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L'utilisation de tablettes tactiles comme outils d'enseignement auprès d'enfants ayant un trouble du spectre de l'autisme

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Thèse présentée
en vue de l'obtention du grade de Philosophiæ Doctor (Ph.D.)
en pychoéducation

Novembre 2016

Résumé

Compte tenu de l'augmentation du taux de prévalence du trouble du spectre de l'autisme (TSA) ainsi que des ratios enseignant : élèves souvent défavorables en milieux scolaires, les chercheurs et intervenants se tournent de plus en plus vers la technologie numérique afin d'enseigner un large éventail d'habiletés aux individus ayant un TSA. En dépit de cet intérêt grandissant pour la technologie numérique en tant qu'outil d'enseignement, nous relevons certaines limites dans les études précédentes nous empêchant d'en tirer des conclusions fermes. Parmi ces limites figurent l'inclusion d'une composante humaine à l'intervention (soutien assez important offert par l'intervenant lors de l'enseignement avec la tablette), le manque de vérification de la généralisation des concepts enseignés à des objets 2D (ex., image d'un chat) et 3D (ex., peluche représentant un chat) ainsi que l'absence d'évaluation du maintien sur une longue période de temps suite au retrait de l'intervention. Reposant sur les fondements d'études précédentes, cette thèse doctorale visait à évaluer l'efficacité des tablettes comme outil d'évaluation et d'enseignement auprès d'enfants ayant un TSA. Dans la première expérience, nous avons évalué l'efficacité des tablettes afin de déterminer la préférence de vidéos de cinq enfants ayant un TSA. Les résultats obtenus soulignent ainsi l'efficacité d'utilisation des tablettes afin d'identifier des renforçateurs vidéos auprès d'enfants ayant un TSA. La deuxième expérience intègre cette même procédure d'évaluation de renforçateurs vidéos pour enseigner des concepts à cinq enfants ayant un TSA. Les résultats de l'étude confirment également l'efficacité des tablettes comme outil d'enseignement de concepts. Finalement, la troisième expérience prend appui sur la deuxième afin de comparer l'efficacité de l'enseignement de concepts dispensé à sept enfants ayant un

TSA par le biais de tablettes à celui dispensé par un intervenant. Les résultats de l'étude suggèrent que l'enseignement avec un intervenant est plus efficace que celui dispensé avec une tablette. Ceci étant dit, bien que la plupart des enfants apprenaient plus lentement avec la tablette, la majorité a tout de même acquis les concepts enseignés avec cette dernière. Dans l'ensemble, les résultats de ces trois expériences indiquent que la tablette constitue un outil d'évaluation de la préférence et d'enseignement efficace auprès d'enfants ayant un TSA. Une présentation plus approfondie des contributions de cette thèse à l'avancement des connaissances, ses implications ainsi que les recommandations offertes aux futurs chercheurs sont étayées dans cette recherche doctorale.

Mots-clés : autisme, tablette, enseignement par essais distincts, intervenant, vidéo, préférence, généralisation.

Abstract

Considering the increased prevalence of with autism spectrum disorder (ASD) coupled with unfavorable teacher: student ratio in school settings; researchers and educators alike have been increasingly turning to technology as an instructional tool for children with ASD. Despite this increased interest for technology as a teaching tool targeting a variety of skills, the limitations of previous studies prevent us from drawing firm conclusions regarding its effectiveness. Among those limitations is the inclusion of a human component to the intervention (important level of support offered by the therapist while teaching with the tablet), the lack of generalisation probes of concepts taught to 2D (e.g., image of a cat) and 3D objects (e.g., toy representing a cat) as well as the lack of maintenance probes conducted over an extended period of time following the withdrawal of the intervention. Based on the previous research, the present doctoral thesis aimed to evaluate the effectiveness of tablets as assessment and teaching tools for children with ASD. In the first experiment, we evaluated the effectiveness of tablets as preference assessment tools for videos in five children with ASD. The results of the experiment highlight the effectiveness of tablets to assess preference for videos children with ASD. The second experiment relies on the same preference assessment procedure in order to teach concepts to five children with ASD. The results of the study also confirm the effectiveness of tablets as teaching tools for children with ASD. Lastly, the third and final experiment build on the results of the second in order to compare the effectiveness of teaching concepts with a tablet to that of an instructor to seven children with ASD. The results obtained suggest that teaching delivered by an instructor seems to be more efficient than the one delivered with a tablet. Even though most children were learning more slowly from the tablet, the vast majority still acquired and generalized concepts taught with it. In sum, the results obtained from the three experiments indicate that tablets could represent an efficient preference assessment tool as well as a teaching tool for children with ASD. A more thorough description of this thesis' contribution to the advancement of knowledge as well as its implications and the recommendations offered to future researchers is further disseminated in this thesis.

Keywords: autism, tablet, discrete trial training, instructor, video, preference, generalization.

