B was also trained with the application.

Phase 2: Treatment (B)

Training with the smart tablet: Before beginning the treatment, one or two training sessions with the smart tablet were held at home with the participant and a relative, if necessary. In the first session, operation of the application was demonstrated with detailed verbal explanations, along with a practice of eight items not included in the treatment. When necessary, a second practice session was held. At the end of the training, the participant was given a paper guide illustrating each step in the treatment. The experimenter also observed the first treatment session to ensure that everything was done properly.

Self-administered treatment: Participants completed the self-administered treatment at home four times a week for four weeks, for a total of 16 sessions. In each session, they had to use the "Treatment" module of the application to train words in list A (n=30; functionality-oriented vocabulary) and list B (n=30; non functionality-oriented vocabulary) presented in random order. The steps were as follows (see Figure 2):

a) Look at the picture of the object presented on the screen;

b) Answer eight yes/no semantic questions related to the object (category, use, associated object, usual location), with immediate feedback;

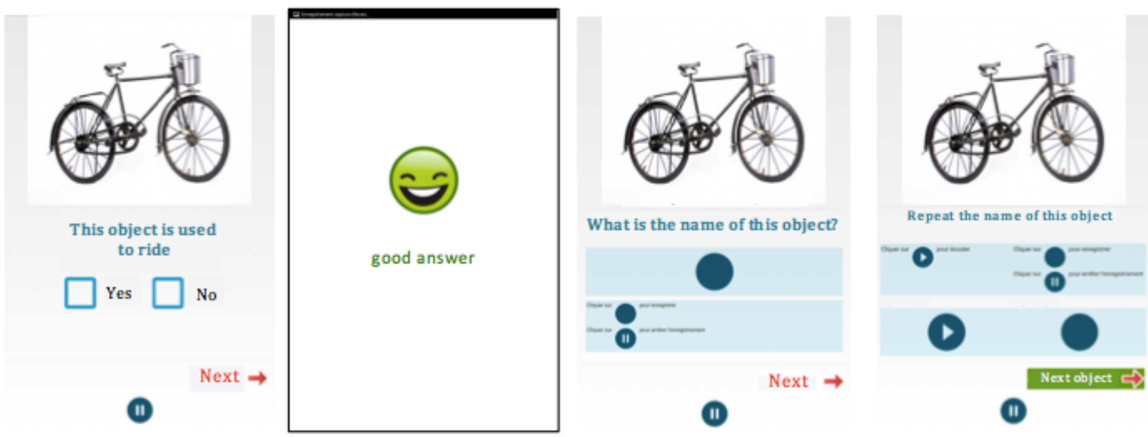
c) Click on the icon and try to say the name corresponding to the pictured object;

d) Click on the icon to listen to the name of the object and repeat it.

For list C (n=30; functionality-oriented vocabulary), which was exposed but not trained, participants had to look at the picture of the object presented on the screen and try to produce its name. No cues were provided and no feedback was given regarding their answer. Pictures from list D (n=30; functionality-oriented vocabulary) were never presented during the treatment sessions. Compliance with the treatment was tracked directly on the application.

At the end of each week of treatment, the first author went to the participants' home to conduct a naming task, comprising the 120 words from lists A, B, C and D, with the "Measures" module of the application. The pictures were presented in random order and no cues or feedback were provided.

Figure 2. Procedure for lists A and B (trained)



Phase 3: Post-intervention and maintenance measures (A^2 and A^3)

At the end of the last treatment session, the same naming task was administered three times within a week (A^2) by the first author to compare the performance to baseline measures. The research assistant also administered the conversation task twice in the week following the end of treatment. Finally, to assess maintenance of the gains, the naming task was administered two weeks, one month and two months post-treatment (A^3) by the first author.

Analyses

Consistent with the current consensus regarding the analysis of single case studies, a combination of visual and statistical analyses was used (e.g., Houle, 2009). Moreover, to ensure that every treatment was completed and to assess the progression of performance for lists A, B and C across the 16 sessions, the first author listened to recordings of the responses produced in each therapy session and rated them (0=wrong answer; 1=right answer).

Visual analyses

A graphical representation of the data collected was first visually analysed to identify general trends in the progression of performance during the different treatment phases. Special attention was paid to changes in level of performance, trend (direction), slope and variability (Ottenbacher, 1986). In the Results section, the progression of performance on the naming attempts recorded during each therapy session is shown in Figure 3. The progression of performance in naming at the measures taken across the main phases of the protocol (i.e. baseline, treatment, post-treatment and maintenance) for each participant is shown in Figures 4-7.

Statistical analyses

To determine if there was a significant change following treatment for each list, the Tau-U statistic was used (Parker, Vannest, Davis, & Sauber, 2011). The Tau-U statistic is a summary index that represents the percentage of data that improved over time considering both nonoverlap and trend in the intervention phase, after controlling for trend in baseline. For example, a Tau-U of 0.67 would mean that 67% of the data improved between the two targeted phases, while a Tau-U of -0.67 would mean that 67% of the data decreased between those two phases. The statistics were calculated using the web-based statistical application available free online (http://www.singlecaseresearch.org/calculators/tau-u). To investigate the efficacy of the treatment, the baseline phase (A^1) was compared to the post-treatment phase (A^2), while to examine maintenance, the post-treatment phase (A^2) was compared to the maintenance phase (A^3).

To compare performance between lists in a specific phase, the Kruskall-Wallis non-parametric test for independent samples was used together with post-hoc analyses (Mann-Whitney U), using the Bonferroni correction for multiple tests. The first objective was to ensure that performance was equivalent for each list at baseline. The second objective was to compare performance at post-treatment and maintenance on lists for which a significant improvement was found. Analyses were conducted using SPSS 24.0. Percentage improvement at the end of the first week and at the end of treatment was also calculated for each list to compare the different conditions.

Conversation

The first author transcribed the recordings for each conversational measure. A lexical analysis was conducted to investigate whether the participants produced the specific items from each list in their conversations. Successful and unsuccessful productions of the 120 words from lists A, B, C and D were retrieved to obtain a percentage of anomia: number of failed productions/number of possibilities to produce the words (i.e. number of successful and unsuccessful productions) multiplied by 100. A production was considered successful when the participant produced the word without any help from the experimenter. If the experimenter used the word in the previous sentence, this word was not counted since it could be a repetition rather than a lexical retrieval of the target. A production was considered failed when the participant could not find the word while the context clearly allowed the experimenter to identify the target or when the experimenter suggested a word and the participant confirmed that it was the word he/she was searching for.

The first author assessed the successful productions by using the Search function in the Word documents containing the transcripts. Both the first author and an experimenter blind to the aim of the study and the vocabulary included in the treatment assessed the unsuccessful productions since this was more subjective. For the blind experimenter, the order of the transcripts was randomised so she did not know which were from baselines and post-treatment. Interrater agreement for the unsuccessful productions was calculated using Cohen's K, and disagreements were resolved by discussion.

RESULTS

The four participants completed the whole research protocol. Compliance with the self-administered treatment was high: C.G. forgot to do one session (#12), while the other three participants attempted all 16 sessions. However, P.R. encountered a technical issue with the tablet for sessions #3 and #13 and the treatment was interrupted before lists A and B were completed. In addition, for the other sessions, the application shut down during treatment of list C due to a lack of space caused by the size of the picture files. Therefore, list C was not taken into account in the analyses for this participant. This problem was solved for the other participants. Finally, for S.T.'s session #6, a technical problem occurred with the tablet, which shut down the application before the session was completed.

Two of the participants, P.R. and C.G., did the self-administered treatment completely independently, while S.T.'s and L.M.'s wives assisted them because of reading difficulties. The mean duration of each treatment session was around 60 to 90 minutes for P.R., S.T. and L.M., and about 30 to 45 minutes for C.G. While L.M. and C.G. completed most therapies in one go, P.R. and S.T divided most of theirs into two or three parts during the same day to minimise fatigue.

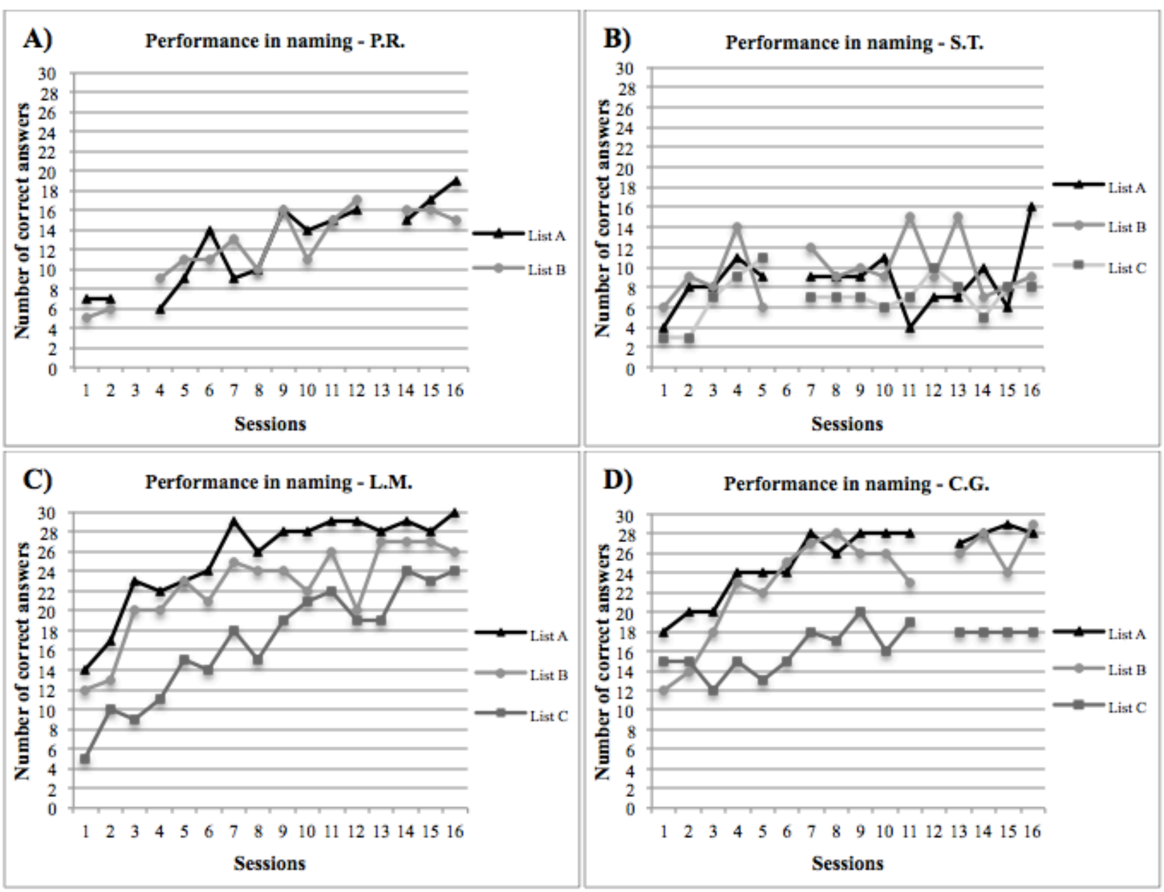
Case 1: P.R.

Visual analyses

Progression of P.R.'s naming performance for lists A and B recorded during therapy sessions is shown in Figure 3A. Over the course of treatment, her performance improved gradually for both lists.

P.R.'s performance on each list across the whole treatment protocol is shown in Figure 4. For list A, an increase in level was observed between baseline (A^1) and treatment (B), as well as between treatment (B) and post-treatment (A^2). For list B, an increase was also observed between baseline (A^1) and treatment (B). Finally, there was no clear change for list D, despite a trend toward improvement at baseline. At each phase of the treatment protocol, the performance was similar for both treated lists. The percentage improvement was alike for both lists after the first week of therapy (List A=20.0%; List B=23.3%) and at the end of treatment (List A=46.7%; List B=40.0%), and this improvement was substantially higher than for list D (0.0% and 6.7%, respectively).

Figure 3. Progression of performance in naming attempts recorded during therapy sessions

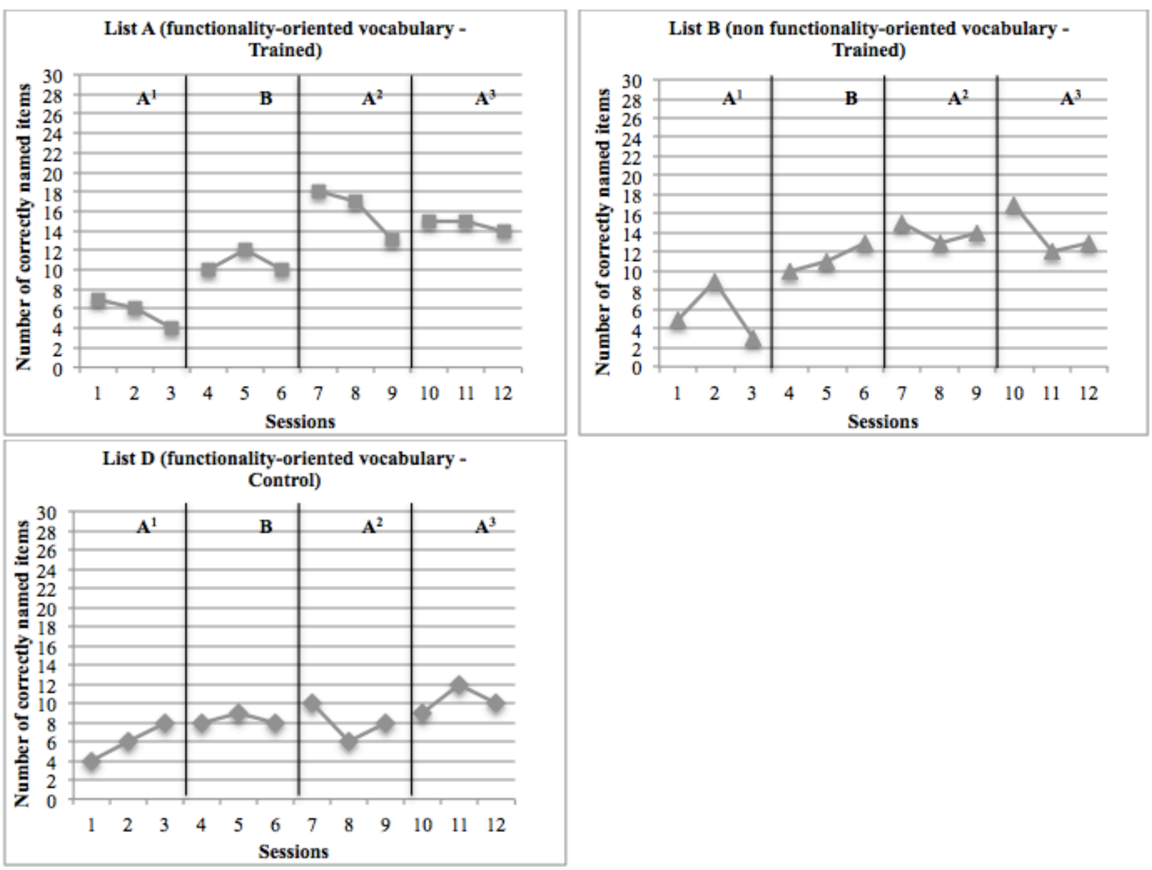


Statistical analyses

For lists A and B, a significant improvement was found at the end of the treatment (Tau-*U*=1, *p*=.0495 for both) and this was maintained two months post-treatment (Tau-*U*=-.33, *p*=.51; Tau-*U*=-.22, *p*=.66, respectively). No significant difference was found between baseline and post-treatment for list D (Tau-*U*=.56, *p*=.28).

All lists were equivalent according to naming performance at baseline (Kruskal-Wallis $X^2(2)=.01$, *p*=.99). Outcomes for lists A and B were compared and no significant difference in performance was found post-treatment (Mann-Whitney U=413, *p*=.57) and at maintenance (Mann-Whitney U=438, *p*=.85).

Figure 4. P.R.'s performance for each list across treatment protocol



A¹= Baseline; B= Treatment (week 1, 2 and 3), A²= Post-treatment; A³= Maintenance (2 weeks, 1 month, 2 months)

Case 2: S.T.

Visual analyses

As shown in Figure 3B, S.T.'s naming performance recorded during therapy sessions for lists A, B and C gradually improved until session 4 and was more variable thereafter, especially for lists A and B. Performance for lists A, B and C was similar until session #11, but was better for list B in subsequent sessions.

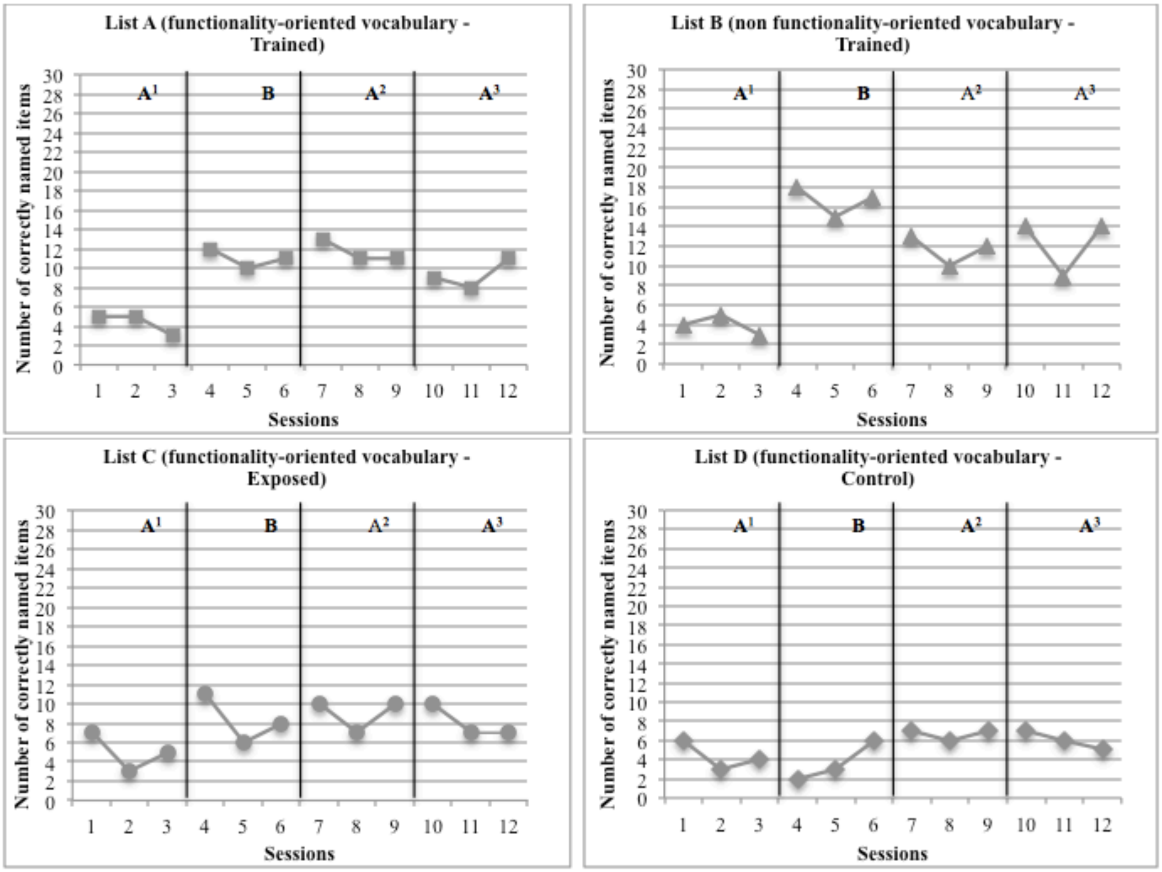
S.T.'s performance on each list across the whole treatment protocol is shown in Figure 5. For list A, a change was observed between baseline (A^1) and treatment (B). The performance level was stable for subsequent phases. For list B, an improvement in performance was also observed between baseline (A^1) and treatment (B). A more subtle decline was also present between treatment (B) and post-treatment (A^2). For lists C and D, no clear change was observed. Performance for list B was better in the treatment phase (B), but similar to that of list A post-treatment and at maintenance. The percentage improvement was higher for list B after the first week of therapy (List A=30.0%; List B=50.0%), but equivalent for both lists at the end of the treatment (33.3%).