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Liste des sigles

AAC : Analyse appliquée du comportement

ABAS-II : Adaptive Behavior Assessment System-Second Edition

APA : American Psychiatric Association

ASD : Autism Spectrum Disorder

CAI : Computer-Assisted Instruction

CARS-2 : Childhood Autism Rating Scale-Second Edition

CRDITED : Centres de réadaptation en déficience intellectuelle et en trouble envahissant du développement

DI : Déficience intellectuelle

DSM : Diagnostic and Statistical Manual of Mental Disorders

DTT : Discrete Trial Training

GAC : General Adaptive Composite

ICI : Intervention comportementale intensive

IOA : Interobserver Agreement

iOS : iPhone Operating System

TSA : Trouble du spectre de l'autisme

MSSS : Ministère de la Santé et des Services sociaux

QI : Quotient intellectuel

À tous les enfants ayant un TSA qui méritent de recevoir des services d'intervention.

Remerciements

Mes premiers remerciements vont d'abord à mon superviseur de thèse, Dr Marc Lanovaz qui m'a accompagnée durant mon parcours. Merci pour ton écoute active, pour tes judicieux conseils et surtout pour ton sincère souci quant au développement professionnel de tes étudiants. Merci aussi pour la qualité de ta supervision ainsi que ta générosité avec ton temps et de ton énergie : malgré les nombreux projets dans lesquels tu es impliqué, tu t'assures toujours d'offrir à chacun et chacune d'entre nous le temps et l'attention nécessaires. Parce que tu m'as offert l'occasion de me dépasser, j'ai pu travailler sur plusieurs projets et articles scientifiques et ainsi développé mes habiletés de chercheure. Plus qu'un superviseur de thèse, tu as agi comme mentor en m'orientant à plusieurs moments durant ce long parcours. Tu m'as offert des conseils très précieux et des leçons qui m'accompagneront, je n'en doute pas, tout au long de ma carrière de chercheure.

Un grand merci à Marie-Michèle Dufour et à Gabrielle St-Onge de leur aide pour ma collecte de données. Travailler avec des enfants présentant des comportements problématiques peut-être lourd à des moments, mais ça été un vrai plaisir que de travailler avec vous en trouvant de l'humour dans des situations difficiles. Un sincère merci également à Valérie Martin et Malena Argumedes avec lesquelles j'ai eu le plaisir de travailler sur différents projets. Ce fut un vrai plaisir de travailler ensemble et Malena, mon parcours de doctorat n'aurait pas été pareil sans toi.

Je tiens également à remercier l'équipe du Laboratoire de recherche comportementale appliquée, qui se distingue non seulement par son dédiement au travail, mais aussi par un bel esprit d'équipe cultivé par l’entremise de multiples activités de groupe. En plus d'avoir soudé notre esprit d'équipe, ces activités ont permis d'alléger et d'entrecouper avec beaucoup d'humour ce parcours de doctorat. J'aimerais aussi remercier Darine Ameyed qui a développé l'application utilisée dans le cadre cette recherche doctorale.

Je tiens par ailleurs à remercier toute l'équipe de l'école de l'Étincelle. Un merci particulier à Brigitte Grignon-Labine et à Pascal Gallant qui ont grandement favorisé le bon déroulement de cette recherche doctorale. Brigitte, un énorme merci de m'avoir accommodée jour après jour en me trouvant un local, voire même en me cédant ton propre bureau lorsqu'aucun n'était disponible. Vous m'avez tous deux touchée par votre grande générosité et par votre désir sincère d'améliorer le quotidien des enfants sous votre charge. Merci également aux enseignants et parents d'enfants impliqués dans cette étude, qui ont eu la gentillesse de m'accommoder et de m'offrir de leur temps. J'ai été particulièrement touchée par votre persévérance et par votre désir de favoriser l'atteinte du plein potentiel de chaque enfant.

Un énorme merci à tous les membres du personnel de l'École, dont notamment Suzanne, Jeannine, Martine et Carmen, puis à tous les professeurs de l'École de psychoéducation, dont Dre Sophie Parent qui m'a offert de précieux conseils durant mon parcours doctoral. Merci aussi à Dre Isabelle Archambault pour tes avis judicieux au fil des années. Toutes deux représentez un modèle de femmes fortes, mais en même temps sensibles aux besoins des autres, modèle auquel j'aspire. Je tiens également à remercier Dr Stéphane Cantin et Dr Normand Giroux dont les rétroactions et conseils offerts tout le long de mon parcours ont grandement contribué à la qualité de cette recherche doctorale. À cet effet, je tiens également à remercier ma famille et mon mari.

Dad, it is by watching you from a young age working countless hours that you have entrusted in me the values of discipline and hard work. You always encouraged me to find a line of work that I loved and to give it my all. It is because of you that I have acquired those work related skills that have carried me to this point. You never criticised my choices but instead encouraged me to go above and beyond the limits our mind sets for ourselves. In doing so, you have taught me lifelong lessons that have carried me this far and that I am sure I will carry for the rest of my life.