Statistical analyses

A significant improvement was found for lists A (Tau-*U*=1, *p*=.0495) and B (Tau-*U*=1, *p*=.0495) at the end of the treatment, while no difference was found for lists C (Tau-*U*=.89, *p*=.08) and D (Tau-*U*=.89, *p*=.08). For both lists A and B, this improvement was maintained 2 months post-treatment (Tau-*U*=-.78, *p*=.13; Tau-*U*=.33, *p*=.51, respectively).

All lists were equivalent according to naming performance at baseline (Kruskal-Wallis $X^2(3)=.33$, *p*=.96). No significant difference in performance between lists A and B was found post-treatment (Mann-Whitney U=441, *p*=.89) and at maintenance (U=375, *p*=.24).

Figure 5. S.T.'s performance for each list across treatment protocol



A[1]= Baseline; B= Treatment (week 1, 2 and 3), A[2]= Post-treatment; A[3]= Maintenance (2 weeks, 1 month, 2 months)

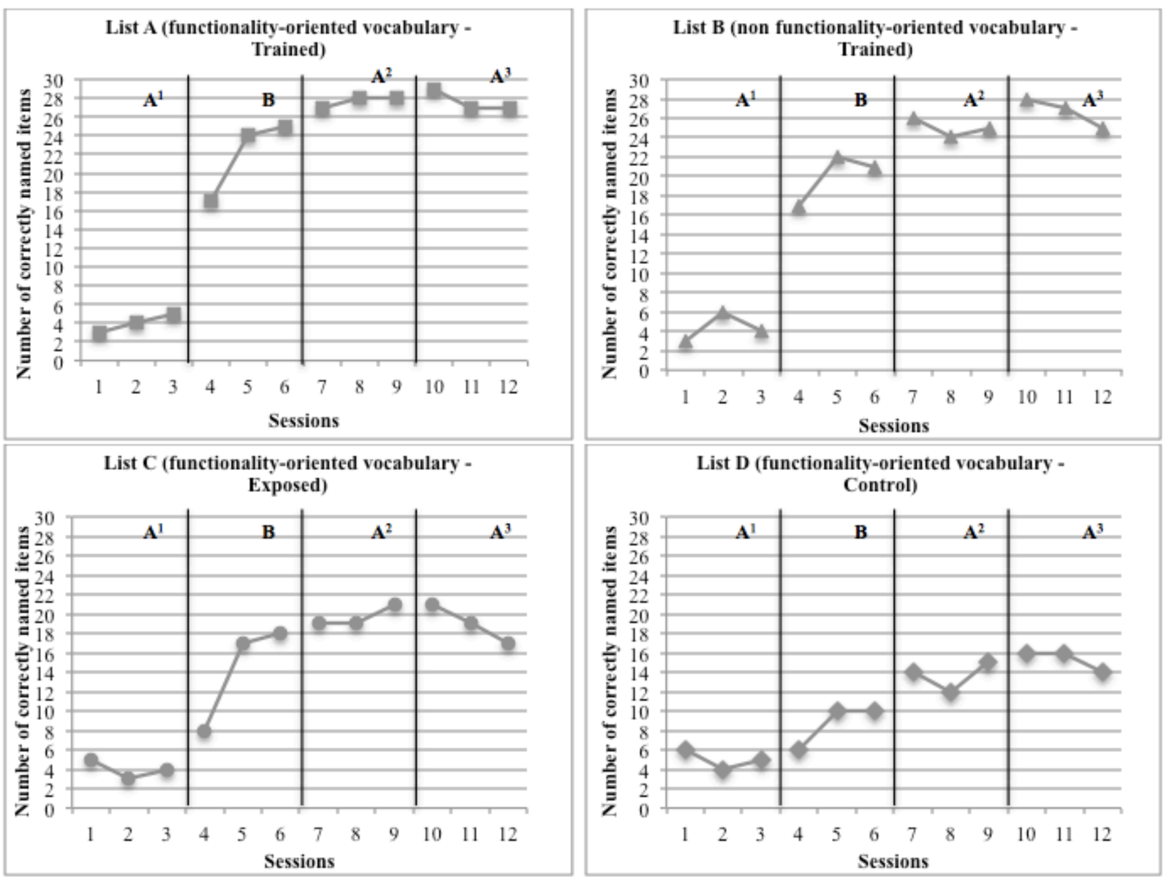
Case 3: L.M.

Visual analyses

As shown in Figure 3C, most of the improvement recorded during therapy sessions took place in the first half of treatment (sessions #1 to #8) for all lists. In the second half, performance was stable for list A, while some variation was observed for lists B and C. Over the course of treatment, performance was consistently better for list A than list B.

L.M.'s performance on each list across the whole treatment protocol is shown in Figure 6. For lists A, B and C, a clear improvement was observed between baseline (A[1]) and treatment (B). For list B, an improvement was also present between treatment (B) and post-treatment (A^2). A more subtle change between baseline (A1) and treatment (B), as well as between treatment (B) and post-treatment (A^2), was observed for list D. Performance was slightly better for list A at each phase of the treatment protocol, followed by list B, list C and finally list D. The percentage change, however, was similar for lists A and B after the first week of treatment (List A=40.0%; List B=43.3%) and equivalent at the end at treatment (73.3%), followed by list C (13.3% and 50.0%, respectively) and list D (3.3% and 30.0%, respectively).

Figure 6. L.M.'s performance for each list across treatment protocol



A^1= Baseline; B= Treatment (week 1, 2 and 3), A^2= Post-treatment; A^3= Maintenance (2 weeks, 1 month, 2 months)

Statistical analyses

For all lists, a significant improvement was found post-treatment (List A: Tau-*U*=1, *p*=.0495; List B: Tau-*U*=1, *p*=.0495; List C: Tau-*U*=1, *p*=.0495; List D: Tau-*U*=1, *p*=.0495). Moreover, this improvement was maintained two months post-treatment for all lists (List A: Tau-*U*=-.11, *p*=.83; List B: Tau-*U*=.67, *p*=.19; List C: Tau-*U*=-.22, *p*=.66; List D: Tau-*U*=.67, *p*=.19).

All lists were equivalent according to naming performance at baseline (Kruskal-Wallis $X^2(3)=.19$, *p*=.98). Outcomes for all lists were also compared and a significant difference in performance was found between the lists post-treatment ($X^2(3)=22.76$, *p*<.001) and at maintenance ($X^2(3)=27.89$, *p*<.001). For the post-treatment phase, post-hoc analyses showed a significant difference in performance between list A and list C (Mann-Whitney U=21.47, *p*=.04) as well as between list A and list D (Mann-Whitney U=35.07, *p*<.001), both in favour of list A. A significant difference in performance was also found between list B and list D (Mann-Whitney U=27.33, *p*=.003), in favour of list B. At maintenance, list A was significantly better than list C (Mann-Whitney U=23.87, *p*=.01) and D (Mann-Whitney U=34.33, *p*<.001). A significant difference was also found between list B and list C (Mann-Whitney U=22.47, *p*=.03), as well as between list B and list D (Mann-Whitney U=32.93, *p*<.001), in favour of list B.

Case 4: C.G.

Visual analyses

Progression of C.G.'s naming performance for each list recorded during therapy sessions is shown in Figure 3D. For lists A and B, performance improved until session #8. For list C, performance progressed until session #11, then stabilised over the last week of treatment. The magnitude of the improvement across the therapies was similar for both treated lists, but smaller for list C. However, at the end of treatment, performance was stable for list A, while much more variability was observed for list B.

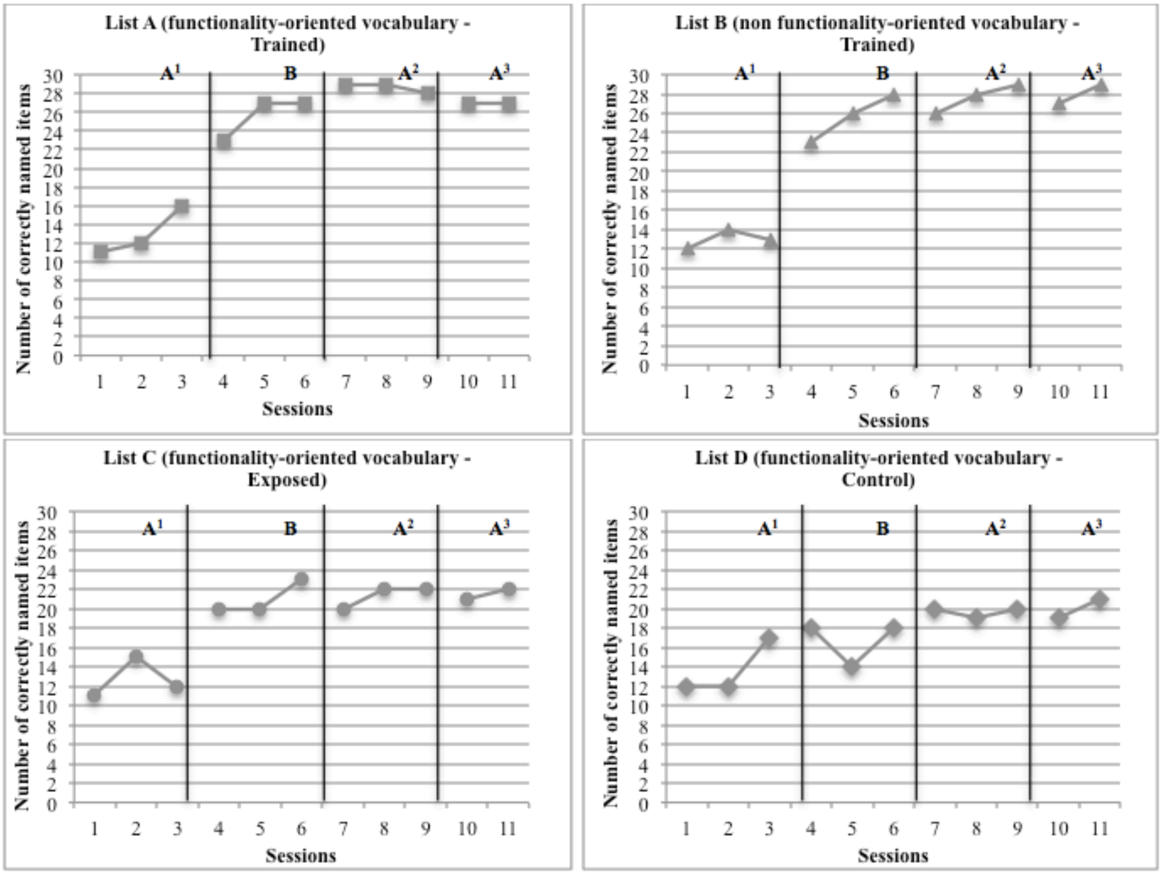
C.G.'s performance for each list across the whole treatment protocol is shown in Figure 7. For lists A and B, an improvement was observed between baseline (A^1) and treatment (B), and the performance level was stable for the subsequent phases. A smaller increase was observed between baseline (A^1) and treatment (B) for list C. Finally, for list D, a trend toward improvement was observed throughout the phases. During the treatment protocol, performance at each phase was similar for lists A and B. However, the percentage improvement was slightly higher for list B (33.3%) than for list A (23.3%) between baseline and the first week of treatment. However, at the end of treatment, the percentage change was the same for both lists (43.3%). The percentage change was smaller for list C (26.7% after the first week and at the end of treatment) and for list D (3.3% and 10.0%, respectively).

Statistical analyses

For all lists, a significant improvement was found post-treatment (List A: Tau-U=1, p=.0495; List B: Tau-U=1, p=.0495; List C: Tau-U=1, p=.0495; List D: Tau-U=1, p=.0495). Moreover, gains were maintained up to two months (List A: Tau-U=-1, p=.08; List B: Tau-U=.17, p=.77; List C: Tau-U=0, p=1; List D: Tau-U=.17, p=.77).

All lists were equivalent according to naming performance at baseline (Kruskal-Wallis $X^2(3)$=.11, p=.99). However, a significant difference in performance was found between the lists at post-treatment ($X^2(3)$=15.04, p=.002) and at maintenance ($X^2(3)$=9.49, p=.02). At post-treatment, a significant difference in performance was found between list A and list D (Mann-Whitney U=22.33, p=.005), in favour of list A, and between list B and list D (Mann-Whitney U=18.87, p=.03), in favour of list B. At maintenance, the pairwise comparisons adjusted for multiple tests showed no significant differences between the lists.

Figure 7. C.G.'s performance for each list across treatment protocol



A^1= Baseline; B= Treatment (week 1, 2 and 3), A^2= Post-treatment; A^3= Maintenance (1 month, 2 months)

Changes in conversation

The percentage of anomia for each participant (number of unsuccessful productions/ number of possibilities to produce the word x 100) pre- and post-treatment is presented in Table 4. For the scoring of the unsuccessful productions, the overall interrater agreement corresponded to a Cohen's k of 0.844 (84%), which constitutes almost perfect agreement. After disagreements were resolved by discussion, the agreement reached 100%.

Table 4. Percentage of anomia in conversation (number of unsuccessful productions/number of production possibilities) for each list pre- and post-treatment

	P.R.		**S.T.**		**L.M.**		**C.G.**	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
List A								
% Anomia	4/12 (33.3)	1/3 (33.3)	0/1 (0.0)	1/2 (50.0)	10/15 (66.7)	1/11 (9.1)	0/6 (0.0)	0/12 (0.0)
List B								
% Anomia	0/3 (0.0)	0/13 (0.0)	2/5 (40.0)	0/2 (0.0)	3/13 (23.1)	2/15 (13.3)	3/16 (18.8)	0/27 (0.0)
List C								
% Anomia	-	-	0/0 (0.0)	0/0 (0.0)	2/6 (33.3)	0/1 (0.0)	1/13 (7.7)	0/7 (0.0)
List D								
% Anomia	1/1 (100.0)	2/5 (40.0)	0/1 (0.0)	1/1 (100.0)	2/4 (50.0)	0/3 (0.0)	1/8 (12.5)	4/13 (30.8)
Total								
% Anomia	5/16 (31.3)	3/21 (14.3)	2/7 (28.6)	2/5 (40.0)	17/38 (44.7)	3/30 (10.0)	5/43 (11.6)	4/59 (6.8)

Overall, a decrease in the total percentage of anomia was observed for all participants, except for S.T. for whom it increased slightly. For P.R., the percentage of anomia remained the same for the trained words (lists A and B). A slight decrease in anomia was observed post-treatment for list D, but this cannot really be interpreted given the small number of production possibilities. For S.T., the small number of production possibilities made interpretation of the results impossible since each percentage is based on seven or less production possibilities. For L.M., the overall percentage of anomia went from 44.7% pre-treatment to 10.0% post-treatment. For lists A and B, the percentage decreased post-treatment, with a relatively stable number of production possibilities. For lists C and D, a decrease was also present, but the results must be interpreted cautiously given the small number of production possibilities. Finally, for C.G., the percentage of anomia was relatively low pre-treatment. However, it decreased from 11.6% to 6.8% post-treatment. Moreover, at the end of the treatment, anomia was observed for items on the control list only, for which the percentage of anomia increased.

DISCUSSION

The main aim of this study was to investigate the efficacy of a self-administered treatment using a smart tablet to improve naming of functional words in post-stroke aphasia. The specific objectives were to: 1) compare efficacy and maintenance of the treatment for functionality-oriented vocabulary vs non functionality-oriented vocabulary, and 2) investigate generalisation of the trained words in an ecological conversation task.

Four participants completed the treatment protocol with a high compliance rate. In all cases, the treatment, self-administered four times a week for four weeks, led to a significant improvement in naming for the trained words that was maintained two months post-treatment. These results are in line with a recent systematic review conducted by our research team (Lavoie et al., 2017) showing the efficacy of technologies in the treatment of post-stroke anomia, as well as maintenance of the gains. In the present study, the treatment led to a significant improvement of trained words, regardless of the functional origin of anomia (i.e. lexical-semantic for P.R. and lexical for S.T., L.M. and C.G.). As cited in Nickels (2002b), semantic treatment can be used in the context of altered semantic processing but also to improve lexical access in the case of well-preserved semantic processing.

Only very few studies have used a smart tablet in post-stroke anomia (Kurland, Wilkins, & Stokes, 2014; Lavoie, Routhier, Légaré, & Macoir, 2016; Routhier, Bier, & Macoir, 2016) and positive outcomes were reported. The present treatment study is, however, the first using a smart tablet to focus on functional vocabulary.

In this study, generalisation to exposed items as well as untrained items was observed in two participants, L.M. and C.G. In the literature, most researchers found little or no generalisation to untrained items (e.g., Fillingham, Sage, & Lambon Ralph, 2006; Thompson, Kearns, & Edmonds, 2006) and instead reported item-specific effects (i.e. only the trained words improved). However, generalisation to semantically related words may occur, based on the spreading effect theory of semantic processing (Collins & Loftus, 1975), according to which activating the semantic network surrounding a target word is likely to facilitate the activation of related concepts. In our study, since the functional words were chosen based on relevant topics for the participants, many of the words in lists A, C and D were semantically related, which could explain this generalisation to untrained items. For example, for L.M., relearning the word “mustard” (List A – Trained), led to the reactivation of the words “mayonnaise” (List C – Exposed) and “ketchup” (List D – Control), which are closely semantically related. In C.G., generalisation to words that were exposed but not trained is likely to have been influenced by his type of anomia. Indeed, many of his errors in the baseline measures were phonological. Therefore, for items in list C, the repeated attempts at picture naming may have allowed him to improve his production and reach the target (Nickels, 2002c).

The results of this study regarding reinvestment of the trained words in connected speech are in line with the few studies that investigated the issue and found evidence of generalisation of the treatment effects for trained words to narrative/procedural discourse (e.g. Conroy et al., 2009; Rider et al., 2008) and to conversation (Mason et al., 2011). Before this study, only Mason et al. investigated generalisation of the treatment effects for specific functional words to an ecological conversation task and obtained positive outcomes for one of the three participants only. In our study, a decrease in anomia for the words trained with the smart tablet was found following treatment in two of the four participants (L.M. and C.G.), suggesting that they could more easily retrieve those words in a task very similar to a conversation in a real-life setting. However, one limitation of this task is that the topics discussed with the participants were relatively general (e.g., cooking, gardening) so that opportunities to produce the target words during the twenty minutes of conversation could be very limited, which could explain the absence of generalisation for P.R. and S.T. The cognitive profile of the participants could also explain the capacity to generalise the effects of the treatment to another context. The two participants for whom there was generalisation to untrained items and to conversation were also the ones who made the most improvement in picture naming following treatment. Moreover, those two participants had spared executive functions along with excellent metacognition and awareness of their deficits.

The present study is also the first to compare treatment outcomes for non functionality-oriented vocabulary, coming from picture databases, to functionality-oriented vocabulary, that is words chosen based on the participant’s activities and interests, in the treatment of post-stroke anomia. In this study, a significant improvement for trained words of both types of vocabulary was found for all participants, which is in line with findings from our systematic review (Lavoie et al., 2017). For all participants, no statistical difference was found between list A (functionality-oriented vocabulary) and list B (non functionality-oriented vocabulary) post-treatment and at maintenance, suggesting that the treatment was equally effective and could result in long-term improvement. Moreover, for all participants, the percentage improvement from baseline to the end of the first week of treatment and from baseline to the end of treatment was roughly equivalent for both lists. Obviously, these observations are preliminary and the study should be replicated with a larger number of participants. On the other hand, since generalisation may occur in conversation, the advantage of targeting useful words for the participant appears clear from a clinical point of view.

Technology seems a promising approach for the management of post-stroke aphasia, particularly in the current context where SLT is very limited for people with chronic aphasia. In the present study, the use of a self-administered treatment using a smart tablet allowed for intensive training (four times a week), which would not have been possible with public services. Moreover, the participants said they enjoyed staying at home to do the treatment and being able to divide the treatment sessions into two or three parts during the day in order to minimise fatigue. Several factors were taken into account in the design of the application to maximise the success of the treatment: 1) “aphasia-friendly” interface (e.g., short and simple information); 2) self-administered treatment inspired by SFA, a treatment with well-demonstrated efficacy (e.g., Maddy et al., 2014); 3) integration of essential components of a processing-oriented treatment (e.g., feedback, effective modelling). The protocol was also designed to maximise success. First, before beginning the therapy, the participants had personal training until they felt ready to use the tablet without help. They were also given a reference paper guide with illustrated steps and simple instructions. This part of the protocol is crucial and has proven effective in previous studies by our research team (Lavoie et al., 2016; Routhier et al., 2016). The weekly measurement of progression also ensured regular contact with the clinician, a factor that may be associated with success in self-administered treatments using a smart tablet (Kurland et al., 2014).