To my dear mother, to my confident and best friend, thank you for always encouraging me, for your unrelenting optimism and especially for supporting my dreams even though they have taken me away from you. I know that spending many years away from you has pained you, yet you always supported me in all my endeavours no matter how small they were. Thank you for being so selfless! I firmly believe that I would not have gotten to this point if it wasn't for your unconditional love, for your unwavering support and for your belief in me. From the bottom of my heart, thank you!

Growing up with two brothers, I often found myself wishing for a sister. Yet in retrospect, I wouldn't have had it any other way, mainly because it helped strengthen my character. To my older brother, Yves, I have always had an enormous amount of respect and admiration for you. Thank you for always paving the way for me! To my younger brother, Guy, thank you for your humour, for your love and support.

To my dear husband, I cannot express how thankful I am for your infinite patience, for listening to me during countless hours, for cooking for me when I barely had time to eat, for finding humour in every situation, for encouraging me and for always trying to make each day better for me. I am enormously grateful for your love, support and understanding of the constraints that often accompany this long journey.

En dernier lieu, un sincère merci à mes amis et plus particulièrement à Laure, Hélène, Solange, Sonia, Nayla, Lynn et Dima qui m'ont soutenue durant des années. Le temps que j'ai passé avec vous m'a apporté beaucoup de joie et a été très important pour la continuation de mon parcours. Merci à Nicole, Julie et Marie-Ève pour votre soutien et précieux conseils! Un énorme merci aussi à mon superviseur de maîtrise Dr Alain Marchand qui m'a partagé son amour de la recherche. J'en serai toujours reconnaissante! Finalement et non le moindre, mon dernier remerciement va à Annick, pour ton écoute et pour avoir participé avec moi à plusieurs activités sportives au fil des années; activités qui m'ont beaucoup aidé à réduire mon stress, à oxygéner mon cerveau et à me remettre sur la bonne voie.

Contributions des auteurs aux articles de thèse doctorale

En plus d'avoir recueilli les données pour les trois articles, j'ai analysé les données et rédigé les trois articles constituant cette thèse. Marc J. Lanovaz a participé à la conception des trois expériences constituant cette thèse doctorale, a supervisé la collecte de données, la revue de littérature, la soumission des articles à des fins de publication et a offert ses conseils tout au long de cette recherche doctorale. Marie-Michèle Dufour quant à elle, a aidé à collecter les données des deux premiers articles et son mémoire de maîtrise a contribué à la conceptualisation du troisième article.

Présentation de la thèse doctorale

Le premier chapitre de cette recherche doctorale présente le contexte théorique sur lequel repose ma thèse. Il offre un aperçu des études ayant évalué l'efficacité de la technologie numérique auprès d'individus ayant un TSA et souligne leurs limites. L'objectif principal de cette thèse est donc de contribuer à la littérature en essayant de bâtir sur les limites des études relevées dans ce chapitre. Plus spécifiquement, l'objectif de la première expérience vise à déterminer l'efficacité de l'utilisation des tablettes à des fins d'évaluation de la préférence de vidéos auprès d'enfants ayant un TSA. La deuxième expérience vise à évaluer l'efficacité de l'apprentissage de concepts sur tablettes auprès d'enfants ayant un TSA. Finalement, la troisième expérience vise à comparer l'efficacité de l'enseignement sur tablette à celui dispensé par un intervenant. À cet effet, les chapitres deux, trois et quatre présentent les trois articles constituant cette thèse doctorale.

Dans le chapitre deux, nous présentons l'article intitulé Using computer tablets to assess preference for videos in vhildren with autism qui a été publié dans la revue *Behavior Analysis in Practice* (voir Chebli et Lanovaz, 2016). L'article visait à évaluer l'efficacité d'utilisation des tablettes afin de déterminer la préférence de vidéos auprès d'enfants ayant un TSA. À notre connaissance, aucune étude n'a comparé l'efficacité de la vidéo préférée avec la moins préférée nous empêchant ainsi de se prononcer sur leurs efficacités relatives.

Dans le chapitre trois, nous avons examiné l'efficacité des tablettes comme outil d'enseignement auprès d'enfants ayant un TSA dans l'article intitulé Generalization of one-word concepts following tablet-based instruction in children with autism spectrum disorders. La rédaction de cet article qui est présentement sous presse a été motivée par les limites d'études précédentes (Bosseler et Massaro, 2003; Heimann, Nelson, Tjus et Gillberg, 1995;

Hetzroni et Tannous, 2004; Moore et Calvert, 2000; Sansosti et Powell-Smith, 2008; Schery et O' Connor, 1997), dont notamment: (a) la dépendance de l'enfant envers son intervenant afin de lui offrir un renforçateur (b) le fait que peu d'études ont démontré un contrôle fonctionnel entre l'intervention et l'apprentissage des concepts et finalement la constatation que (c) la plupart des études précédentes ont évalué la généralisation des concepts enseignés à des images au profit d'objets véritables. Reposant sur cette analyse, l'article deux visait donc à : évaluer si les enfants démontraient une généralisation des concepts enseignés sur tablette à de nouveaux exemples non enseignés, vérifier le maintien de ces concepts plusieurs semaines suite au retrait de l'intervention, minimiser la dépendance de l'enfant envers son intervenant et réduire les menaces à la validité interne de l'étude.