The experimental design used was rigorous and everything was designed to have the greatest internal validity possible: use of three measures for baselines, use of four equivalent treatment lists, conversation task conducted by a blind experimenter, interrater agreement for scoring the conversation task, etc. However, there are also some limitations to take into account, the most important being the small number of participants in the study. Thus, results must be interpreted with caution and the study should be replicated with more participants to increase external validity. Another limitation is the duration of the treatment. For three participants, each therapy lasted between 60 to 90 minutes, which is relatively long, especially for people with chronic aphasia, who may tire more easily. This limitation was unavoidable in the research context (i.e. two trained lists + exposed and control lists) whereas in a clinical setting, only one list of trained functional words and a control list would be necessary. Finally, although precise instructions were given to the participants and their family members, self-administered treatments allowed less control over the environment in which the therapy was done.

To conclude, the therapeutic possibilities of smart tablets, under the guidance of a skilled clinician, are numerous and their potential is unquestionable, especially to overcome limitations in the current health system. Moreover, by specifically targeting vocabulary that is relevant for each patient, this type of therapy may result in significant changes in daily communication, thus helping to improve the quality of life and social relationships of people with aphasia.

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Chapitre 5. Étude expérimentale: Rééducation de mots fonctionnels en APP

Étude 3. Improvement in functional vocabulary and generalization to conversation following a self-administered treatment using a smart tablet in primary progressive aphasia

Lavoie, M., Bier, N., Laforce Jr, R., & Macoir, J. (2018). Improvement of functional vocabulary and generalization to conversation following a self-administered treatment by smart tablet in primary progressive aphasia (en révision pour *Neuropsychological Rehabilitation*)

Résumé

INTRODUCTION: L'aphasie primaire progressive (APP) est une maladie neurodégénérative affectant principalement le langage. Les services actuels en orthophonie pour cette population sont très limités, même si l'efficacité de plusieurs interventions a été démontrée dans les écrits scientifiques. Dans ce contexte, les nouvelles technologies ont le potentiel de permettre aux personnes qui souffrent d'APP d'améliorer leurs compétences communicationnelles via des traitements auto-administrés, contribuant ainsi à améliorer leur qualité de vie et leurs relations sociales. L'objectif principal de cette étude était donc d'évaluer l'efficacité d'une thérapie auto-administrée via tablette électronique pour l'amélioration de mots fonctionnels et de mesurer la généralisation dans une tâche écologique de conversation. Un second objectif était de comparer cette approche à une approche plus classique, dans laquelle les mots rééduqués proviennent de banques d'images, en termes d'efficacité, de maintien et de généralisation.

MÉTHODE: Cinq participants présentant une APP (vsAPP = 2; vlAPP = 3) ont complété l'étude. À l'aide d'un devis de type ABA avec lignes de base multiples, la performance en dénomination a été comparée pour quatre listes équivalentes: 1) traitée, comprenant des mots fonctionnels choisis avec le participant; 2) traitée, comprenant des mots choisis selon une approche classique « non fonctionnelle »; 3) exposée, mais non traitée; 4) non exposée (contrôle). Le traitement a été auto-administré à la maison, à raison de quatre fois par semaine durant quatre semaines.

RÉSULTATS: À la suite de la thérapie, une amélioration significative pour les mots traités a été observée chez tous les participants ainsi qu'un maintien des gains deux mois après son arrêt chez quatre d'entre eux. De plus, une généralisation en conversation a été observée chez trois des cinq participants.

DISCUSSION: Les résultats de cette étude suggèrent l'efficacité de la tablette électronique pour l'amélioration de la dénomination en APP et la possibilité de généraliser les gains du traitement en contexte écologique. Davantage d'études seront nécessaires afin de confirmer ces résultats et de mieux comprendre les caractéristiques individuelles associées au succès dans un tel type de traitement.

Abstract

BACKGROUND: Primary progressive aphasia (PPA) is a neurodegenerative disorder primarily affecting language. Currently, public services in speech-language pathology for PPA are very limited, although several interventions have been shown to be effective. In this context, new technologies have the potential to enable people with PPA to improve their communication skills. The main aim of this study was to investigate the efficacy of a self-administered therapy using a smart tablet to improve naming of functional words and to assess generalization to an ecological conversation task.

METHODS: Five adults with PPA completed the protocol. Using an ABA design with multiple baselines, naming performance was compared across four equivalent lists: 1) trained with functional words; 2) trained with words from a picture database; 3) exposed but not trained; and 4) not exposed (control). Treatment was self-administered four times a week for a period of four consecutive weeks.

RESULTS: A significant improvement for trained words was found in all five participants, and gains were maintained two months post-treatment in four of them. Moreover, in three participants, evidence of generalization was found in conversation.

DISCUSSION: This study supports the efficacy of using a smart tablet to improve naming in PPA and suggests the possibility of generalization to an ecological context. More studies are needed to confirm these results and clarify which individual characteristics are associated with treatment success.

INTRODUCTION

Primary progressive aphasia (PPA) was introduced into modern literature by Mesulam in 1982 as a "slowly progressive aphasia", that is, a progressive disorder restricted to language. In subsequent years, several authors described variants of PPA (e.g., Grossman et al., 1996; Hodges, Patterson, Oxbury, & Funnell, 1992; Snowden, Goulding, & Neary, 1989), generally categorized as semantic dementia (fluent PPA) and nonfluent PPA. A third variant, logopenic PPA, was proposed by Gorno-Tempini et al. (2004) to describe cases in the literature that did not fit the previous binary classification. More recently, Gorno-Tempini et al. (2011) provided a common framework to facilitate diagnosis of the three variants of PPA. Generally speaking, a diagnosis of PPA can be made when the predominant and first clinical symptom is a progressive impairment of language, without impairment of other cognitive domains for at least the first two years of the disease. The authors provided specific diagnostic features for the three variants of PPA. In summary, the semantic variant (svPPA) is characterized by an impairment of semantic memory that causes difficulties in all tasks involving semantic knowledge (e.g., comprehension, word retrieval, object recognition). This variant is associated with significant anterior temporal lobe atrophy. The nonfluent/agrammatic variant (nf/aPPA) is characterized by agrammatism and/or apraxia of speech. Comprehension of syntactically complex sentences is often impaired. This variant is associated with atrophy in the left posterior-frontal/insular region. Finally, the logopenic variant (lvPPA) is characterized by word-finding difficulties and impaired repetition of sentences with a clearly deleterious effect of length. This variant is associated with predominantly left posterior perisylvian or parietal atrophy and its underlying pathology is most often Alzheimer's disease. Only participants with svPPA and lvPPA were included in this study. Currently, in Canada, patients receive their diagnosis of PPA after an extensive examination by a neurologist in a hospital or specialized clinic. Other health professionals, such as neuropsychologists and speech-language pathologists, can contribute to the differential diagnosis. Once diagnosis is made, an annual follow-up is carried out with the patient. However, although language is the core symptom of the disease, long-term services in speech-language pathology (SLP) are extremely limited for this population.

Among the language difficulties found in PPA, anomia is often the first symptom reported by patients and the most disturbing. Anomia has been described as difficulty retrieving a specific word at the right time (Goodglass, 2001). It occurs in conversation as well as in specific tasks involving word-finding (e.g., naming, picture description). The manifestations of anomia may include non-responses, delays, production of semantic paraphasias (i.e., substitution of the target word by a word that is semantically related; e.g., pear → apple) or phonological paraphasias (i.e., production of a phonological error within the word; e.g., apple → papple). According to cognitive models of spoken production (Caramazza, 1997), a series of specialized and interconnected components must be activated in order to produce a specific word. First, the concept corresponding to the word is activated in semantic memory, a long-term memory that stores conceptual knowledge about words, objects, etc. The corresponding phonological representation is then retrieved in the phonological output lexicon, a long-term memory encoding the phonological representations of words. This phonological representation is maintained in the phonological output buffer, also known as phonological working memory, allowing the motor processes to prepare for the production of the word. In svPPA, the primary cause of anomia is impairment to the semantic memory, while in lvPPA, anomia is mostly caused by an impairment of the phonological buffer, which results in difficulty maintaining the sequence of sounds correctly.

In the traditional treatment of anomia, clinicians provide cues (i.e., semantic, phonological, or orthographic) to help retrieve or reactivate specific words. For example, Semantic Feature Analysis (SFA; Boyle & Coelho, 1995) is a treatment in which the participant has to produce semantic features of a target item (e.g., category, location, use) in order to facilitate its retrieval, based on the spreading activation theory of semantic processing (Collins & Loftus, 1975). SFA also includes a phonological component since when the participant has been unable to name the object after evoking all its semantic features, the clinician produces the correct answer and asks him/her to repeat it. The effectiveness of SFA has been clearly demonstrated in the literature for post-stroke anomia, regardless of the origin of the deficit with regard to components of the cognitive models described above (e.g., Coelho, McHugh, & Boyle, 2000; Maddy, Capilouto, & McComas, 2014). Although this treatment was initially designed for post-stroke aphasia, it could be well suited for people with svPPA and lvPPA. For svPPA, SFA could help to relearn and maintain semantic knowledge about the target word, thus facilitating its subsequent access (Collins & Loftus, 1975), in addition to strengthening the access to the word phonological form. In their review on anomia treatment in PPA, Jokel, Graham, Rochon and Leonard (2014) concluded that participants with svPPA could show significant improvement following both a semantic-based treatment and a phonological-based treatment. Indeed, in many studies conducted with svPPA participants, treatments including both a semantic and a phonological component led to a significant improvement in naming (e.g., Jokel, Rochon, & Anderson, 2010; Macoir, Leroy, Routhier, Auclair-Ouellet, Houde, & Laforce, 2015; Savage, Piguet, & Hodges, 2014). In lvPPA, even if semantic knowledge is well preserved, semantic processing performed on the word before trying to retrieve it (i.e., evoking semantic features of the word) could also facilitate its subsequent access. In post-stroke aphasia, there is evidence that semantic tasks can improve word production even when semantic processing is intact (Nickels, 2002). Beeson et al. (2011) used SFA in a participant with lvPPA and obtained positive outcomes.

Literature reviews on non-pharmacological therapies for language deficits in PPA show that anomia has received the most attention (Gravel-Laflamme, Routhier, & Macoir, 2012; Routhier, Gravel-Laflamme, & Macoir, 2013; Jokel et al., 2014). In a recent systematic review, Cadório, Lousada, Martins and Figueiredo (2017) confirmed the efficacy of word-finding therapy in the three variants of PPA. Results regarding generalization to untrained items, generalization to other tasks and maintenance, however, were mixed. For svPPA, these authors concluded that relearning was context-dependent and greatly supported by episodic memory. Improvement is often limited to treated items, thus compromising generalization to untrained vocabulary. Nevertheless, in various studies conducted with participants with svPPA, some elements were found to improve generalization to untrained items, such as implementation early in the disease course (Henry et al., 2013), and generalization to other contexts, such as random presentation of the items, and use of different versions of the target items (Bier et al., 2009; Stark, Stark, & Gordon, 2005). As for maintenance, longer intervention and higher dosage were associated with better outcome (Cadório et al., 2017). Compared to svPPA, fewer studies were conducted with participants with lvPPA and any conclusions, therefore, must be interpreted cautiously. In this variant, Cadório et al. (2017) reported generalization to untrained items as well as generalization to untrained tasks. Maintenance was found up to six months post-treatment. For all subtypes of PPA, continued practice was cited as a way to achieve long-term maintenance.

Only a few studies investigated generalization to connected speech and the results were mixed. In some studies, evidence of generalization to discourse was found. For example, Beeson et al. (2011) reported more efficient lexical retrieval in a picture description task following a treatment based on SFA with a participant with lvPPA. Savage et al. (2014) reported improvement in a video description task in four of five participants with svPPA following a two-months online computer program involving written/spoken word-picture association and repetition. Following a self-cueing treatment including phonological, orthographic and semantic cues, Beales, Cartwright, Withworth and Panegyres (2016) obtained a significant increase of correct information units in discourse in three svPPA participants, but no change for the participant with lvPPA. However, an absence of generalization was also reported in some studies. Jokel et al. (2010) found no generalization to a sentence production task based on an action picture description with one individual with svPPA. Moreover, Croot et al. (2015) found no improvement in structured interviews using trained words with two individuals with nf/aPPA and lvPPA. To our knowledge, no study investigated generalization to a more ecological task such as conversation.

Meaningfulness and familiarity of the target words have been mentioned as having a positive effect on treatment success (Jokel, Rochon, & Leonard, 2006; Snowden & Neary, 2002), in relation, among others, to the residual semantic knowledge and contextual information being more available for significant and familiar words. To our knowledge, no study investigated the impact of those variables on generalization to other contexts. However, it is likely that choosing words to be trained based on the participant's activities and interests is the best way to achieve generalization to ecological contexts, which is the ultimate goal of anomia treatment. Nevertheless, in most studies conducted with people with PPA, pictures were selected from databases (e.g., Peabody Picture Collection), regardless of their relevance to participants. In only a few studies, words were selected according to their significance to participants (e.g., Bier et al., 2011; Evans, Quimby, Dickey, & Dickerson, 2016; Villanelli, Russo, Nemni, & Farina, 2011). For example, Evans et al. (2016) used a computer-based flashcard program for relearning personally-relevant words with a participant with svPPA and showed relearning and retention of the trained words. To our knowledge, no study compared treatment success and generalization to untrained items and to other contexts for words from generic databases vs. personally relevant words.

In the last decade, the use of technology in SLP has grown significantly. Some studies investigated the use of technology to improve naming in PPA (e.g., Bier et al., 2015; Croot et al., 2015; Henry et al., 2013; Jokel, Cupit, Rochon, & Leonard, 2009; Jokel et al., 2010; Meyer, Getz, Brennan, Hu, & Friedman, 2016; Savage et al., 2014). For example, Jokel et al. (2010) improved word retrieval for the items treated with the MossTalk Words® program, using errorless learning with repetition and picture description, in a participant with svPPA. Savage et al. (2014) used a home-based online treatment with a program consisting of picture-word matching and repetition, with five participants with svPPA. After eight weeks of practice (five sessions of 30 minutes/week), their results showed a clear gain in naming for the trained pictures as well as generalization to different tasks. Among the few studies retrieved that used technology, none was conducted with a smart tablet.

The main aim of this study was therefore to investigate the efficacy of a self-administered treatment using a smart tablet to improve naming of functional words in svPPA and lvPPA. The second objective was to compare this approach in which words are selected according to the participants' interests to a more common approach, in which trained words come from a picture database, in terms of efficacy, maintenance, and generalization to untrained items. Finally, the third objective was to examine generalization of the treatment effects to an ecological conversation task.

METHODS AND MATERIALS

This single-case series used an ABA design with multiple baselines across four lists of words. The study was conducted in three phases: 1) baselines (A^1), including measures of naming and conversation before treatment; 2) treatment (B), comprising training with the smart tablet and self-administered treatment; and 3) post-intervention (A^2) and maintenance (A^3) measures.

Participants

Five adults with a diagnosis of PPA took part in the study. Sociodemographic information is presented in Table 5. Recruitment was done in collaboration with a neurologist (RLJ) from the *Clinique interdisciplinaire de mémoire* at *Hôpital de l'Enfant-Jésus* and speech-language pathologists from the *Clinique d'enseignement en orthophonie* at *Université Laval.* To be included in the study, participants had to: 1) be diagnosed with PPA using Gorno-Tempini et al.'s (2011) criteria and undergone structural brain imaging to support the probable clinical diagnosis; 2) present moderate to severe anomia for nouns (z score ≤ -2 at the TDQ-60, Macoir, Beaudoin, Bluteau, Potvin, & Wilson, 2017); and 3) live at home. Exclusion criteria were: 1) moderate or severe receptive impairment that could interfere with understanding the experimental tasks (score < 30/47 at the MT-86 words and sentences -to- picture matching task, Nespoulous et al., 1992); 2) moderate or severe apraxia of speech or dysarthria (determined by the clinical observations made during assessment); 3) non-corrected visual or hearing impairment; 4) severe visual agnosia (score <17/30 at the BORB Object Decision task, Riddoch & Humphreys, 1993); 5) psychiatric disorders; and 6) illiteracy. Prior to the study, an exhaustive neuropsychological and language assessment was conducted with all participants to verify compliance with the inclusion/exclusion criteria and establish a comprehensive cognitive profile (see Table 5).

Table 5. Participants' sociodemographic characteristics and summary of neuropsychological and language assessments

	GT	MS	CL	AV	RD
1) Sociodemographic characteristics					
- Age (years)	66	75	69	80	71
- Gender	F	M	M	F	F
- Handedness	R	R	R	R	R
- Education (years)	14	22	11	16	13
- Diagnosis	sv	sv	lv	lv	lv
1) Neuropsychological tests					
Visual episodic memory/working memory					
DMS-48 (/48)					
- Immediate recognition	37*	43	ND	44	48
- Delayed recognition	38	43	46	45	47
Digit span - WAIS					
- Forward span	6	4*	6	5	4*
- Backward span	5	4	3*	4	5
Corsi block-tapping test					
- Forward span	5	4*	4*	4*	5
- Backward span	5	3*	2*	4	5
Executive functions					
Trail Making Test (time, seconds)					
- A	51	53	69*	59	42
- B	69	226*	281*	345*	110
Visuoperceptual abilities					

BORB					
- Length match task (/30)	29	28	14*	25	24
- Object decision B - Easy (/32)	21*	26*	30	22*	29
Praxis					
Brief praxis evaluation battery					
- Production of symbolic gestures (/5)	3*	2*	2*	2*	4
- Imitation of actions (/10)	8	6*	10	9	8*
- Imitation of abstract gestures (/8)	8	2*	6	6*	7
2) Language and semantic knowledge tests					
Oral comprehension					
- Words - BECLA (/20)	15*	18*	20	18*	20
- Words and sentences - MT-86 (/47)	46	44	46	44	45
- Instructions - MT-86 (/8)	7	5*	6*	8	8
Lexical decision - BECLA					
- Spoken modality (/20)	20	20	20	13*	20
- Written modality (/20)	18*	20	13*	14*	19
Oral expression					
Picture naming					
- TDQ-60 (/60)	25*	48*	30*	ND	50*
- BECLA (/20)	12*	15*	11*	12*	18
Repetition - BECLA					
- Words (/15)	15	15	15	9*	15
- Nonwords (/10)	10	9	10	6*	10
Reading aloud - BECLA					
- Words (/10)	10	9*	6*	10	8*
- Nonwords (/10)	10	10	2*	10	9*
Written expression					
Written spelling to dictation - BECLA					
- Words (/20)	17*	15*	15*	18	16*
- Nonwords (/10)	10	8	7	3*	5*
Written picture naming – BECLA (/20)	12*	15*	ND	11*	18
Semantic knowledge					
Semantic picture matching					
- Pyramids and Palm Trees Test (/52)	33*	37*	49	45	49
- BECLA (/20)	8*	16*	20	17*	19
Written word matching - BECLA (/20)	11*	17*	18	15*	19

Note: *Indicates a score below the norm (≥ 2 SD) or below the 5th percentile; sv: semantic variant of primary progressive aphasia; lv: logopenic variant of primary progressive aphasia; ND: Not or partially done due to difficulties; DMS-48: Visual recognition memory test; WAIS: Wechsler Adult Intelligence Scale; BORB: Birmingham Object Recognition Battery; BECLA: Batterie d'Évaluation Cognitive du Langage chez l'Adulte; MT-86: Protocole Montréal-Toulouse d'examen linguistique de l'aphasie; TDQ-60: Test de dénomination de Québec,

Case 1: G.T.

G.T. is a 66-year-old right-handed woman with 14 years of education. She worked as a nurse prior to retiring five years ago. She lives alone and has two children. She is very active and has numerous hobbies such as bike riding, cross-country skiing, reading and traveling. G.T. is independent for her activities of daily living but reported needing occasional help from her daughter, who is very involved. About six months prior to enrolment, she received a diagnosis of svPPA based on a neurological examination, including an MRI and a speech-language assessment. However, G.T. reported that difficulties to retrieve words started about a year before her enrolment in the study, while her daughter reported to have noticed changes for five years.

In March 2016, she underwent neuropsychological and language examinations. Neuropsychological assessment showed spared working memory and executive functions. Mild to moderate visual agnosia was observed, which could explain the impairment found in the visual episodic memory task. Gestural praxis was also impaired for one of the subtests requiring semantic processing (i.e., production of symbolic gestures). Concerning language, G.T.'s speech was fluent but characterized by significant word-finding difficulties. Impairments in semantic memory were found, associated with a deficit in single-word comprehension, naming impairment, as well as surface dysgraphia.

Case 2: M.S.

M.S. is a 75-year-old right-handed man. He has 22 years of education, including a Ph.D. in linguistics, and worked as a professor before his retirement. M.S. lives with his wife and has no children. He has many hobbies and loves to write, mainly about his trips around the world. At the time of the study, he was still very engaged in activities of daily living (e.g., grocery shopping), although he sometimes needed help from his wife. Thirteen months prior to the study, he received a diagnosis of svPPA based on a neurological examination, including an MRI and a speech-language assessment.

Neuropsychological assessment, conducted in November 2016, revealed spared visual episodic memory. Working memory, executive functions, visuoperceptual abilities as well as praxis were mildly impaired. With respect to language, M.S.'s speech was fluent with occasional signs of anomia (i.e., delays, circumlocutions and paraphasias). M.S. also showed semantic memory impairment, leading to deficits in word comprehension, fluency, as well as surface dysgraphia.

Case 3: C.L.

C.L. is a 69-year-old right-handed man. He has 11 years of education and used to be in the military. He lives with his wife and has two children, who are very involved. At the time of the study, he was still involved in activities of daily living but needed more and more help from his wife. Approximately six months prior to his enrolment in the study, a neurological and language assessment along with an FDG-PET scan led to a diagnosis of lvPPA. However, his wife and daughter reported that the difficulties had been increasing gradually over the past two years.

In April 2017, a neuropsychological assessment revealed spared visual episodic memory while working memory, executive functioning, visuoperceptual skills and praxis were impaired. Regarding language, C.L. was fluent but his speech showed significantly reduced content due to severe anomia. Oral comprehension and semantic memory were well preserved. Repetition of single words was unimpaired but significant difficulties were found for sentences. Mixed dyslexia and dysgraphia were observed.

Case 4: A.V.

A.V. is an 80-year-old right-handed woman with 16 years of education. Prior to her retirement, she worked as a lawyer. A.V. lives alone and has no children. However, she often does activities with her sisters, who are very involved with her. At the time of the study, she was independent in her activities of daily living. Four months prior, she received a diagnosis of lvPPA based on a neurological examination, including a speech-language assessment and an MRI.

A neuropsychological assessment conducted in June 2017 showed spared visual episodic and working memory. Executive functions, visuoperceptual abilities, praxis and semantic memory were mildly impaired. A.V.'s speech had slowed down and was marked by moderate anomia, which was also observed in naming tasks. For words and sentences, her comprehension was well preserved but repetition was impaired.

Case 5: R.D.

R.D. is a 71-year-old right-handed woman with 13 years of education who worked for the government before she retired. She lives with her husband and is still very active. She has many hobbies including reading, cooking and going to the gym. She is independent in all her activities of daily living. Approximately nine months prior to the study, she received a diagnosis of lvPPA, based on a neurological examination, including an FDG-PET scan, a cognitive assessment and an extensive language assessment. However, according to her, her difficulties began about nine years ago, but have increased over the past year.

In June 2017, a neuropsychological assessment showed that all her cognitive functions except language were well preserved. Regarding language, R.D.'s speech was fluent with mild to moderate anomia. Comprehension and semantic knowledge were preserved while reading and writing were mildly impaired.

Materials

In collaboration with the Software Engineering Department at *Université Laval,* our research team developed iTSA, an application for Android© tablets that was adapted from Semantic Feature Analysis (SFA; Boyle & Coelho, 1995). The specific procedure used in this study is described below.

The application includes three modules connected to an internal database: 1) the "Therapist" module allows the clinician to enter demographic information about the participant as well as information needed for the treatment (pictures of functional objects at the participant's home, questions about semantic features and name of each object); 2) the participant uses the "Treatment" module to complete the self-administered therapies. Answers to the yes/no semantic questions and audiotapes of the participant's attempts and repetition of the words are stored directly in a file that can be easily retrieved on the tablet; 3) the "Measures" module is used by the experimenter for the efficacy and maintenance measures.

For the treatment of functional vocabulary (hereafter, functional vocabulary treatment), treatment targets were determined with each participant based on his/her interests and activities of daily living (e.g., cooking, traveling). For each participant, a list of approximately 120 significant words related to these topics was created and, when possible, pictures were taken directly in his/her home with iTSA. When a picture of the target word could not be found in the participant's home (e.g., airplane, grocery cart), pictures were retrieved from copyright-free digital image sets (e.g., Pixabay). For the treatment of target words selected regardless of their usefulness (hereafter, non-functional vocabulary treatment), 60 words related to various topics (e.g., gardening, music) that were not significant for the participant were randomly chosen from a picture database (Brodeur, Guérard, & Bouras, 2014).

Procedure

Baselines (A[1])

Three baseline sessions, comprising a naming task and a conversation task, were conducted within a week with each participant to assess stability of performance. For the naming task, the participant had to name the 180 pictures presented in random order. For the conversation task, the participant had to discuss four topics with a blind experimenter, two relating to the functional words and two relating to the words chosen using the traditional approach. The blind experimenter, a speech-language pathologist who was used to discussing with people with PPA, conducted all conversation tasks. She knew the topics to discuss (e.g., cooking) and had a few examples of questions to address (e.g., How often do you cook? /What meals do you like to cook? / What is your favourite food?) but did not know the potential target words for each topic (e.g., chicken, tomatoes, cooking pan). The participant and blind experimenter had to talk for approximately five minutes about each topic, for a total of 20 minutes per session. All conversations were recorded. In the first session, the participants also had to rate the degree of usefulness of each of the 180 items (i.e., the 120 functional and the 60 non-functional items), that is to say how useful this item is for them in their everyday life, on a scale of 1 (not useful) to 5 (very useful).

Planning the treatment: Following baselines, three lists of 30 functional words, equivalent in terms of performance to the naming task (total score), syllabic length, lexical frequency (New, Pallier, Brysbaert, & Ferrand, 2004) and degree of usefulness, were created for each participant: 1) List A: words trained with the application, 2) List C: words exposed but not trained, and 3) List D: words not exposed (control). A fourth list, List B, was created comprising 30 non-functional words. This list was equivalent to the other three in terms of performance to the naming task, syllabic length and lexical frequency. Words from list B were also trained with the application.

Finally, the digital pictures corresponding to the items in the four lists were entered in the application. For lists A and B, the semantic questions and spoken names of the items were also recorded.

Treatment (B)

Training with the smart tablet: From one to three training sessions with the smart tablet were conducted at home with the participant and a relative, if necessary. The first session included a demonstration of the application with detailed verbal instructions and practice with eight items not included in the treatment. During this practice, reinforcement was provided to the participant and, if necessary, explanations regarding the instructions were given. At the participant's request, additional practice sessions could take place. A paper guide illustrating each step in the treatment was also given to each participant. Finally, to ensure the treatment was done properly, the experimenter observed the first treatment session.

Self-administered treatment: Four times a week for four weeks, participants completed the self-administered treatment at home. In each session, the "Treatment module" was used to train the 30 words from list A (trained functional vocabulary) and the 30 words from list B (trained non-functional vocabulary), presented in random order. For each word, participants had to perform the following steps (see Figure 8):

a) Look at the picture of the object shown on the screen;

b) Answer eight yes/no semantic questions related to the object (category, use, associated object, usual location), with immediate feedback;

c) Click on the icon and try to say the name corresponding to the picture;

d) Click on the icon to listen to the name of the object and repeat it.

Figure 8. Procedure for lists A and B (trained)

The 30 words from list C (exposed but not trained functional vocabulary) were then presented. Participants had to look at the picture presented on the screen and try to produce its name, without receiving any cues or feedback regarding their answer.

At the end of each week of treatment, the experimenter went to the participants' house and used the "Measures" module to administer a naming task in which they had to name the 120 words from lists A, B, C and D, presented in random order, with no cues or feedback provided. In self-administered sessions just like in weekly assessments, no time limit was imposed to the participant to produce the target word.

Post-intervention and maintenance measures (A^2 and A^3)

The experimenter administered the naming task three times in the week following the last treatment session in order to have a measure of stability and to compare performance post-treatment to baseline measures. During this same week, the blind experimenter administered the conversation task twice. Finally, to assess maintenance, the naming task was also administered 2 weeks, 1 month and 2 months after the treatment ended.

Analyses

Visual and statistical analyses were used jointly, as prescribed in the current consensus for the analysis of single-case studies (e.g., Harrington & Velicer, 2015; Houle, 2009). Moreover, the first author (M.L.) listened to and rated (0=wrong answer; 1=right answer) the recordings for each word in lists A, B, and C across the 16 sessions to assess the progression of performance for each list.

Visual analyses

Visual analysis was performed on the graphical representation of the data to identify general trends in the evolution of performance between the treatment phases, and especially changes in level of performance, trend (direction), slope and variability (Ottenbacher, 1986). Figure 9 shows the progression of performance in the naming attempts recorded during each therapy session while Figures 10-14 show the progression of performance in naming at the measures taken across the different phases of the protocol (i.e., baseline, treatment, post-treatment and maintenance).

Statistical analyses

The Tau-U statistic, developed specifically for single-case research by Parker, Vannest, Davis, and Sauber (2011), was used to detect significant improvement following treatment for each list. This statistic combines the analysis of nonoverlap between phases and trend within the intervention phase. It can also control for undesirable trends at baseline, if necessary.

Basically, the Tau-U statistic represents the percentage of data that improves over time between two phases. For example, a Tau-U of 1 means that 100% of the data improved between the two selected phases while a Tau-U of -1 means that 100% of the data deteriorated between the two phases. More specifically, efficacy of the treatment was assessed by comparing the baseline phase (A) to the post-treatment phase (A^2), and maintenance was assessed by comparing the post-treatment phase (A^2) to the maintenance phase (A^3). For each assessment of the various phases, words were transcribed by the experimenter and given a score of 1 (retrieval success) or 0 (retrieval failure). For each participant, the statistics were calculated using the web-based statistical application developed by Parker et al. (2011), which is available free online (http://www.singlecaseresearch.org/calculators/tau-u).

Comparisons between lists at specific phases were performed to: a) ensure that performance was equivalent for each list at baseline; and b) compare performance post-treatment and at maintenance on lists for which a significant improvement was found. The Kruskall-Wallis non-parametric test for independent samples was used together with post-hoc analyses (Mann-Whitney U) to perform these comparisons, along with the Bonferroni correction for multiple tests. Analyses were conducted using SPSS 24.0. For each list, the percentage improvement between baselines and the end of the first week of treatment, as well as between baselines and the end of treatment, was calculated.

Conversation

For each conversational measure, M.L. transcribed the recordings and a lexical analysis was performed to investigate whether each individual could produce the specific items trained in therapy in a conversational context. For each of the 120 words from lists A, B, C and D, the successful and failed productions were computed. A successful production was counted when the participant produced the specific word without receiving any help from the experimenter or a relative. The production of the word was not considered successful when the experimenter had produced this same word in the previous sentence since it was likely to result from a repetition rather than a real lexical retrieval. If the participant could not find the right word when the context allowed the experimenter to clearly identify the target or if the participant produced a circumlocution, the production was considered unsuccessful. A production was also considered unsuccessful when the experimenter suggested a word to the participant and he/she confirmed that it was the word he/she was trying to retrieve. Finally, a percentage of anomia was obtained by dividing the number of unsuccessful productions by the number of possibilities to produce the words (unsuccessful + successful productions) multiplied by 100 (see Appendix for an example).

M.L. used the Search function in Microsoft® Word to retrieve the successful productions of the target words from the transcripts. For the unsuccessful productions, both M.L. and a blind experimenter conducted the analysis since this was more subjective. For the blind experimenter, the order of the transcripts was randomized so she could not know which transcripts were from baselines and which came from post-treatment measures. Interrater agreement was calculated using Cohen's K, and disagreements were resolved by discussion.

RESULTS

In all participants, compliance with the self-administered treatment was generally high. G.T. and M.S. (svPPA) completed all 16 sessions. For M.S., however, performance on list C was not taken into account for 3 sessions (#2, 5 and 6) because his wife gave him some of the answers during the treatment. C.L. (lvPPA) completed 15 sessions but forgot the last one. After the first week of treatment, C.L.'s wife reported that when he practiced items from list C (without any cues or feedback), her husband would get mad and could not understand why she would not give him the answers. Therefore, it was decided to omit this list and do the treatment for lists A and B only. Maintenance was measured two weeks post-treatment and since performance was back to baseline, the research protocol was ended. A.V. (lvPPA) forgot one session and two were incomplete, resulting in 13 completed sessions. Finally, for R.D. (lvPPA), the treatment phase was shortened to 12 sessions since a ceiling effect was reached after the first week of therapy.

The wives of two participants, M.S. and C.L., assisted them during the treatment because they had difficulty managing the smart tablet independently. G.T., M.S. and R.D. completed each of the 16 sessions without interruption. The mean duration of each session was 75 minutes for G.T. and M.S and about 45 minutes for R.D. C.L. completed a few therapies in 2 or 3 parts during the same day to minimize fatigue. Finally, there was a misunderstanding with A.V. that led to 4 sessions being done over two different days.

The results of the visual and statistical analyses for each participant are discussed below, beginning with the two participants with svPPA, followed by the three with lvPPA.

Case 1: G.T. (svPPA)

Visual analyses

As shown in Figure 9, performance for lists A and B during the therapy jumped significantly between sessions 2 and 3 and increased gradually thereafter. For list C, performance was stable until session 12, then improved slightly. Throughout the sessions, performance was always better for list A, followed by lists B and C.

G.T.'s performance on each list across the whole treatment protocol is shown in Figure 10. For lists A and B, an improvement was observed between baseline (A^1) and treatment (B), and a small increase between treatment (B) and post-treatment (A^2). The change was largest for list A. A trend toward improvement was observed between baseline, treatment and post-treatment for lists C and D. The percentage improvement was greater for list A than B after the first week of treatment (List A=33.3%; List B=13.3%) and at the end of treatment (List A=43.3%; List B=26.7%). For lists C and D, the percentage improvement was negative or zero after the first week of treatment (-10.0% and 0.0%, respectively), and minimal at the end of treatment (3.3% and 6.7%, respectively).

Statistical analyses

For list A, a significant improvement for G.T. was found at the end of treatment (Tau-*U*=1, *p*=.0495) and was maintained two months post-treatment (Tau-*U*=-.33, *p*=.56). For list B, there was also a significant improvement post-treatment (Tau-*U*=1, *p*=.0495) and at maintenance two months later (Tau-*U*=0, *p*=1); this was also true for list C (respectively Tau-*U*=1, *p*=.0495; Tau-*U*=.67, *p*=.25). No significant difference was found between baseline and post-treatment for list D (Tau-*U*=.89, *p*=.08).

Figure 9. Progression of performance in naming attempts recorded during therapy sessions

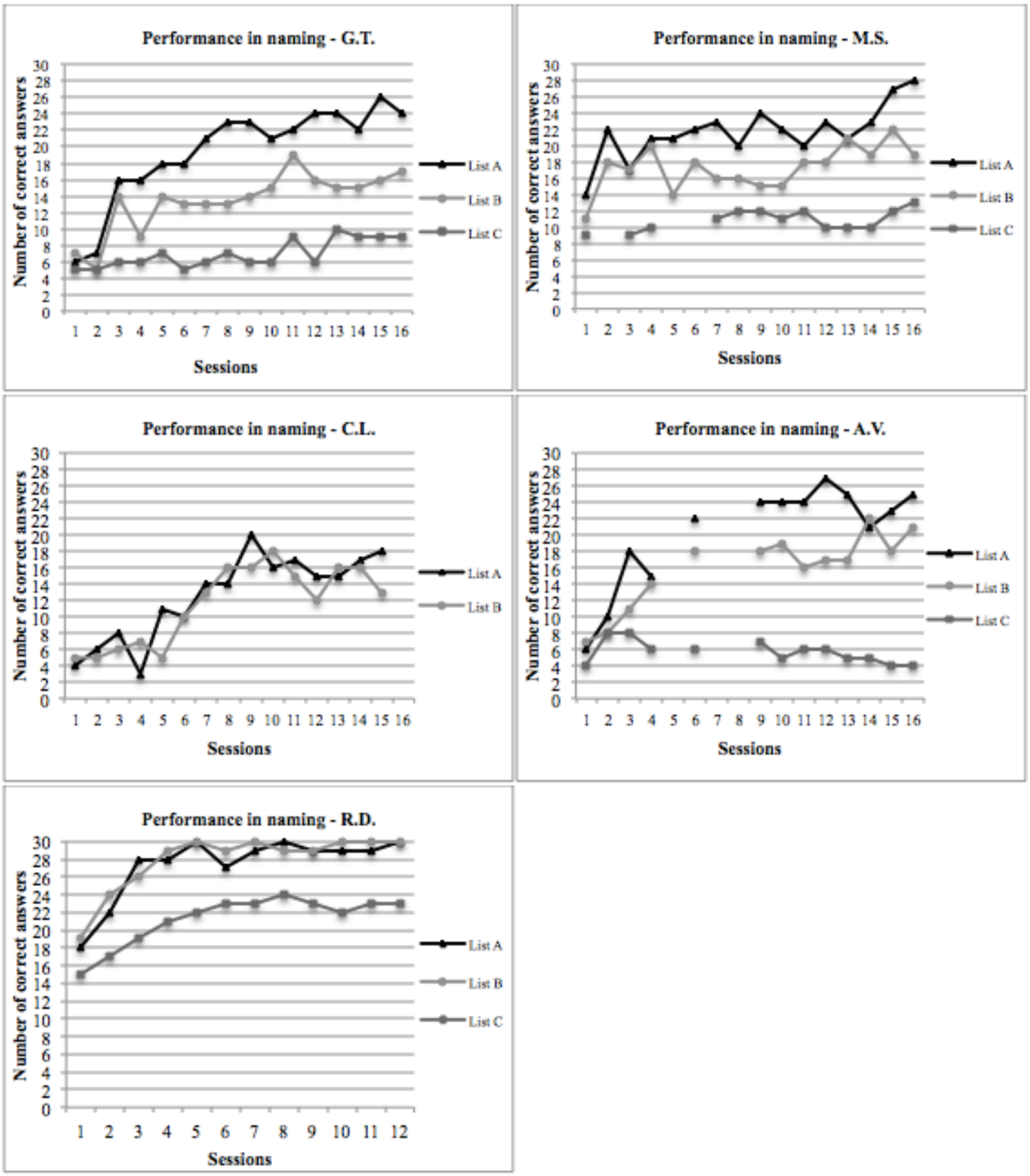
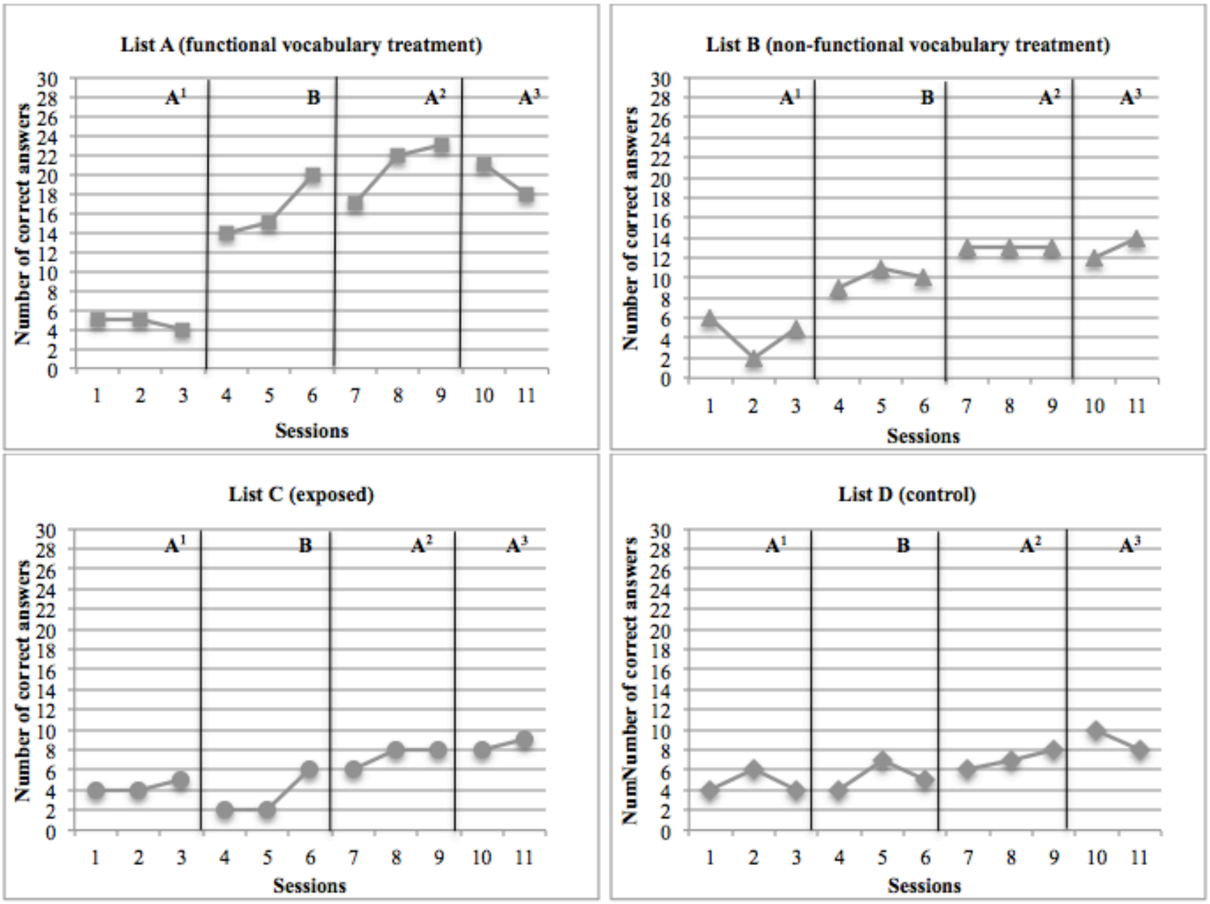