Dans le chapitre quatre, nous avons comparé l'efficacité de l'enseignement dispensé par le biais d'une tablette à celui dispensé par un intervenant. L'article intitulé Comparison of tablet-delivered and instructor-delivered teaching on receptive identification in children with autism spectrum disorders est présentement en évaluation par le comité d'une revue scientifique. Un retour sur la littérature nous a ainsi permis de constater que peu d'études ont comparé ces deux modes d'apprentissage (Allen, Hartley et Cain 2015; Moore et Calvert, 2000). Les objectifs de cette expérience visaient donc à : (a) comparer l'efficacité de l'enseignement dispensé par un intervenant à celui dispensé par le biais d'une tablette sur la généralisation de concepts non enseignés, (b) comparer le maintien des concepts enseignés à l'aide de ces outils et finalement (c) comparer l'engagement et le travail hors tâche des enfants lors de la dispensation de l'enseignement.

Finalement, le chapitre cinq offre un résumé des conclusions tirées de ces trois expériences et élabore sur leurs implications pour la recherche, la clinique ainsi que pour la psychoéducation. La thèse se conclut avec les forces et les limites de l'étude doctorale, suivies par des pistes de recherches pour les futures études.

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Chapitre 1. Introduction

Contexte théorique

Selon des estimations récentes, environ 123 enfants sur 10 000 âgés entre quatre et dix-ans sont diagnostiqués avec un TSA au Québec (Noiseux, 2015). Les personnes ayant un TSA présentent des difficultés sur le plan des habiletés sociales, de la communication ainsi que des comportements répétitifs (American Psychiatric Association, 2013). Entre 25 et 30% d'enfants ayant un TSA seraient non verbaux (Goupil et Poirier, 2012) et entre 25 et 70% présenterait une déficience intellectuelle (DI; Matson et Shoemaker, 2009). S'ajoutent également à ce portrait des problèmes de santé mentale et physique additionnels dont entres autres, des difficultés en lien avec le sommeil, l'alimentation, l'anxiété ainsi que les habiletés motrices (Bauman, 2010; Matson, Matson et Beighley, 2011;Simonoff, Pickles, Charman, Chandler, Loucas et Baird, 2008). Ce lourd portrait clinique pourrait entraver leurs apprentissages et se solder par un manque d'inclusion sociale et scolaire (Goupil et Poirier, 2012).

En raison de ces nombreuses difficultés, seulement 40% des enfants identifiés par le Ministère de l'Éducation, des Loisirs et du Sport comme ayant un TSA et bénéficiant de services seraient intégrés dans des classes ordinaires, alors que la majorité (60%) fréquenterait une classe spéciale (Goupil et Poirier, 2012).

Malgré l'amélioration des services offerts aux enfants ayant un TSA, plusieurs difficultés demeurent présentes tout au long de leur vie. C'est pourquoi plusieurs personnes restent dépendantes de leurs familles et des services de soutien. Notamment, seulement une minorité des personnes ayant un TSA vivent seules, ont des amis ou un emploi (Howlin, Goode, Hutton et Rutter, 2004). Contrairement aux enfants sans difficulté de développement qui apprennent par le biais du jeu, de la communication, de l'imitation et de la conversation (Bredekamp et Copple, 1997; Ginsburg, 2007), les enfants ayant un TSA, semblent se heurter plus souvent à des difficultés en lien avec l'apprentissage, d'où la nécessité de leur dispenser une intervention individualisée.

Les difficultés d'imitation souvent relevées auprès d'enfants ayant un TSA pourraient expliquer en partie leurs problèmes d'apprentissage. Alors qu'un enfant sans difficulté du développement apprend naturellement par le simple fait d'être exposé à ses parents et ses pairs (Ingersoll, 2008; Williams, Whiten et Singh, 2004), les enfants ayant un TSA semblent se heurter à plus de difficultés à ce niveau (Lovaas, 2003). Or, l'imitation représente un moteur de développement qui permet de multiplier et surtout d'accélérer les occasions d'apprentissage des enfants (Meltzoff, Kuhl, Movellan et Sejnowski, 2009). Considérant que l'imitation est essentielle au développement d'une cognition sociale, à l'apprentissage du langage et à l'utilisation d'objets, il devient d'autant plus important de la cibler en premier dans le cadre d'une intervention (Charman et al., 2003; Meltzoff, 2007; Rendell et al., 2010; Sommerville, Woodward et Needham, 2005).