Figure 10. G.T.'s performance for each list across treatment protocol



A^1= Baseline; B= Treatment (week 1, 2 and 3), A^2= Post-treatment; A^3= Maintenance (1 month, 2 months)

All lists were equivalent on naming performance at baseline (Kruskall-Wallis: $X^2(3)=.30$ $p=.96$). Outcomes for lists A, B and C were compared and a significant difference in performance was found between the lists post-treatment ($X^2(2)=16.70$, $p<.001$) and at maintenance ($X^2(2)=9.76$, $p=.008$). For post-treatment and maintenance, post-hoc analyses showed a significant difference in performance between list A and list C (Mann-Whitney U = 25.70, $p<.001$; U=19.10, $p=.006$, respectively), both in favour of list A. However, no significant difference was found between lists A and B post-treatment (U=15.10, $p=.051$) and at maintenance (U=11.25, $p=.20$), or between lists B and C (U=10.60, $p=.28$; U=7.85, $p=.60$, respectively).

Case 2: M.S. (svPPA)

Visual analyses

Figure 9 shows that for lists A and B, most of the improvement during therapy took place between the first and second sessions while performance stabilized for the subsequent sessions. For list A, however, an improvement in performance was observed towards the end of treatment. For list C, performance was more or less stable throughout the sessions. Across all sessions, performance was slightly better for list A, followed by list B and list C.

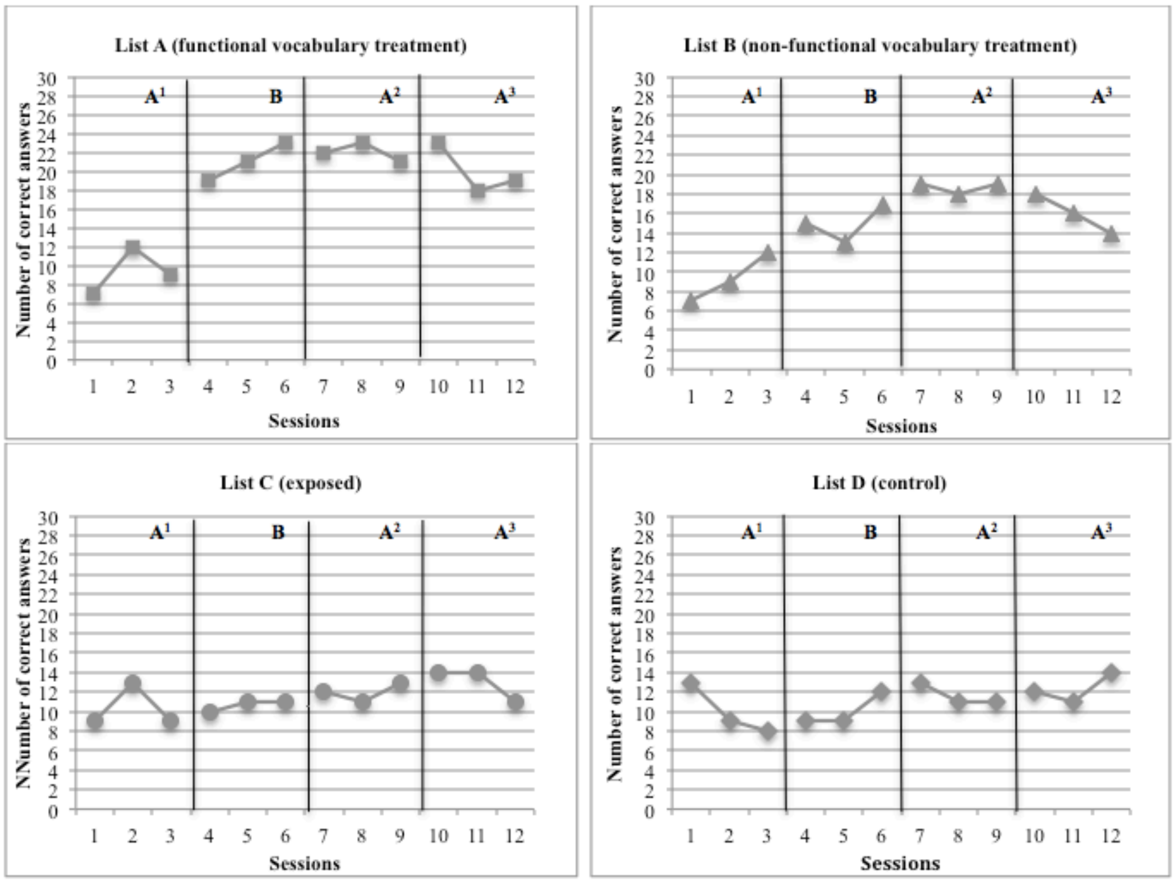
M.S.'s performance on each list across the whole treatment protocol is shown in Figure 11. For list A, an improvement was observed between baseline (A^1) and treatment (B). For list B, a more limited improvement was observed between baseline (A^1) and treatment (B), and between treatment (B) and post-treatment (A^2). A decline was observed between post-treatment (A^2) and maintenance (A^3) for lists A and B. No clear changes were observed for lists C and D. The percentage improvement was greater for list A than B after the first week of therapy (List A=33.3%; List B=10.0%) and post-treatment (List A=43.3%; List B=23.3%). For lists C and D, the percentage improvement was small after the first week of therapy (both 3.3%) and after the end of treatment (List C=10.0%; List D=16.7%).

Statistical analyses

A significant improvement for M.S. was found for lists A and B at the end of treatment (Tau-*U*=1, *p*=.0495 for both) as well as at maintenance, 2 months post-treatment (Tau-*U*=-.44, *p*=.38; Tau-*U*=-.89, *p*=.08, respectively). No significant difference was found post-treatment for lists C (Tau-*U*=.44, *p*=.38) and D (Tau-*U*=.44, *p*=.38).

All lists were equivalent on naming performance at baseline (Kruskall-Wallis: $X^2(3)=.16$, *p*=.98). Outcomes for lists A and B were compared and no significant difference in performance was found post-treatment (Mann-Whitney U=389, p=.32) and at maintenance (U=373, p=.22).

Figure 11. M.S.'s performance for each list across treatment protocol



A[1]= Baseline; B= Treatment (week 1, 2 and 3), A[2]= Post-treatment; A[3]= Maintenance (2 weeks, 1 month, 2 months)

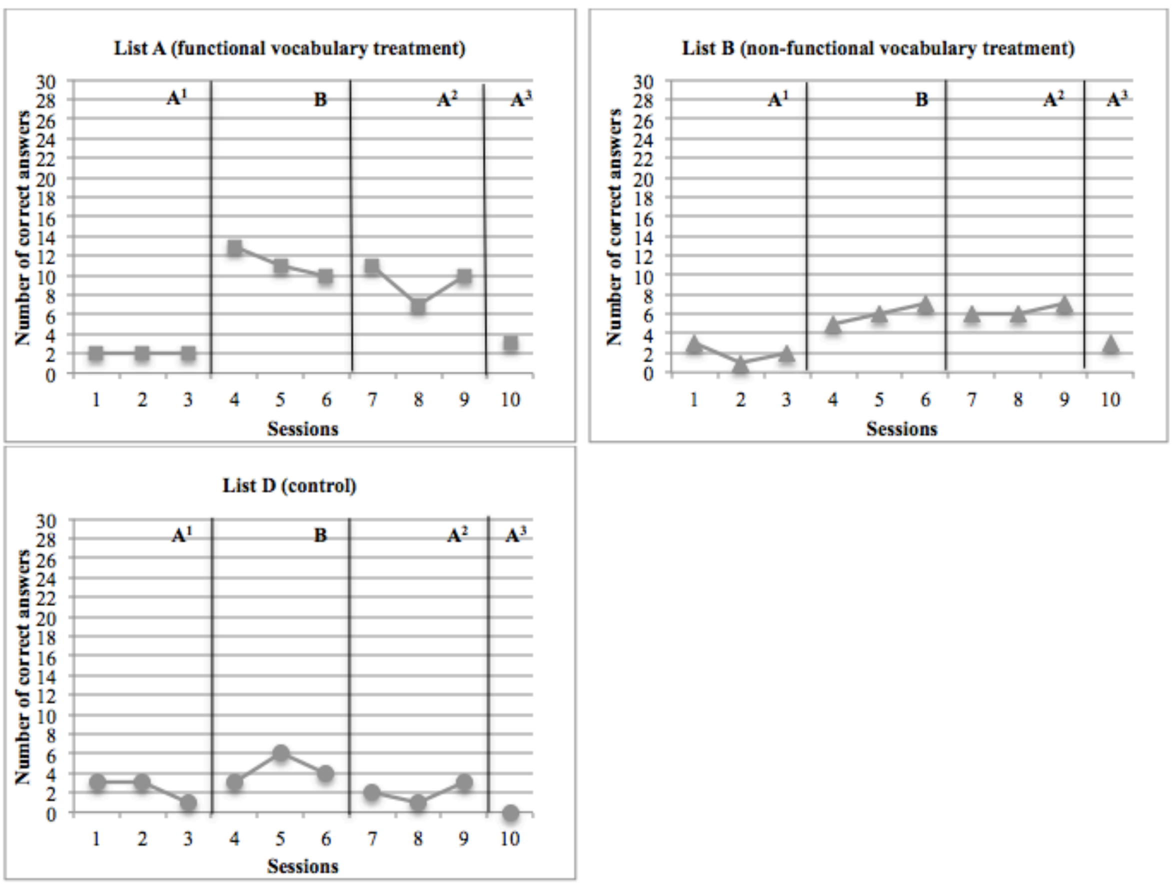
Case 3: C.L. (lvPPA)

Visual analyses

As shown in Figure 9, performance during therapy for list A improved gradually until session 9 and stabilized thereafter. For list B, performance also improved until session 10, followed by a small decline. Across all sessions, performance was similar for both lists.

C.L.'s performance on each list across the whole treatment protocol is shown in Figure 12. For both lists A and B, an improvement was observed between baseline (A^1) and treatment (B) but the improvement was smaller for list B. For both lists, a decline was observed between post-treatment (A^2) and maintenance (A^3). Finally, for list D, no clear change was observed between the phases. Consistent with the visual analysis, the percentage change was greater for list A after the first week of treatment (36.7%) and at the end of treatment (30.0%), followed by list B (10.0% and 13.3%, respectively) and list D (6.7% and 3.3%, respectively).

Figure 12. C.L.'s performance for each list across treatment protocol



A^1= Baseline; B= Treatment (week 1, 2 and 3), A^2= Post-treatment; A^3= Maintenance (2 weeks)

Statistical analyses

Statistical analyses were not performed for C.L. for the maintenance phase since only one measure was taken. For lists A and B, a significant improvement was found post-treatment (List A: Tau-*U*=1, *p*=.0495; List B: Tau-*U*=1, *p*=.0495), while no significant change was observed for list D (Tau-*U*=-.22, *p*=.66).

All lists were equivalent on naming performance at baseline (Kruskall-Wallis: $X^2(2)=.46$, *p*=.80). Performance post-treatment was compared between lists A and B and no significant difference was found (Mann-Whitney U=395.0, *p*=.35).

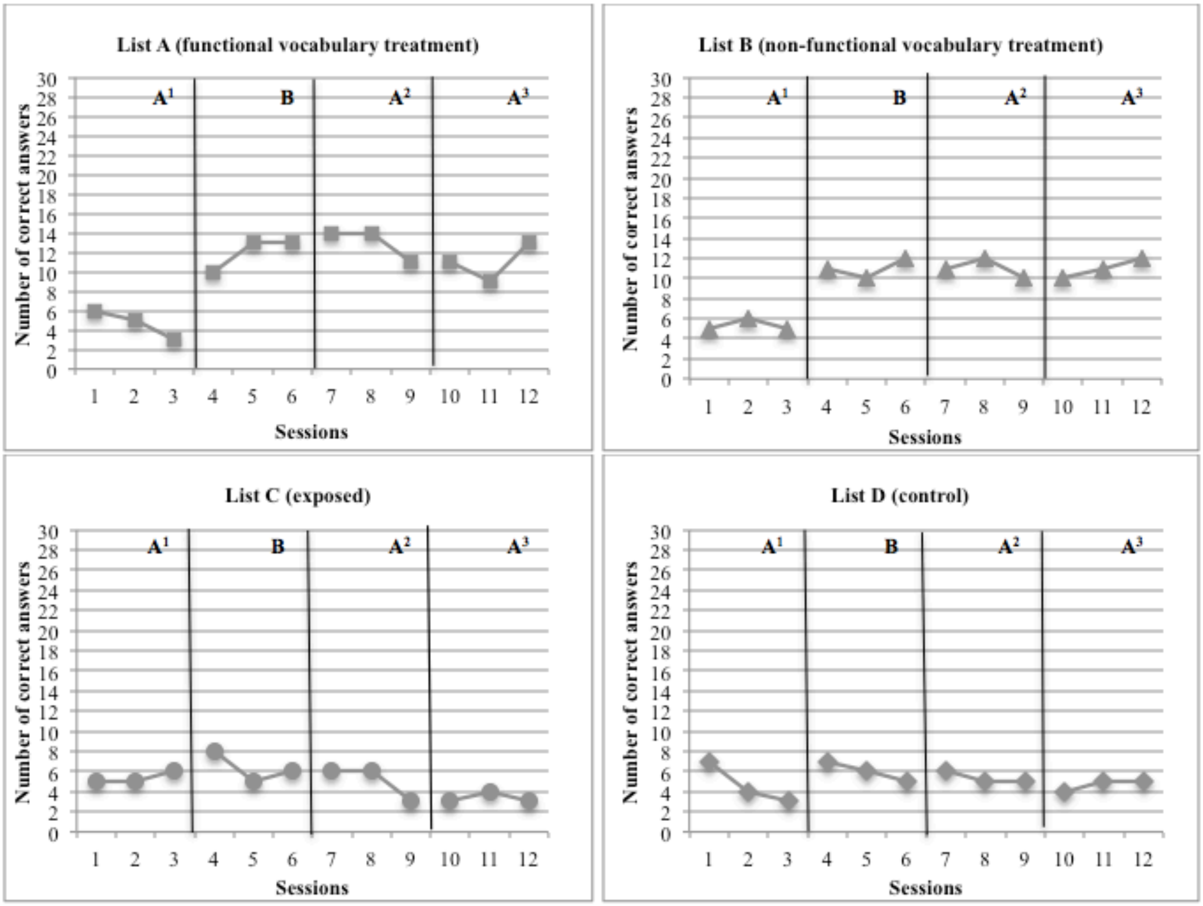
Case 4: A.V. (lvPPA)

Visual analyses

Figure 9 shows that performance during therapy for list A improved until session 12 and stabilized thereafter. For list B, most of the improvement took place between sessions 1 and 6 and performance was more stable afterwards. Throughout the sessions, performance was always slightly better for list A than B. For list C, a gradual decline was observed throughout the treatment.

Figure 13 shows performance on each list across the whole treatment protocol. For lists A and B, an improvement of about the same magnitude was observed between baseline (A^1) and treatment (B). For both lists, performance was stable for the subsequent phases. No clear change was observed for lists C and D. The percentage improvement was similar for lists A and B after the first week of treatment (List A=23.3%; List B=20.0%) but smaller for list C (6.7%) and D (13.3%). At the end of treatment, the percentage improvement was greatest for list A (36.7%), followed by list B (20.0%), list D (10.0%) and list C (0.0%).

Figure 13. A.V.'s performance for each list across treatment protocol



A^1= Baseline; B= Treatment (week 1, 2 and 3), A^2= Post-treatment; A^3= Maintenance (2 weeks, 1 month, 2 months)

Statistical analyses

For lists A and B, a significant improvement for A.V. was found post-treatment (List A: Tau-*U*=1, *p*=.0495; List B: Tau-*U*=1, *p*=.0495), while no significant change was found for list C (Tau-*U*=.11, *p*=.83) and D (Tau-*U*=.33, *p*=.51). Gains were maintained two months post-treatment for lists A and B (List A: Tau-*U*= -.67, *p*=.19; List B: Tau-*U*=0, *p*=1).

All lists were equivalent on naming performance at baseline (Kruskall-Wallis: $X^2(3)$ = .02, *p*=.99). Performance post-treatment and at maintenance was compared between lists A and B and no significant difference was found (Mann-Whitney U=402.0, *p*=.45 and U=442, *p*=.90, respectively).

Case 5: R.D. (lvPPA)

Visual analyses

As shown in Figure 9, most of the improvement during therapy took place between sessions 1 and 3 for lists A and B. Performance then improved gradually until session 5 and stabilized thereafter. For list C, the improvement was gradual until session 8 and performance was quite stable afterwards. Across all sessions, the magnitude of the improvement in performance was similar for lists A and B but smaller for list C.