Un manque de motivation sociale pourrait également expliquer les difficultés d'apprentissage des enfants ayant un TSA puisque les renforçateurs sociaux sous forme de sourire ou de félicitations ne sont pas toujours efficaces auprès d'eux (Chevallier, Kohls, Troiani, Brodkin et Schultz, 2012). D'où le fait qu'il est souvent nécessaire d'intégrer des renforçateurs tactiles ou alimentaires préférés par l'enfant afin de susciter chez lui un certain degré de motivation puis transiter graduellement vers des renforçateurs sociaux plus naturels. Par la suite, il importe de reconnaitre et de cibler les difficultés de généralisation des acquis, souvent rencontrées par les personnes ayant un TSA (Brown et Bebko, 2012; Happé et Frith, 2006; Lovaas, Koegel, Simmons et Stevens, 1973; Plaisted, O'Riordan et Baron-Cohen, 1998). Cette notion de généralisation se réfère à la capacité d'un individu à transférer ses apprentissages à de nouveaux exemples non enseignés ou à de nouveaux contextes (Stokes et Baer, 1977). À titre d'exemple, apprendre à dire « j'ai besoin d'aide » à l'école ne garantit pas le transfert de cette habileté à la maison. De même, enseigner le concept de « chat » avec un chat de couleur blanche, ne garantit pas la reconnaissance du concept « chat » lors de la perception d'un chat de couleur noire. Finalement, il importe également de mentionner les atypies sensorielles sur le plan de l'ouïe, de la vision et même du toucher qui pourraient entraver le processus d'apprentissage des enfants ayant un TSA dans leur milieu naturel (Leekam, Nieto, Libby, Wing et Gould, 2007).

En dépit des difficultés d'apprentissage, de nombreuses études ont souligné l'efficacité de l'apprentissage par essais distincts afin d'enseigner de nouveaux comportements aux enfants ayant un TSA. Aussi connue sous le nom de Discretre Trial Training (DTT), cette méthode d'enseignement est souvent privilégiée en intervention en raison de son large soutien empirique (Downs, Downs, Johansen et Fossum, 2007; Downs, Downs, Fossum et Rau, 2008; Lovaas, 1987; Smith, 2001; Smith, Mruzek, Wheat et Hughes, 2006; Tsiouri, Schoen, Simmons et Paul, 2012). À cet effet, un essai distinct représente une petite unité d'enseignement mise en place par un intervenant. Cet essai distinct est habituellement constitué de cinq composantes :

(a) Un *stimulus discriminatif* dans le cadre duquel un intervenant présente une instruction concise et claire telle que par exemple : « Lance le ballon », ou pose une question à l'enfant telle que : « Où est le chien? »

(b) Une *incitation* qui est offerte soit en même temps que le stimulus discriminatif, soit suite à un délai de quelques secondes, visant ainsi à aider l'enfant à répondre correctement. Par exemple, l'intervenant pourrait pointer l'objet représentant le concept enseigné ou modeler le comportement requis. Au fur et à mesure qu'un enfant progresse, l'intervenant devrait minimiser le nombre d'incitations offertes afin que seul le stimulus discriminatif évoque le comportement attendu.

(c) Une *réponse* émise par l'enfant suite à l'incitation de l'intervenant. Cette réponse pourrait d'ailleurs être correcte ou incorrecte.

(d) Une *conséquence* offerte par l'intervenant, qui dépendra de la réponse de l'enfant. Dans le cas d'une réponse correcte, l'intervenant renforcera la réponse émise par l'enfant par le biais d'un renforçateur. Ce renforçateur est offert dans le but d'augmenter la probabilité que l'enfant émette cette même réponse dans le futur. À cet égard, les renforçateurs pourraient prendre différentes formes, dont celles d'ordre social (ex., bravo, super, excellent), alimentaire, audiovisuel ou autres. Inversement, si l'enfant émet une réponse incorrecte, l'intervenant ne devrait pas renforcer cette réponse, mais plutôt déclencher une procédure de correction (ex., émettre un « non », puis pointer la bonne image).

(e) Finalement, la dernière composante est l'*intervalle entre les essais*. Après la conséquence, l'intervenant devrait attendre quelques secondes avant de présenter le prochain stimulus discriminatif.

L'efficacité de la méthode d'enseignement par essais distincts est attribuable à plusieurs variables, dont notamment, la réduction de la frustration de l'enfant, souvent engendrée par des longues séances d'enseignements traditionnels (Carroll, Kodak et Adolf, 2016; Caroll, Joachim, St Peter et Robinson, 2015; Sepulveda, 2015; Smith, 2001). Dans le but de maintenir la motivation de l'enfant, les intervenants devraient privilégier des renforçateurs variés qui rejoignent ses intérêts, en plus de travailler individuellement avec l'enfant, dans un environnement dépourvu de distractions et dans lequel ils peuvent individualiser les instructions à ses besoins.