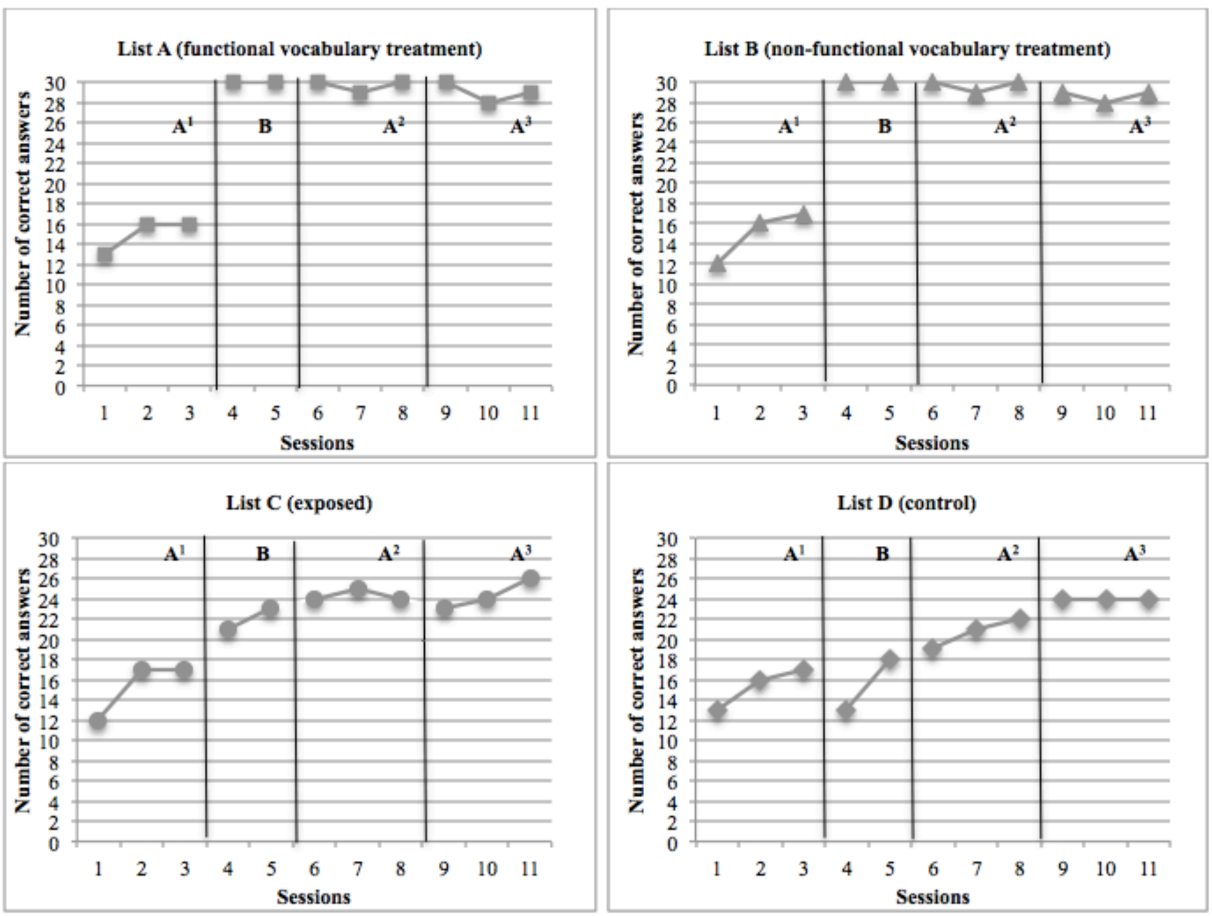
R.D.'s performance on each list across the whole treatment protocol is shown in Figure 14. For lists A and B, a large improvement was observed between baseline (A^1) and treatment (B), and performance was stable for subsequent phases. For list C, an improvement was observed between baseline (A^1) and treatment (B), and between treatment (B) and post-treatment (A^2). A trend toward improvement was observed in the maintenance phase (A^3). Finally, for list D, an improvement was found between treatment (B) and post-treatment (A^2), and between post-treatment (A^2) and maintenance (A^3). The percentage improvement was similar for lists A and B after the first week of treatment and post-treatment (for both: List A=46.7%; List B=43.3%). It was smaller for list C after the first week of treatment (13.3%) and post-treatment (23.3%). Finally, for list D, a decline in performance was observed after the first week of treatment (-13.3%) and the percentage improvement post-treatment was minimal (6.7%).

Statistical analyses

For all lists, a significant improvement for R.D. was found post-treatment (for all: Tau-*U*=1, *p*=.0495) and gains were maintained 2 months later (List A: Tau-*U*=-.44, *p*=.38; List B: Tau-*U*=-.78, *p*=.13; List C: Tau-*U*=-.11, *p*=.83). For list D, a significant improvement was even found between post-treatment and maintenance (Tau-*U*=1, *p*=.0495).

All lists were equivalent on naming performance at baseline (Kruskall-Wallis: $X^2(3)=.03$ $p=.99$). Outcomes for lists A, B, C and D were compared and a significant difference in performance was found between the lists post-treatment ($X^2(3)=18.68$, $p<.001$) but not at maintenance ($X^2(3)=7.49$, $p=.06$). Post-hoc analyses showed a significant difference in performance post-treatment between lists A and D (Mann-Whitney U= 20.92, $p=.003$), in favour of list A, as well as between lists B and D (Mann-Whitney U= 20.92, $p=.003$), in favour of list B.

Figure 14. R.D.'s performance for each list across treatment protocol



A¹= Baseline; B= Treatment (week 1 and 2), A²= Post-treatment; A³= Maintenance (2 weeks, 1 month, 2 months)

Changes in conversation

For each participant, the percentage of anomia pre- and post-treatment, that is the number of unsuccessful productions/number of possibilities to produce the target multiplied by 100, is shown in Table 6. The overall interrater agreement for unsuccessful productions corresponded to a Cohen's k of 85.3% and reached 100% after resolution of disagreements by discussion.

Table 6. Percentage of anomia (number of unsuccessful productions/number of production possibilities) in conversation for each list pre- and post-treatment

	G.T.		M.S.		C.L.		A.V.		R.D.	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
List A										
% Anomia	3/3 (100.0)	1/4 (25.0)	0/4 (0.0)	0/7 (0.0)	0/3 (0.0)	2/3 (66.7)	3/6 (50.0)	2/4 (50.0)	3/25 (12.0)	0/23 (0.0)
List B										
% Anomia	5/12 (41.7)	1/13 (7.7)	2/10 (20.0)	3/14 (21.4)	5/10 (50.0)	8/11 (72.7)	5/8 (62.5)	2/11 (18.2)	4/29 (13.8)	2/38 (5.3)
List C										
% Anomia	1/1 (100.0)	1/1 (100.0)	1/6 (16.7)	0/2 (0.0)	-	-	1/5 (20.0)	2/2 (100.0)	1/6 (16.7)	2/14 (14.3)
List D										
% Anomia	1/1 (100.0)	3/4 (75.0)	0/1 (0.0)	0/1 (0.0)	6/8 (75.0)	1/1 (100.0)	2/2 (100.0)	1/2 (50.0)	0/6 (0.0)	0/8 (0.0)
Total										
% Anomia	10/17 (58.8)	6/22 (27.3)	3/21 (14.3)	3/24 (12.5)	11/21 (52.4)	11/15 (73.3)	11/21 (52.4)	7/19 (36.8)	8/66 (12.1)	4/83 (4.8)

Overall, a decrease in the total percentage of anomia post-treatment was found in three of the five participants. For G.T., a decrease was found for lists A, B and D while no change was observed for list C. However, results must be interpreted very cautiously given the small number of production possibilities, especially for lists A, C and D. The total percentage of anomia decreased from 58.8% to 27.3% following treatment. For M.S., the percentage of anomia was relatively low and remained about the same pre- and post-treatment. C.L.'s results must be interpreted cautiously given the few production possibilities for each list. Overall, a slight increase in anomia was found post-treatment on each list, as well as in the total percentage of anomia. For A.V., the number of possibilities to produce the words was also relatively small. Therefore, the results from each list are difficult to interpret separately. However, a decrease in the total percentage of anomia was observed post-treatment. Finally, for R.D., the percentage of anomia was relatively low pre-treatment. However, a decrease was observed post-treatment for both lists A and B while lists C and D remained stable. Overall, the total percentage of anomia decreased by half following treatment.

DISCUSSION

The aim of this study was to investigate the efficacy of a self-administered therapy using a smart tablet for participants with PPA. More specifically, the aims were to: 1) investigate the efficacy of this treatment to improve naming of functional/relevant pictures; 2) compare the efficacy, maintenance, and generalization to untrained items of the treatment for those functional/relevant pictures to non-functional/irrelevant pictures coming from a picture database; and 3) examine generalization to an ecological conversation task. Two participants with svPPA and three with lvPPA completed the whole treatment protocol. In all participants, the self-administered therapy led to a significant improvement for the trained words, and this was maintained two months post-treatment in four of the five participants.

Our results are in line with the conclusions of several reviews confirming the efficacy of treatment for anomia in PPA (Cadório et al., 2017; Gravel-Laflamme et al., 2012; Routhier et al., 2013). To our knowledge, only two studies used SFA with participants with PPA and positive outcomes following treatment were obtained with one participant with lvPPA (Beeson et al., 2011) and one with nf/aPPA (Marcotte & Ansaldo, 2010). Beyond treatment efficacy, the maintenance of gains post-treatment is a major issue in PPA, given the degenerative nature of the disease. In this study, gains were maintained two months post-treatment in four of the five participants. Similar results were found in the systematic review by Cadório et al. (2017), in which the selected studies reported maintenance of the gains up to six months after the end of the intervention in participants with svPPA and lvPPA.

However, these authors reported that without continued practice, long-term maintenance was compromised, with performance declining below baseline level more than six months post-treatment. In the present study, a practice book containing the 120 words used in the study was given to each participant at the end of the research protocol. When they went to their SLP annual follow-up, two participants (G.T., svPPA and R.D., lvPPA) reported to one of the authors (J.M.) that they still used the practice book every week. For one participant with lvPPA (C.L.), performance returned to baseline level only two weeks post-treatment, despite a significant improvement post-therapy. However, we learned that C.L. had stopped his medication (Donepezil: Aricept) in the middle of the self-administered treatment because of serious side effects, which may account, at least in part, for this lack of maintenance.

In this study, an item-specific improvement was found in most participants. However, generalization to exposed items (list C) was observed in one participant with svPPA (G.T.) and one with lvPPA (R.D.), while only the latter showed generalization to control items (list D). Improvement of untrained items in G.T. is surprising since generalization to untrained items is not common in svPPA. As explained by Cadório et al. (2017) in their systematic review, relearning is often supported by episodic memory in svPPA, which limits generalization to untrained vocabulary. In G.T., this improvement is most likely the result of a strategy she used rather than a real generalization. She had to name exposed items in every session without receiving feedback, which could have increased her awareness of functional words that she could no longer name (e.g., clementine, corn). She confirmed that she looked at the labels on some of those items to learn and memorize their names, which could explain the improvement found for list C. In R.D., generalization to untrained items is in line with results from previous studies conducted with patients with lvPPA (e.g., Beeson et al., 2011). According to the authors, preservation of semantic knowledge in this population would explain the generalization of treatment effects to other items and to other tasks.

Interestingly, in two participants with lvPPA (C.L. and A.V.), the performance recorded on the tablet during each therapy session was substantially better than the performance measured after each week of treatment and post-treatment. For example, in the self-administered sessions, A.V. was able to name between 21 and 27 items out of a total of 30 items for list A while at the progression and efficacy measures, she never succeeded in naming more than 14. For C.L., a similar discrepancy was observed. This difference could be related to the impairment of executive functions in both participants. More specifically, the semantic questions they had to answer before attempting to name the picture helped these two participants organize their search, thus facilitating lexical retrieval. In the progression and efficacy measures, no semantic priming was provided, and therefore, the lexical search relied more on executive functioning, leading to a poorer performance. However, although he also had impaired executive functioning, M.S. did not show such a discrepancy. In future studies, it would be helpful to assess executive functioning more in-depth to better understand the influence of executive functions on performance.

Our study is the first to assess generalization to a context as ecological as conversation. In previous studies on anomia treatment, the results regarding generalization to discourse were mixed, as some studies reported positive results (e.g. Beales et al., 2016; Beeson et al., 2011; Savage et al., 2014), while others not (Croot et al., 2015; Jokel et al., 2010). In the present study, we observed a decrease in the total percentage of anomia for the words included in the treatment in three of the five participants. Although no statistical analyses could be conducted on these data, we can assume that the change yielded by the treatment was clinically significant. For example, before the self-administered treatment, G.T. presented anomia 58.8% (5/8.5) of the time when she wanted to produce the words included in the study, and this percentage dropped to 27.3% (3/11) post-treatment. Since the words trained were significant and relevant to her, this decrease in anomia could well have improved her communication effectiveness in the context of daily living. However, results from this task must be interpreted very cautiously since the percentage of anomia was often based on few possibilities to produce the target words. To conduct a conversation as naturally as possible, the blind experimenter only had the general topics to discuss and therefore the chance of the participant producing one of the target words was relatively low. Moreover, the participants knew that the conversation was part of the experimental protocol and therefore the task was not 100% ecological. In future studies, words to be trained could be selected from the conversation tasks (i.e. training words that the participant failed to produce in conversation) to facilitate pre-post assessment of generalization to conversation. It would also be interesting to conduct conversations with familiar communication partners such as family members or friends. Nevertheless, our study is the first to show some evidence of generalization to an ecological task in participants with PPA, and future studies should try to replicate these results to shed light on which contexts and for which individuals generalization to conversation might occur.

Another aim of this study was to compare a functional vocabulary treatment, in which the words were chosen according to the participant's activities and interests, to a non-functional vocabulary treatment, in which the words came from picture databases. Regarding the success of the treatment, a significant improvement was found for both trained lists and no significant difference between the lists was found post-treatment and at maintenance. However, although the statistical analysis did not show any difference between functional (list A) and non-functional (list B) vocabulary treatment, the change between baseline and post-treatment in the visual analyses seemed greater for the list A in three participants (G.T., M.S. and C.L.), which was corroborated by the percentage improvement calculations. Since some evidence of generalization to conversation is possible in PPA, words that are functional and relevant to the participant could be chosen as therapeutic targets in order to maximize their use in daily life.

As mentioned earlier, public services in speech-language pathology are currently very limited for people with PPA, despite positive results from various treatment studies. Therefore, self-administered treatment using new technologies is an interesting alternative to improve communication skills. However, before introducing such a treatment, certain factors must be considered. First, given the possible presence of other cognitive impairments, it can be a challenge to manage the technology and a relative's help may be necessary. In the present study, two participants could not have completed the treatment without their wives' assistance. Even when the participant can manage the treatment independently, the application should be designed to make it as easy and intuitive to use as possible. In the past few years, the popularity of new technologies has grown significantly in older people and they are more and more interested in incorporating it in their daily life, which opens up many new possibilities. In this study, one participant (R.D.) already used a smart tablet to read, use the Internet and play games, which greatly facilitated her learning of the application used for the self-administered treatment. Sufficient and appropriate training with the technology prior to beginning the self-administered treatment is a crucial step. In this study, between one and three structured practice sessions were conducted with the participants, depending on their needs. This training proved to be effective in previous studies conducted by our research team in post-stroke aphasia (Lavoie, Routhier, Légaré, & Macoir, 2016; Routhier, Bier, & Macoir, 2016) and Alzheimer's disease (Imbeault, Langlois, Bocti, Gagnon, & Bier, 2018; Imbeault et al. 2018, Imbeault et al., 2014). Moreover, since neurological disorders are often associated with cognitive fatigue, self-administered treatment allows the participants to complete the sessions at home and take breaks when needed; this was reported by the participants as being a major advantage. Furthermore, weekly visits by the clinician to measure progression involved regular contact with participants, a factor noted as being associated with success in self-administered treatments using a smart tablet (Kurland, Wilkins, & Stokes, 2014). In the present study, these weekly assessments also allowed the treatment to be adjusted based on the participant's experience and performance. For example, for C.L., list C was abandoned to reduce frustration and completion time, while for R.D., treatment duration was shortened because of her excellent performance.

Among the studies relating to anomia treatment in PPA, only a few investigated the efficacy of a home-based treatment using technologies (e.g., Croot et al., 2015; Jokel et al., 2010; Savage et al., 2014), and none used the smart tablet. Besides its innovative aspect, another important strength of this study is its rigorous methodological design (e.g., use of repeated measures across the study protocol, use of four equivalent treatment lists, conversation task conducted by a blind experimenter, interrater agreement for scoring the conversation task).

This study also has some limitations. First, it was conducted with a small number of participants, which limits its external validity. However, the participants varied widely with respect to language and cognitive profile and responded differently to the treatment in terms of maintenance, generalization to untrained items, and generalization to conversation. Therefore, although it is crucial to replicate this study with more participants with svPPA and lvPPA to understand which characteristics are associated with better treatment outcomes, our results suggest that the treatment can be applied in various profiles. Finally, many of the participants reported duration as being the only major disadvantage of the treatment. Treatment duration varied greatly among the participants, ranging from 45 to 120 minutes. In a clinical situation, the number of lists and stimuli should be reduced so the sessions do not exceed 60 minutes, which would be more realistic.

To conclude, this study supports the efficacy of an innovative type of treatment delivery, namely self-administered treatment using a smart tablet, to improve communication skills in PPA. In the current context of public health services, using technologies to help people with PPA relearn words that are significant to them is clearly an option that warrants further exploration.

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Chapitre 6. Discussion générale

Dans ce dernier chapitre, les résultats de la présente thèse seront synthétisés, incluant la recension systématique des écrits et les articles expérimentaux portant sur l'efficacité de la tablette électronique pour l'amélioration de mots fonctionnels en aphasie. Une analyse des forces et des limites des études sera ensuite proposée, suivie d'une discussion concernant les retombées de cette thèse ainsi que les perspectives futures. Finalement, une brève conclusion sera présentée.

6.1 Synthèse des résultats

L'objectif global de cette thèse était d'évaluer l'efficacité des technologies pour la rééducation de l'anomie acquise. Le premier objectif général était de faire le point sur l'efficacité de l'ordinateur et de la tablette électronique pour la rééducation de l'anomie post-AVC via la réalisation d'une recension systématique des écrits (étude 1). Afin de répondre en partie aux lacunes mises en lumière dans cette recension systématique, les deuxième et troisième objectifs généraux étaient d'évaluer l'efficacité d'une thérapie auto-administrée via tablette électronique pour la rééducation de mots fonctionnels en aphasie post-AVC (étude 2) et en APP (étude 3). Pour chaque population, l'étude visait plus spécifiquement à mesurer l'efficacité de l'intervention ainsi que le maintien, la généralisation et le transfert des acquis en conversation. Finalement, ces deux études avaient également pour objectif de comparer les effets du traitement pour les mots fonctionnels, choisis selon les besoins et intérêts des participants, et les mots issus d'une banque d'images, sans égard à leur valeur fonctionnelle.

La recension systématique des écrits réalisée dans le cadre de l'étude 1 a permis de confirmer l'efficacité des technologies, plus spécifiquement de l'ordinateur et de la tablette électronique, pour la rééducation de l'anomie post-AVC. En effet, dans chacune des 23 études recensées, le traitement informatisé a permis une amélioration significative de la production des mots travaillés, que le traitement soit administré en présence du clinicien ou auto-administré, ainsi qu'un maintien des gains jusqu'à un an après l'arrêt du traitement. Parmi toutes les études recensées, seules trois ont été menées avec une tablette électronique, ce qui n'est guère surprenant puisque cette nouvelle technologie est beaucoup plus récente que l'ordinateur. La recension des écrits a également permis de mettre en lumière certaines lacunes des études publiées jusqu'à présent, notamment le peu de considération fonctionnelle dans le choix du vocabulaire à rééduquer et la quasi-absence d'évaluation de la généralisation en contexte écologique. Les conclusions tirées de cette recension systématique des écrits ont été le point de départ de la conception du protocole de recherche élaboré pour les études 2 et 3.

Ces deux études ont ainsi porté sur la mesure de l'efficacité d'une thérapie auto-administrée par tablette électronique pour la rééducation de mots fonctionnels en aphasie post-AVC et en APP. Une synthèse des résultats obtenus pour tous les participants des deux études est présentée au Tableau 7. Dans un premier temps, les résultats des deux études démontrent la faisabilité d'un tel type de rééducation auprès de ces populations cliniques. En effet, les quatre participants présentant une aphasie post-AVC et les cinq participants présentant une APP ont complété le protocole complet de recherche avec une adhérence élevée au traitement. En ce qui concerne son efficacité, les résultats démontrent qu'un traitement auto-administré à raison de quatre fois par semaine pendant quatre semaines a permis une amélioration significative de la dénomination pour les items traités (listes A et B) chez les neuf participants étudiés. De plus, un maintien des gains deux mois après l'arrêt du traitement a été observé pour huit d'entre eux. Les résultats obtenus sont donc en accord avec les conclusions de la recension systématique des écrits réalisée en aphasie post-AVC dans le cadre de cette thèse (Lavoie, Macoir, & Bier, 2017) ainsi que les résultats obtenus dans différentes recensions des écrits réalisées en APP (Cadório et al., 2017; Gravel-Laflamme et al., 2012; Jokel et al., 2014; Routhier et al., 2013).