Finalement, dans le cadre de cette méthode d'enseignement, les interactions auxquelles sont exposées les enfants dans un contexte d'enseignement traditionnel sont décomposées à leurs composantes essentielles : chaque essai commence par un point de départ (le stimulus discriminatif) et se termine par une fin bien délimitée (la conséquence). Le contexte de présentation et le format précis d'un essai distinct permettent donc de simplifier le processus d'apprentissage de l'enfant. Il ressort donc de l'analyse précédente que la méthode d'enseignement par essais distincts permet de contourner plusieurs difficultés souvent présentées par les enfants ayant un TSA. C'est la raison pour laquelle une multitude de chercheurs et d'intervenants se sont tournés vers cette méthode d'enseignement afin de cibler diverses habiletés, dont le langage et l'imitation (Carroll, Kodak et Adolf, 2016; Downs, Conley, Downs, Fossum et Rau, 2008; Howlin, 1981; Sepulveda, 2015; Young et al., 1994), la lecture et les tâches scolaires (Caroll, Joachim, St Peter et Robinson, 2015), les habiletés sociales émotionnelles et adaptatives (Downs, Conley, Downs, Johansen et Fossum, 2008; Newsom, 1998) et afin de réduire des comportements problématiques (Matson, Benavidez, Compton, Paclawskyj et Baglio, 1996).

Ceci étant dit, l'enseignement par essais distincts présente toutefois certains désavantages, dont le fait qu'il se doit d'être dispensé en individuel, dans un environnement calme et dépourvu de distractions. Sa mise en place nécessite également des intervenants formés, une fidélité au protocole et une mobilisation considérable de ressources humaines et financières (Lovaas, 1987; Reichow et Wolery 2009; Smith, 2001). Compte tenu des désavantages de l'enseignement par essais distincts habituellement dispensé par un intervenant, le besoin d’identifier des moyens de les pallier semble être important.

Des tablettes avec des programmes d’enseignement individualisés aux besoins de l’enfant pourraient représenter une solution potentielle. Leur utilisation ne nécessite pas d’intervention continue avec un intervenant spécialisé et offre d’autres avantages, dont un espace de travail contrôlable, prévisible et structuré. Comme l’enseignement devrait être amusant pour l’enfant, l’usage de tablettes se justifie par le fait que la majorité des enfants ayant un TSA percevraient les ordinateurs comme étant intrinsèquement motivants. Un tel outil permettrait de minimiser le stimulus aversif, tel que celui associé avec des demandes faites par l’intervenant (Ramdoss et al., 2011; Sundberg et Michael, 2001).

Les enfants ayant un TSA éprouveraient de la difficulté à filtrer les informations auxquelles ils sont exposés dans leur environnement pour ne retenir que celles nécessaires à leur apprentissage (Happé et Frith, 2006; Kern et al., 2006). Ainsi, l’emploi d’une tablette leur permettrait d’être exposés à une quantité plus limitée d’information, réduisant ainsi leur confusion (Williams, Wright, Callaghan, & Coughlan, 2002). En misant sur les forces visuelles des enfants ayant un TSA, l’usage de propriétés visuelles et auditives saillantes des tablettes pourrait revêtir une importance particulière puisque leur réactivité aux stimuli environnementaux est améliorée lorsqu’ils sont exposés à des évènements prévisibles (Keay-Bright et Howarth, 2012; Moore et Calvert, 2000).

Une tablette offre par ailleurs plusieurs autres avantages dont : (a) la possibilité de contrôle de la vitesse d’apprentissage permettant aux enfants de réviser les mêmes notions autant qu’ils le désirent; (b) l'option de contrôle du volume, option pertinente pour certains enfants ayant une sensibilité sensorielle en lien avec le bruit et finalement (c) l'évitement de la fatigue de l'intervenant qui pourrait nuire à la qualité de l'enseignement (Kern et al., 2006; Williams et al., 2002). La disponibilité croissante de tablettes dans différents environnements représente un avantage indéniable, dont un outil de travail accepté facilement par les éducateurs et parents et utilisable dans différents contextes (Munson et Pasqual, 2012; Sansosti et Powell-Smith, 2008). Les raisons énumérées précédemment pourraient donc expliquer pourquoi certains enfants ayant un TSA préfèrent la technologie à d'autres outils de communication (Van der Meer, Sutherland, O'Reilly, Lancioni et Sigafoos, 2012) ainsi qu'aux interventions dispensées par des individus (Moore et Calvert, 2000). En somme, une tablette avec un programme d'enseignement individualisé aux enfants ayant un TSA pourrait représenter un mode d'enseignement intéressant : une tablette ne se fatigue pas, est prévisible, n'est jamais en colère, fatiguée ou ennuyée, ce qui n'est pas toujours le cas d'un intervenant (Colby, 1973; Munson et Pasqual, 2012).