Tableau 7. Synthèse des résultats des études 2 et 3

	Efficacité du traitement - Liste A	Efficacité du traitement - Liste B	Maintien des gains (2 mois post)	Généralisation à des items exposés - Liste C	Généralisation à des items contrôles - Liste D	Généralisation en conversation
Post-AVC						
P.R.	✓	✓	✓	ND	✗	✗
S.T.	✓	✓	✓	✗	✗	✗
L.M.	✓	✓	✓	✓	✓	✓
C.G.	✓	✓	✓	✓	✓	✓
APP						
G.T.	✓	✓	✓	✓	✗	✓
M.S.	✓	✓	✓	✗	✗	✗
C.L.	✓	✓	✗	ND	✗	✗
A.V.	✓	✓	✓	✗	✗	✓
R.D.	✓	✓	✓	✓	✓	✓
Total	9/9	9/9	8/9	4/7	3/9	5/9

ND = Non disponible

Les résultats de la présente thèse apportent également un appui supplémentaire quant à l'efficacité de l'ATS (Boyle & Coelho, 1995) pour la rééducation de l'anomie acquise. En effet, dans les études 2 et 3, un traitement adapté de l'ATS a été utilisé pour le traitement auto-administré. L'amélioration significative obtenue dans l'étude 2 pour les listes A et B est concordante avec les écrits scientifiques ayant démontré à plusieurs reprises l'efficacité de l'ATS pour l'anomie post-AVC (ex., Coelho, McHugh, & Boyle, 2000; Maddy et al., 2014). Dans l'étude 3, l'amélioration significative observée à la suite du traitement appuie les conclusions émises dans les deux études dans lesquelles un traitement par ATS a été utilisé en APP (vnf/aAPP: Marcotte & Ansaldo, 2010; vlAPP: Beeson et al., 2011). Les études 2 et 3 réalisées dans le cadre de cette thèse ont également permis de démontrer l'efficacité de l'ATS, quelle que soit l'origine fonctionnelle de l'anomie (déficit sémantique et/ou phonologique), ce qui concorde avec les conclusions émises dans la recension systématique réalisée par Maddy et collaborateurs (2014). Parmi les participants aphasiques post-AVC, P.R. présentait une anomie d'origine lexico-sémantique alors que l'origine était lexicale pour les trois autres participants. Chez les participants avec APP, deux souffraient de la variante sémantique et trois de la variante logopénique. En contexte d'atteinte sémantique, il est probable que les questions sémantiques auxquelles le participant devait répondre avant de nommer l'objet aient permis de réapprendre ou de réactiver certaines connaissances sémantiques sur les concepts, facilitant ainsi l'accès subséquent au mot associé. En contexte d'atteinte lexicale, le fait d'activer le réseau sémantique associé au mot cible est susceptible d'avoir pu faciliter l'accès subséquent à ce même mot (Collins & Loftus, 1975).

Dans les études 2 et 3, la généralisation à des items exposés et à des items contrôles a également été mesurée. Un effet item-spécifique (i.e. seuls les mots travaillés s'améliorent) est généralement attendu à la suite d'un traitement de l'anomie (Caramazza, 1997; Levelt et al., 1999). Cependant, dans les études 2 et 3 de la présente thèse, une généralisation à des items exposés, mais non traités (liste C), a été montrée chez deux participants souffrant d'aphasie post-AVC et deux participants souffrant d'APP. Pour les items contrôles (liste D), une généralisation a également été trouvée chez les deux mêmes participants post-AVC, mais seulement chez un des participants APP. Plusieurs hypothèses peuvent être émises pour expliquer ces résultats. Dans un premier temps, Howard (2000) et Nickels (2002c) ont avancé que, lorsque des items étaient présentés plusieurs fois à un participant sans être traités, une amélioration résultant des tentatives répétées de production du mot cible pouvait survenir. En effet, puisque l'accès aux mots est souvent variable dans l'aphasie, le participant pourrait, à l'occasion, parvenir à trouver le mot cible, entrainant ainsi l'activation de ses représentations sémantique et phonologique, renforçant son réseau et facilitant son accès ultérieur (Nickels, 2002b). Cette hypothèse pourrait donc expliquer l'amélioration obtenue pour la liste C, dont les images étaient présentées pour dénomination à chaque séance de thérapie auto-administrée, sans qu'aucun indice ou feedback ne soit donné. Une autre hypothèse provient du fait que, dans le cas de la présente thèse, les mots travaillés appartenaient à des thèmes significatifs pour le participant et certains mots des listes A, C et D étaient donc étroitement reliés au plan sémantique. Ainsi, selon la théorie de l'activation étendue pour le traitement sémantique (Collins & Loftus, 1975), il est possible que le fait de travailler un certain mot cible (liste A) ait permis l'activation de concepts sémantiquement reliés, facilitant par le fait même l'accès à d'autres mots contenus dans les listes C et D. Pour G.T., participante souffrant de la vsAPP, l'amélioration significative obtenue pour la liste C est cependant surprenante puisque dans cette variante, la généralisation à d'autres items est généralement très limitée en raison de l'atteinte sémantique (Cadório et al., 2017). Après investigation, il est apparu qu'une stratégie mise en place par la participante était probablement à l'origine de cette amélioration. En effet, à divers moments de l'étude, G.T. a rapporté trouver très frustrant de ne pas avoir accès à la bonne réponse pour les mots de la liste C. Lorsque questionnée, elle a avoué que, pour certains des objets qu'elle possédait à la maison (ex., bouillon de poulet), elle a regardé le nom sur l'étiquette lors des thérapies auto-administrées. Pour cette participante, il est donc possible que l'amélioration obtenue pour la liste C soit le résultat d'une stratégie de compensation plutôt que d'une réelle généralisation.

Les études menées dans la présente thèse figurent également parmi les premières à investiguer le transfert des gains du traitement en conversation. Bien que des améliorations significatives aient été rapportées dans le discours descriptif, narratif et procédural dans l'aphasie post-AVC (ex., Conroy et al., 2009; Peach & Reuter, 2010) et dans l'APP (ex., Beeson et al., 2011; Savage et al., 2014), une seule étude avait, à notre connaissance, investigué la généralisation des mots spécifiquement travaillés en thérapie dans un contexte aussi écologique que la conversation (Mason et al., 2011). Dans l'étude 2, une réduction de l'anomie a été observée pour deux des quatre participants souffrant d'aphasie post-AVC, alors que pour les deux autres participants, le nombre restreint de possibilités de production a limité de façon importante l'interprétation des résultats. Dans l'étude menée en APP (étude 3), une réduction de l'anomie pour les mots travaillés a été observée chez un des deux participants souffrant de vsAPP et deux des trois participants souffrant de vlAPP. Le transfert en conversation obtenu en vsAPP est particulièrement intéressant puisque, en raison de l'atteinte sémantique prédominante, l'apprentissage est souvent soutenu par la mémoire épisodique, ce qui compromet le transfert à d'autres contextes. En effet, bien qu'une généralisation à d'autres tâches ait été obtenue dans certaines études (ex., Jokel & Anderson, 2012; Savage et al., 2014), le transfert observé en conversation suggère un réel réapprentissage des concepts en mémoire sémantique plutôt qu'une simple association mot-image relevant de la mémoire épisodique. Chez l'autre participant souffrant de vsAPP, l'absence de différence post-traitement pourrait être en partie expliquée par le pourcentage d'anomie relativement bas en conversation avant même le début du traitement auto-administré. Les conclusions émises par Cadório et collaborateurs (2017) suggèrent que la généralisation est beaucoup plus fréquente dans la vlAPP que dans la vsAPP en raison de la préservation des connaissances sémantiques. Pour R.D., la généralisation en conversation n'est pas surprenante étant donné la bonne préservation de toutes les fonctions cognitives, à l'exception du langage. Cependant, chez A.V., une généralisation en conversation a été trouvée malgré la présence d'une atteinte légère des fonctions exécutives et de la mémoire sémantique, ce qui suggère qu'un transfert peut survenir malgré des atteintes cognitives plus étendues.

Finalement, les études 2 et 3 visaient également à comparer les effets du traitement, en termes d'efficacité, de maintien et de généralisation des acquis en conversation, pour les mots choisis pour leur valeur fonctionnelle (liste A) vs les mots issus de banques d'images (liste B). Pour l'étude 2, menée auprès de participants avec aphasie post-AVC, les deux types d'approches ont généré des résultats similaires. Cependant, dans l'étude 3, menée en APP, un certain avantage a été observé pour les mots fonctionnels choisis avec le participant. Dans cette pathologie, une amélioration significative a été obtenue à la suite du traitement pour les listes A et B et les analyses statistiques n'ont révélé aucune différence significative entre les deux listes en post-traitement et au maintien. Cependant, les analyses visuelles et le calcul du changement (en pourcentage) ont permis de démontrer une amélioration de plus grande amplitude pour les items choisis pour leur valeur fonctionnelle (liste A) chez les deux participants souffrant de vsAPP et un participant souffrant de vlAPP. Il semble donc que le choix d'un vocabulaire fonctionnel puisse entrainer de meilleurs résultats dans le traitement de l’anomie, et plus particulièrement en contexte dégénératif. Jokel et collaborateurs (2014) ont émis l’hypothèse que, lorsque les connaissances sémantiques relatives aux items à travailler sont mieux préservées, leur réapprentissage est facilité. Ainsi, il est possible de croire, particulièrement pour les deux participants souffrant de vsAPP, que les connaissances sémantiques pré-traitement étaient mieux préservées pour les items qui ont été choisis avec eux en raison de leur utilité au quotidien, favorisant ainsi leur réapprentissage. L’avantage pour les mots fonctionnels pourrait aussi découler d’une plus grande motivation à réapprendre ces items. Évidemment, d’autres études sont nécessaires afin d’investiguer davantage cette question. Néanmoins, les résultats de ces deux études expérimentales démontrent qu’un traitement de l’anomie ciblant un vocabulaire fonctionnel est au moins aussi efficace qu’un traitement plus traditionnel dans lequel les mots sont issus d’une banque d’images. Considérant les résultats quant à la généralisation possible en conversation, il apparait donc logique de privilégier le choix d’un vocabulaire susceptible d’être utile pour le participant dans sa vie de tous les jours.

6.2 Forces et limites

Plusieurs forces et limites des études ont été présentées dans les articles respectifs des chapitres 3, 4 et 5. Celles-ci seront donc synthétisées dans la présente section afin d’en tirer des recommandations plus générales.

L’une des plus grandes forces de cette thèse est sans contredit son aspect novateur. En effet, jusqu’à ce jour, très peu d’études ont porté sur le traitement auto-administré de l’anomie via tablette électronique (Cadório et al., 2017; Lavoie et al., 2017). De plus, un des atouts significatifs de cette thèse est la considération apportée aux répercussions fonctionnelles du traitement. Dans un premier temps, les mots rééduqués ont été choisis avec chaque participant, en fonction de ses besoins, ses activités quotidiennes et ses intérêts. Une tâche de conversation a également été réalisée afin de mesurer le transfert des gains du traitement en contexte écologique, ce qui n'avait encore jamais été fait en APP. De plus, nos études sont les premières à comparer cette approche de sélection des cibles du traitement à une approche plus classique, dans laquelle les mots sont issus de banques d'images, sans égard à leur degré d'utilité pour le participant.

La rigueur méthodologique employée dans les trois études est également une force significative de la présente thèse. Dans un premier temps, les lignes directrices du *Prisma Statement* (Liberati et al., 2009) ont été minutieusement respectées lors de la rédaction de la recension systématique des écrits portant sur l'efficacité de l'ordinateur et de la tablette électronique pour la rééducation de l'anomie post-AVC. De plus, le processus de sélection des articles ainsi que l'évaluation de la qualité méthodologique de chacun des articles inclus dans la recension systématique ont été réalisés par deux expérimentateurs indépendants. Pour les articles expérimentaux (études 2 et 3), de nombreux éléments ont été mis en place afin d'assurer la meilleure validité interne possible. Tout d'abord, afin de s'assurer de la stabilité des performances, trois mesures ont été réalisées avant le début du traitement (lignes de base) ainsi qu'à la suite du traitement auto-administré (mesures d'efficacité). De plus, quatre listes équivalentes ont été comparées afin de tirer l'interprétation la plus juste possible quant à l'efficacité du traitement. La tâche de conversation a été menée par un expérimentateur aveugle aux objectifs spécifiques de l'étude et aux mots travaillés afin de ne pas influencer les résultats obtenus. Finalement, la cotation de cette tâche a été réalisée par deux expérimentateurs indépendants afin de s'assurer d'un accord inter-juges satisfaisant étant donné le caractère plus subjectif de l'analyse.

La limite principale des deux études expérimentales réalisées dans le cadre de cette thèse est sans contredit le petit nombre de participants ayant complété le protocole de recherche. Cette limite s'explique notamment par les contraintes techniques en lien avec le protocole utilisé (i.e. nombre élevé de rencontres avec chaque participant avant, pendant et après le traitement auto-administré, rencontres effectuées à domicile, etc.) Ainsi, il est clair que ce même protocole devrait être répliqué avec un plus grand nombre de participants afin de confirmer les résultats obtenus dans la présente thèse et d'en augmenter la validité externe. Cependant, bien que les participants aux deux études présentaient des profils cognitifs et langagiers très variés, une amélioration significative à la suite du traitement auto-administré a été obtenue pour tous, suggérant ainsi que ce type de traitement est efficace pour plusieurs individus présentant une anomie acquise. Toutefois, des résultats variables ont été obtenus quant au maintien et à la généralisation des acquis et de futures études devraient donc viser à mieux comprendre quelles caractéristiques individuelles sont associées à de meilleurs résultats post-traitement.

Du point de vue méthodologique, une limite importante, rapportée par une majorité de participants, est la durée du traitement. En effet, pour plusieurs des participants souffrant d'aphasie post-AVC et d'APP, la durée du traitement excédait 60 minutes, ce qui est particulièrement problématique en contexte d'atteinte neurologique où une plus grande fatigabilité peut être observée. Cependant, l'utilisation d'un tel traitement auto-administré en contexte clinique pourrait être simplifiée (i.e. réduction du nombre de listes et de stimuli) afin de diminuer de façon significative la durée du traitement. De plus, malgré que des résultats positifs aient été obtenus à la tâche de conversation pour plusieurs participants, le nombre limité de possibilités de production des cibles a sans contredit nui à une interprétation plus fine de celle-ci. En effet, dans certains cas, le pourcentage d'anomie était basé sur moins de cinq occurrences, ce qui limite considérablement les conclusions à tirer. Néanmoins, malgré le défi que représente l'analyse d'une tâche conversationnelle, il s'agit d'une mesure écologique beaucoup plus représentative des capacités fonctionnelles réelles des participants que d'autres tâches plus structurées, comme la description d'images ou la narration d'une histoire.

Finalement, même lorsque des consignes claires sont données aux participants, l'aspect auto-administré implique nécessairement un moins grand contrôle sur l’environnement dans lequel les sessions de thérapie sont réalisées. Cependant, l’enregistrement des réponses aux questions sémantiques via l’application ainsi que les enregistrements audios ont permis de vérifier la complétion de chacune des sessions de thérapie. De plus, ces enregistrements audios ont permis d’avoir un aperçu du contexte dans lequel les thérapies étaient complétées. Par exemple, dans le cas d’un participant souffrant de vsAPP, l’écoute de ces enregistrements a permis de confirmer que la conjointe avait fourni des réponses lors de trois sessions de thérapie, qui ont ensuite été retirées des analyses. Les rencontres hebdomadaires avec les participants pour les mesures de progression ont également permis de s’assurer que tout se déroulait comme prévu et de maintenir le lien avec le clinicien, favorisant ainsi l’adhésion au traitement. Selon Kurland, Wilkins et Stokes (2014), un contact régulier avec le clinicien serait en effet associé au succès des traitements auto-administrés avec une tablette électronique.

6.3 Retombées

Tel que mentionné en introduction de cette thèse, un nombre élevé de Canadiens vit actuellement avec les conséquences d’un AVC (Ontario Stroke Network, 2017), incluant l’aphasie, et les dernières décennies ont été marquées par une augmentation fulgurante du nombre de personnes souffrant de maladies neurodégénératives (Société Alzheimer du Canada, 2017), dont l’APP. Toutefois, bien que les conséquences de l’aphasie acquise soient claires, les services orthophoniques offerts à cette population sont actuellement très limités, notamment en raison de contraintes humaines et financières. Ainsi, il apparait primordial de s’intéresser à des solutions alternatives permettant aux personnes souffrant d’aphasie post-AVC ou d’APP de maximiser leurs compétences communicationnelles. La retombée globale de ce projet de thèse est donc l’apport de nouvelles données cliniques appuyant l’efficacité de la prise en charge de l’anomie via un traitement auto-administré par tablette électronique en contexte d’aphasie post-AVC et d’APP.

Dans un premier temps, une des retombées spécifiques de la présente thèse est la réalisation d'une recension systématique des écrits suggérant que le traitement de l'anomie post-AVC via les technologies est efficace (étude 1) et permettant un aperçu global des résultats obtenus dans les études ayant porté sur le sujet. En effet, l'accès à des résultats synthétisés est d'une grande pertinence, tant pour les chercheurs que les cliniciens travaillant dans le domaine des troubles acquis du langage. D'un point de vue clinique, le fait de connaitre les caractéristiques des traitements administrés via les technologies ayant entrainé des améliorations significatives pour les participants permettra aux cliniciens de proposer des interventions efficaces, basées sur les données probantes. En contexte de recherche, l'accès à ces données permettra de mettre en place de nouveaux projets de recherche prenant en compte les forces et les limites des écrits scientifiques existants.

Une autre des retombées spécifiques de cette thèse est la démonstration de l'efficacité d'une thérapie auto-administrée pour la rééducation de l'anomie en contexte d'aphasie post-AVC et d'APP. En effet, l'offre actuelle de services en orthophonie ne permet généralement pas d'atteindre la fréquence optimale de traitement (Bhogal, Teasell, & Speechley, 2003). Ainsi, le traitement auto-administré permet à la personne aphasique de maximiser son potentiel de rééducation, tout en demeurant une alternative réaliste en contexte clinique. Le fait de pouvoir compléter la thérapie à domicile est également un avantage notable pour plusieurs participants aphasiques, pour qui le fait de se déplacer fréquemment dans les centres de réadaptation et les cliniques externes peut être plus difficile en raison d'atteintes motrices concomitantes ou d'une plus grande fatigabilité. Dans un contexte où les technologies sont très accessibles, leur utilisation à des fins de réadaptation représente donc un choix logique, même auprès d'une clientèle plus âgée. Dans une étude récente menée par Vaportzis, Clausen et Gow (2017), un *focus group* réalisé chez des personnes âgées entre 65 et 76 ans a permis de démontrer que les participants étaient enthousiastes à l'idée d'adopter une technologie comme la tablette électronique. L'excellente adhérence au traitement et les résultats obtenus dans les études 2 et 3 démontrent d'ailleurs la faisabilité et l'efficacité de ce type de traitement chez des adultes âgés. Jusqu'à maintenant, les thérapies auto-administrées sont peu utilisées en contexte clinique et les résultats d'études comme celles réalisées dans le cadre de la présente thèse permettront de donner aux cliniciens les outils nécessaires pour les intégrer dans leur pratique.