Basées sur cette prémisse, plusieurs études ont confirmé l'efficacité de l'enseignement avec un logiciel informatique (Heimann, Nelson, Tjus et Gillberg, 1995; Hetzroni et Tannous, 2004; Knight, McKissick et Saunders, 2013; Lorah, Parnell, Schaefer, Whitby et Hantula, 2015; Ploog et al., 2012; Ramdoss et al., 2011; Sansosti et Powell-Smith, 2008; Simpson, Langone et Ayres, 2004; Smith, Spooner et Wood, 2013; Stephenson et Limbrick, 2015;Van Laarhoven, Johnson, Van Laarhoven-Myers, Grider et Grider, 2009; Williams et al., 2002). De nombreuses habiletés furent ciblées, notamment les habiletés sociales, la communication, la lecture, les mathématiques, l'orthographe, l'écriture ainsi que la réduction de stéréotypies. Parmi ces nombreuses études, une en particulier mise en place par Bosseler et Massaro (2003) a enseigné des concepts à quatorze enfants ayant un TSA dont l'âge variait entre sept et douze ans. Les résultats de l'étude soulignent l'efficacité du logiciel puisque les enfants qui y ont été exposés ont pu acquérir de nouveaux concepts en plus de démontrer une généralisation à de nouveaux exemples non enseignés. Bien que cette étude représente un bel exemple de l'utilisation de la technologie comme outil d'enseignement auprès d'enfants ayant un TSA, certaines spécificités nécessitent d'être mentionnées, dont entre autres, le soutien offert par l'intervenant lors des séances d'enseignement. Plus précisément, les intervenants ont offert des renforçateurs alimentaires ainsi que des renforçateurs sociaux (félicitations) aux enfants durant les séances d'enseignement par ordinateur, intégrant ainsi une composante humaine à l'intervention. Le renforçateur alimentaire (chips, poisson doré, croustille) a été offert suite à trois réponses consécutives durant la première et la deuxième séance d'enseignement puis suite à la sixième réponse. Le renforçateur social quant à lui, a été offert de manière non contingentée (c'est à dire indépendamment de la réponse de l'enfant) et ce, sous forme de félicitations verbales telles que : «tu as fait du bon travail » et «continue tu travailles très bien».

Cette particularité est aussi partagée par d'autres études (ex., Heimann, Nelson, Tjus et Gillberg, 1995; Sansosti et Powell-Smith, 2008; Schery et O' Connor, 1997). Par exemple, dans l'étude de Sansosti et Powell-Smith (2008), les intervenants ont incité et aidé les enfants à mettre en application leurs habiletés de communication précédemment apprises par le biais de l'ordinateur. Plus précisément, durant la période de récréation, les enseignants ont incité les enfants à pratiquer leurs habiletés de communication sociale (salutation, se joindre au groupe, partage). Ceux-ci ont également incité les pairs à participer à une activité choisie par les enfants ayant un TSA : lorsque les participants de l'étude ont demandé adéquatement de jouer avec les autres enfants, ces derniers ont accepté. Dans une autre étude mise en place par Schery et O'Connor (1997), les intervenants ont donné aux enfants les objets demandés durant leurs séances d'enseignement par ordinateur et leur ont même permis de jouer avec eux. Les objets présentés durant les séances d'enseignement par ordinateur représentaient ceux habituellement utilisés dans un contexte de jeu, tels que des hélicoptères et des voitures. Afin de favoriser le transfert du 2D (images présentées sur l'écran) au 3D (jouets), les intervenants ont donné aux enfants les objets sélectionnés sur l'écran. À titre d'exemple, si l'enfant a sélectionné «une voiture » en choisissant l'image qui lui associée sur l'écran, l'intervenant lui a donné « le jouet de voiture » et l'a encouragé à jouer avec. L'intervenant a également offert un encouragement social, a nommé l'objet donné et a commenté les actions de l'enfant. Bien que l'intégration d'une composante humaine à l'intervention ne soit pas nécessairement inadéquate, ce niveau d'implication pourrait être contreproductif dans certains contextes, notamment dans un contexte où l'intervenant n'est pas disponible pour offrir une intervention individualisée. Considérant les maigres ressources humaines et financières, l'avantage des tablettes a trait à la possibilité de les utiliser à des fins d'enseignement avec plusieurs enfants simultanément. Si l'intervenant doit offrir l'objet sélectionné sur l'écran ainsi que renforcer les bonnes réponses avec un renforçateur social et alimentaire, le ratio coûts : bénéfices d'utilisation des tablettes à des fins d'enseignement devient moins intéressant comparativement à celui traditionnellement dispensé par un intervenant.