Finalement, une retombée clinique significative des études 2 et 3 est la démonstration des effets positifs d'une approche fonctionnelle pour la rééducation de l'anomie acquise. Tel que mentionné précédemment, la plupart des études réalisées en aphasie post-AVC et en APP ont porté sur le traitement de mots provenant de banques d'images, sans égard à leur valeur fonctionnelle pour le participant. Dans la présente thèse, les mots rééduqués ont été choisis avec chaque participant, en fonction de ses besoins, de ses activités quotidiennes et de ses intérêts. Les études 2 et 3 ont permis de démontrer que cette approche est aussi efficace que l'approche classique en ce qui a trait à l'amélioration obtenue à la suite du traitement et au maintien des acquis. Chez les personnes souffrant d'APP, des indices suggèrent même un avantage de cette approche fonctionnelle quant à l'amplitude de l'amélioration obtenue. Dans les études 2 et 3, une généralisation des gains du traitement en contexte de conversation a également été démontrée pour la majorité des participants. Ainsi, puisque l'objectif ultime du traitement de l'anomie est d'améliorer la communication au quotidien, il apparait clair que la réalité quotidienne du client devrait guider le choix des items à rééduquer.

6.4. Perspectives futures

À la lumière des résultats des écrits scientifiques existants et des nouvelles données issues de cette thèse, plusieurs perspectives futures peuvent être dégagées.

Dans un premier temps, bien que l'efficacité de l'utilisation des technologies pour la prise en charge de l'anomie ait été démontrée à de nombreuses reprises dans les écrits scientifiques (Lavoie et al., 2017), des études de plus grande envergure et utilisant des devis méthodologiques comme l'essai randomisé contrôlé seront nécessaires afin de positionner ce type d'intervention comme un standard de pratique. En effet, jusqu'à maintenant, la plupart des études ayant porté sur la question ont utilisé des devis à cas uniques. Ainsi, l'ajout de nouvelles données plus robustes pourrait encourager les différentes institutions de soins de santé à intégrer ce type d'intervention à leur pratique de façon plus formelle.

Des questions cliniques émergent également des résultats issus de la présente thèse. En effet, bien que la majorité des personnes aphasiques semble répondre positivement à un traitement auto-administré, des résultats variables ont été obtenus quant au maintien et à la généralisation (Lavoie et al., 2017). Des études futures devraient donc s'intéresser à mieux comprendre quelles caractéristiques individuelles sont prédictives de l'issue du traitement, ce qui permettrait aux cliniciens de faire un choix éclairé quant aux candidats potentiels avec qui implanter ce type d'approche. Notre équipe de recherche a d'ailleurs publié récemment un article proposant des facteurs clés à prendre en compte lors de l'implantation d'un traitement auto-administré via les technologies auprès d'une clientèle avec aphasie post-AVC (Macoir, Lavoie, Routhier, & Bier, sous presse). De plus, il serait bénéfique de comprendre davantage les ingrédients actifs du traitement. En effet, l'efficacité de l'ATS a été démontrée à plusieurs reprises dans les écrits scientifiques (ex., Maddy et al., 2014) ainsi que dans les études 2 et 3 de la présente thèse. Cependant, il serait intéressant de pouvoir cibler quelles composantes du traitement (ex., réponse aux questions sémantiques, répétition du mot cible) permettent cette amélioration afin d'optimiser l'intervention offerte.

Finalement, tel que mentionné à de nombreuses reprises, très peu d'études menées en aphasie post-AVC et en APP se sont penchées sur la généralisation des gains du traitement de l'anomie en contexte écologique. Il est donc nécessaire de poursuivre le travail concernant le développement d'outils permettant de documenter les changements observés en contexte fonctionnel. Bien que cela représente un défi méthodologique de taille, les études futures devraient intégrer des tâches écologiques à leur devis expérimental puisque l'amélioration de la communication dans la vie quotidienne demeure l'objectif ultime de la rééducation de l'anomie. L'ajout de données à ce sujet permettrait également de mieux comprendre comment favoriser la mise en place de cette généralisation, ce qui serait un atout majeur en contexte clinique.

6.5 Conclusion

Pour conclure, les résultats de cette thèse apportent un nouvel éclairage aux écrits scientifiques existants quant à l'efficacité de l'utilisation des technologies pour la rééducation de l'anomie acquise. Dans le contexte actuel où les services orthophoniques offerts en aphasie post-AVC chronique et en APP sont grandement limités, l'intégration des technologies à l'offre de services de soins de santé actuelle semble une solution prometteuse afin de permettre aux personnes aphasiques d'améliorer la production de mots significatifs pour eux, entrainant ainsi des effets positifs sur leur communication au quotidien et leur qualité de vie.

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Annexe

Table 1. Main characteristics of the included studies (studies 1 to 5)

#	Identification	MQA	LOE	Experimental design	n	Time postonset	Type of aphasia	Technology	Treatment name/ Software	Target
1	Lavoie et al. 2016	12	III	Single-subject	1	27 months	Mixed	Smart tablet	NS	Verbs 3 lists: cued, uncued and control
2	Routhier et al. 2016	13	III	Single-subject	2	12 - 72 months	Fluent (n=1) Non fluent (n=1)	Smart tablet	NS	Verbs 3 lists: cued, uncued and control
3	Furnas & Edmonds 2014	12	III	Single-subject	2	48 - 72 months	NS	Computer	Computerised Verb Network Strenghtening Treatment (VNeST-C)	Verbs 2 lists: trained and control
4	Kurland et al. 2014	10	III	Single-subject	5	17 - 84 months	Anomic (n=3) Wernicke (n=1) Trans. sensory (n=1)	Smart tablet	NS	Nouns + verbs 4 lists: trained in intensive language treatment (ILT) and to be practiced, trained in ILT and not practiced, not trained in ILT and to be practiced, not trained in ILT and not practiced
5	Weill-Chounlamountry et al. 2013	12	III	Single-subject	1	10 months	Fluent	Computer	*Au fil des mots*	NS 1 list: trained

Cueing	Treatment intensity	Setting	Presence of the clinician	Main results	Magnitude of change (range)
Orthographic	4x/week for 3 weeks	Home	No	Significant improvement in naming for cued and uncued lists, with greater improvement for the cued list, and maintenance of the gains 3 weeks post-therapy. Significant generalization observed in a noun-to-verb production task for the cued list only.	Effect size: 47.38
Semantic and phonological	4x/week for 5 weeks	Home	No	Significant improvement on the cued list only for both participants, with maintenance of the gains up to 8 weeks post-therapy. No generalization observed in a novel verb-to-verb production task.	Effect sizes: .71-30
Semantic and orthographic	3x/week for 8 weeks	Home	Yes	Significant improvement on lexical retrieval during sentence production for both trained and untrained items. Maintenance of the gains 3 months post-treatment. Improvement in single-word naming for untrained words. Limited generalization to discourse but general increase in word output and decrease in typed neologisms.	Effect sizes: 2.91-8.29
Semantic, phonological and orthographic	2 weeks of intensive treatment followed by 6 months of home practice (5-6 days/week)	Home	No	Trend toward maintenance or continued improvement for practiced words that were trained in ILT (5/5) and dramatic gains for practiced words that were not trained in ILT (4/5). Clinical significance (at least 20% change in performance) achieved on all practiced words. With few exceptions, equal or better scores in post-treatment standardized measures of aphasia (Boston Diagnostic Aphasia Examination and Boston Naming Test).	Effect sizes: 3.91-13.28 % of change: 126-1633
Phonological and orthographic	3 treatment phases Each phase: 3x/week followed by a 2-months break	NA	Yes	Significant improvement in naming for trained words following therapy and still present 2 months after therapy. Significant generalization to untrained words from DO-80 and significant improvement to daily-life communication assessed by «Échelle de communication verbale de Bordeaux».	NA

NS= Not specified, NA= Non available, USA=United States of America, UK=United-Kingdom,
MQA=Methodological quality assessment, LOE= Level of evidence, CVA=Cerebrovascular accident, TBI=Traumatic brain injury
* Magnitude of change was calculated based on the raw data available in the study

Table 1. Main characteristics of the included studies (studies 6 to 10)

#	Identification	MQA	LOE	Experimental design	n	Time postonset	Type of aphasia	Technology	Treatment name/ Software	Target
6	Herbert et al. 2012	12	III	Single-subject	6	25 - 60 months	Anomic (n=2) Broca(n=2) Conduction (n=1) Trans. Sensory (n=1)	Computer	NS	Nouns 2 lists: trained and control
7	Palmer et al. 2012	22	I	Randomized Controlled Trial	Usual care: 17 Computer: 16	12 - 348 months	Fluent (n=6) Non fluent (n=25) Global (n=2)	Computer	StepByStep	Nouns + verbs 1 list: trained
8	Adrian et al. 2011	11	III	Single-subject	Healthy controls: 15 People with aphasia: 15	12 - 104 months	Anomic (n=3) Broca (n=2) Wernicke (n=4) Conduction (n=1) Mixed (n=5)	Computer	Computer-assisted Anomia Rehabilitation Program 2 (CARP-2)	Nouns + verbs 1 list: trained
9	Choe & Stanton 2011	13	III	Single-subject	2	49 - 173 months	Broca (n=1) Anomic (n=1)	Computer	NS	Nouns 3 lists: trained with auditory-visual cues, trained with auditory-only cues and control
10	Fridriksson et al. 2009	13	III	Single-subject	10	17 - 216 months	Broca (n=10)	Computer	NS	Nouns 2 lists: trained with audio-visual treatment and trained with audio-only treatment

Cueing	Treatment intensity	Setting	Presence of the clinician	Main results	Magnitude of change (range)
Lexical and syntactic	3 levels of therapy with 2 sessions at each level	Home	No	Improved picture naming for treated nouns for 5/6 participants but not for untreated nouns. Significant increase in determiner + noun combinations in a story-telling task for 4/6 participants. Maintenance of therapy effects six weeks post-treatment.	Effect sizes: 2.59-6.43
Semantic, phonological and orthographic	≥ 20 minutes 3x/week for 5 months	Home	No	Intervention associated with significant 19,8% mean improvement in change in percentage of all words named correctly at 5 months at the Object and Action Naming Battery. Mean difference in change not statistically significant at 8 months. Participants with more severe aphasia (<10% of words at baseline) showed little benefit.	NA
Semantic, phonological and orthographic	2x/week for a total of 30 sessions	Clinic	Yes	Significant improvement in naming of the trained items for the aphasic group but still a significant difference between their skills and the control group. Significant generalization to trained items in a different context for all participants and to untreated items for 11/15 participants.	% of change: 17.4-1037.5*
Semantic and phonological presentend auditory and/ or visually	P1: 30 minutes, 5x/week for 4 weeks P2: 30 minutes, 10x over 4 weeks	Clinic	No	Participant 1 (Broca): Greater improvements in the auditory-visual condition than in the auditory-only condition. No significant change in control condition. Participant 2 (Anomic): Significant improvement in the auditory-visual and auditory-only conditions. However, qualitative analysis of number of words produced without the clinician's support suggests the advantage of the auditory-visual practice.	NA
Phonological presented auditory and/or visually	5x/week 3 levels and maximum of 15 sessions/level	Home	No	Significant improvement in naming for items trained in the audio-visual condition but not for those in the audio-only condition. Significant generalization to untrained items (Philadalphia Naming Test) following audio-visual treatment but not following audio-only treatment.	NA

NS= Not specified, NA= Non available, USA=United States of America, UK=United-Kingdom,
MQA=Methodological quality assessment, LOE= Level of evidence, CVA=Cerebrovascular accident, TBI=Traumatic brain injury
* Magnitude of change was calculated based on the raw data available in the study

Table 1. Main characteristics of the included studies (studies 11 to 15)

#	Identification	MQA	LOE	Experimental design	n	Time postonset	Type of aphasia	Technology	Treatment name/ Software	Target	Cueing	Treatment intensity	Setting	Presence of the clinician	Main results	Magnitude of change (range)
11	Choe et al. 2007	13	III	Single-subject	4	17 - 156 months	Non fluent (n=4)	Computer	NS	Nouns 3 lists: trained with computer only, trained with clinician only and control	Semantic, phonological and orthographic	Computer: 1x/day for 14 weeks Clinician: 1x/week for 14 weeks	Home Clinic	No Yes	Words trained with computer: Significant improvement for 2 participants and marginally significant gains for another one. Maintenance of the gains 5 weeks post-treatment. Words trained with clinician: Significant improvement for 1 participant but no maintenance. No significant improvement for untrained words.	NA
12	Ramsberger & Marie 2007	12	III	Single-subject	4	6 - 72 months	Anomic (n=1) Broca (n=1) Wernicke (n=1) Conduction (n=1)	Computer	MossTalk Words (Cued Naming Module)	Nouns 3 lists: trained with intensive treatment, trained with nonintensive treatment and control	Semantic, phonological and orthographic	Intensive: 5x/week Nonintensive: 2x/week	Home	No	Clinically meaningful improvement (at least 20% over baseline) achieved on trained words for all participants immediatly after treatment and at maintenance. Weak evidence of generalization to untrained words for 2 participants and no evidence of generalization for the other 2 participants. No difference in level of evidence when intense and nonintense treatments are compared for 3 of 4 participants.	Effect sizes: 2.08-14.68 % of change: 22-519
13	Laganaro et al. 2006	11	III	Single-subject	8	1 - 2 months	Anomic (n=3) Broca (n=1) Wernicke (n=1) Conduction (n=1) Trans. Sensory (n=1) Mixed (n=1)	Computer	NS	Nouns 2 conditions: single list (48 items) and double list (96)	Semantic, phonological and orthographic	5 sessions/condition	Clinic	No	Significant improvement in picture naming for 7 of 8 participants. Superior overall gains after practising the double list, despite fewer item repetitions.	NA
14	Raymer et al. 2006	11	III	Single-subject	5	4 - 42 months	Broca (n=2) Conduction (n=2) Mixed trans. (n=1)	Computer	MossTalkWords (Multi-Mode Matching Exercices Module)	Nouns 3 lists: trained in phase 1, trained in phase 2 and control	Spoken and/or written picture matching + repetition	Phase 1: 1-2x/week for 12 sessions Phase 2: 3-4x/week for 12 sessions	Clinic	Yes	Improvement for trained word for 5/5 participants post-treatment and at one month post. Greater improvements for trained sets during the most frequent schedule of training. Increases in picture naming for untrained sets present for 3/5 participants but only when training was provided 3-4 times/week.	Effect sizes: .12-11
15	Doesborgh et al. 2004	19	I	Randomized Controlled Trial	No treatment: 10 Computer: 8	11 - 17 months	NS	Computer	Multicue	Nouns 1 list: trained	Semantic and orthographic	30-45 minutes, 2-3x/week for 2 months	Clinic	Yes	Significant generalization on the Boston Naming Test for the computer group only. No significant generalization to verbal communicative ability (Amsterdam Nijmegen Everyday Language Test) for both groups. No significant difference between the two groups for mean improvement on both tests.	NA

NS= Not specified, NA= Non available, USA=United States of America, UK=United-Kingdom, MQA=Methodological quality assessment, LOE= Level of evidence, CVA=Cerebrovascular accident, TBI=Traumatic brain injury
* Magnitude of change was calculated based on the raw data available in the study

Table 1. Main characteristics of the included studies (studies 16 to 20)

#	Identification	MQA	LOE	Experimental design	n	Time postonset	Type of aphasia	Technology	Treatment name/ Software	Target
16	Mortley et al. 2004	12	III	Single-subject	7	24 - 144 months	NS	Computer	StepByStep	Nouns + verbs 1 list: trained (sets 1 and 2)
17	Adrian et al. 2003	12	III	Single-subject	1	NS	Fluent	Computer	Computer-assisted Anomia Rehabilitation Program (CARP)	Nouns + verbs 1 list: trained
18	Laganaro et al. 2003	12	III	Single-subject	Out-patients: 4 In-patients: 7	2 - 120 months	Anomic (n=2) Broca (n=1) Wernicke (n=1) Conduction (n=3) Trans. motor (n=1) Mixed (n=3)	Computer	NS	Nouns 3 lists: trained by computer, trained by clinical treatment and control
19	Fink et al. 2002	12	III	Single-subject	Clinician guided: 3 Partially self-guided: 3	28 - 92 months	Anomic (n=2) Broca (n=1) Conduction (n=3)	Computer	MossTalk Words (Cued Naming Module)	NS 2 sets: trained
20	Pedersen et al. 2001	10	III	Single-subject	3	≈ 6 - 21 months	Anomic (n =2) Trans. sensory (n=1)	Computer	NS	Nouns 2 lists: trained and control

Cueing	Treatment intensity	Setting	Presence of the clinician	Main results	Magnitude of change (range)
Semantic, phonological and orthographic	27 weeks	Home	No	Significant improvement for naming of the trained items for all participants. Generalization to untreated items of set 2 for 3/7 participants. Improvement in naming ability and functional communication for all participants reported by semi-structured interviews.	% of change: 41.7-165.2*
Semantic, phonological and orthographic	45 minutes/day x 12 days	Home	Yes	Significant improvement in naming for the trained items 30 days after the end of the treatment. Significant generalization to untrained items (PALPA Oral Picture Naming Test).	% of change: 31*
Phonological and orthographic	Out-patients: 2-3x/week for 2 weeks In-patients: 1x/day for 2 weeks	Clinic	No	Out-patients: Increase in naming for items trained by computer and clinical treatment and maintenance of effects 2 weeks after the end of the treament. No generalization for untrained items. In-patients: Increase in naming performance for 6/7 participants. Item-specific effect of computer treatment observed for 3/7 participants.	NA
Phonological and orthographic	3x/week for a maximum of 4 weeks	Clinic	Yes/No	Significant improvement for trained words in both conditions and maintenance at 4 weeks. Generalization for untrained items observed for 3/6 participants. Greater acquisition and maintenance effects for the clinician-guided group, but 50% of the stronger performers in partially self-guided group.	NA
Semantic, phonological and orthographic	Until criteria is reached	Home	No	Specific effect for the trained word observed for 2/3 participants while a more general effect was found for the other one.	% of change: 13.1-50.7*

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* Magnitude of change was calculated based on the raw data available in the study

Table 1. Main characteristics of the included studies (studies 21 to 23)

#	Identification	MQA	LOE	Experimental design	n	Time postonset	Type of aphasia	Technology	Treatment name/ Software	Target	Cueing	Treatment intensity	Setting	Presence of the clinician	Main results	Magnitude of change (range)
21	Deloche et al. 1993	11	III	Single-subject	2	≈ 10-144 months	NS	Micro-computer	NS	NS 2 lists: trained and control	Semantic, orthographic and morphological	25 sessions, approximately 6 weeks	Clinic	Yes	P1: Significant improvement for trained and control items, in both trained (written) and untrained (oral) modalities. Maintenance up to 1 year post-treatment. P2: Significant improvement for trained and control items in the trained modality (written). Significant improvement for trained items only in the untrained modality (oral). Maintenance up to 1 year post-treatment.	NA
22	Deloche et al. 1992	12	III	Group study	18	5 - 216 months	Anomic (n=4) Broca (n=2) Wernicke (n=5) Conduction (n=2) Global (n=4) Thalamic (n=1)	Micro-computer	NS	NS 3 lists: cued, uncued and control	Semantic, orthographic and morphological	3x/week	NS	NS	Significant improvement in naming for trained items with greater effect for cued items. Significant generalization to control items and to untrained (oral) modality.	NA
23	Bruce & Howard 1987	13	III	Single-subject	5	11 - 50 months	Broca (n=5)	Micro-computer	NS	Nouns 4 lists: trained + aid, trained without aid (control condition), untrained + aid, untrained without aid	Phonological	5 sessions	Clinic	Yes	Significantly better performance with the aid than in control condition for 4/5 participants. Significantly better performance for treated items but generalization to untreated items observed for 2 participants.	NA

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MQA=Methodological quality assessment, LOE= Level of evidence, CVA=Cerebrovascular accident, TBI=Traumatic brain injury
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Appendix

<u>Example of scoring for the conversation task</u>

1) Transcript

E = Experimenter; P = Participant; SP = Successful production; UP = Unsuccessful production

E = What did you have for breakfast this morning?

P = I had a <u>coffee</u> (SP). And the things I eat with milk every morning…

E = Cereals?

P = Yes <u>cereals</u> (UP)! With <u>strawberries</u> (SP) and <u>blueberries</u> (SP) in it.

* Words included in the study are underscored.

2) Analysis

Number of production possibilities = 4

Number of successful productions = 3

Number of unsuccessful productions = 1

Percentage of anomia = $\frac{\text{Number of unsucessful productions}}{\text{Number of production possibilities}}$ x 100 = ¼ x 100 = 25%