C'est d'ailleurs la raison pour laquelle l'intégration d'un renforçateur au logiciel pourrait représenter une solution utile puisqu'il permettrait de minimiser la dépendance de l'enfant envers son intervenant. De plus, plusieurs études précédentes ont démontré que des renforçateurs vidéos pourraient permettre d'enseigner et de maintenir des comportements acquis par les enfants ayant un TSA (Davis, Fuentes et Durand, 2014; Mechling, Gast et Cronin, 2006). Toutefois, la recherche portant sur l'évaluation de la préférence de vidéos demeure peu abondante. Parmi les quelques études s'étant penchées sur le sujet, Dattilo (1986) a démontré l'efficacité de l'évaluation de la préférence sur ordinateur à l'aide de deux interrupteurs en comparant l'efficacité de la stimulation auditive, visuelle et tactile en tant que renforçateurs auprès d'enfants ayant une déficience intellectuelle (DI). Étant donné que chaque enfant a démontré une préférence pour un type de renforçateur, l'évaluation de la préférence sur ordinateur pourrait représenter une avenue intéressante pour les chercheurs et intervenants. Toutefois, les résultats de l'étude sont limités pour plusieurs raisons : les chercheurs ont offert aux enfants des stimulations visuelles et auditives séparément (c'est à dire, les vidéos étaient sans bruit). Plus encore, l'efficacité du renforçateur pour favoriser l'acquisition et le maintien d'un comportement n'ayant pas été évaluée : nous ne savons donc pas à quel point un renforçateur identifié par ordinateur pourrait être efficace dans un cadre clinique. Dans le même ordre d'idées, Mechling et al. (2006) a également mis à profit la technologie en évaluant la préférence de vidéos d'enfants ayant un TSA par ordinateur. Les résultats de l'étude suggèrent que comparativement à des items tangibles, des vidéos préférées ont permis de réduire le temps nécessaire pour accomplir une tâche. Cependant, les chercheurs n'ont pas comparé l'efficacité des vidéos préférées à ceux moins préférés dans cette étude, limitant ainsi les conclusions qu'on puisse en tirer.

Un petit nombre d'études ayant évalué l'efficacité de l'apprentissage par ordinateur ont démontré que les concepts ont été acquis suite à l'intervention offerte. Dans certaines études, les participants étaient déjà en train d'apprendre les concepts cibles et ce, avant même de débuter les séances d'enseignement par ordinateur (Bossler et Massaro, 2003). D'autres études semblent également partager la même limite, puisque les séances sur ordinateur ont été offertes en plus des séances d'enseignement dispensées par leurs parents, intervenants ou enseignants (Heimann, Nelson, Tjus et Gillberg, 1995; Schery et O' Connor, 1997; Wainer et Ingersoll, 2011). Plusieurs modes d'enseignement ont été utilisés (enseignement avec ordinateur et modelage par le biais d'un enregistrement vidéo) dans l'étude menée par Sansosti et Powell-Smith (2008), nous empêchant ainsi de nous prononcer sur l'efficacité individuelle de chacun.

Dans le même ordre d'idées, une des difficultés souvent rencontrées par les enfants ayant un TSA a trait à la généralisation. Ces enfants éprouvent souvent plus de difficulté que les enfants sans difficulté du développement à démontrer une généralisation de nouveaux mots à de nouveaux contextes et stimuli (Carr et Kologinsky, 1983; Lovaas, 2003; Stokes et Baer, 1977). En dépit de cette difficulté, peu d'études ont évalué la généralisation de concepts acquis par le biais d'un ordinateur à de nouveaux exemples non enseignés. Parmi les rares études ayant entrepris cette démarche, les chercheurs ont surtout évalué la généralisation de concepts enseignés à de nouvelles images au profit de nouveaux objets (Bosseler et Massaro, 2003; Whalen et al., 2006). Les images et les objets constituant différentes modalités ; la généralisation à l'un ne garantit pas nécessairement la généralisation à l'autre (Lovaas, 2003), d'où la nécessité de s'y attarder.

Similairement, peu de chercheurs ont évalué le maintien de concepts enseignés à long terme. Ceci étant dit, certains chercheurs s'y sont quand même attardés, mais le maintien des concepts a souvent été évalué sur une courte période de temps (Bernard-Opitz et al., 2001; Simpson et al., 2004). À titre d'exemple, Sansosti et Powell-Smith (2008) ainsi que Moore et Calvert (2000) ont évalué le maintien des concepts une à deux semaines seulement suivant au retrait de l'intervention. Sachant que le maintien de concepts enseignés représente un des déterminants de l'efficacité d'un outil d'apprentissage, nous jugeons pertinent de l'évaluer sur plusieurs semaines suite au retrait de l'intervention.

Finalement, la comparaison de l'efficacité de l'enseignement par ordinateur avec celui dispensé par un intervenant a fait l'objet de peu d'études précédentes. Dans une exception notable, une étude menée par Moore et Calvert (2000) a évalué l'efficacité de l'enseignement de concepts par ordinateur à celui dispensé par un intervenant à quatorze enfants ayant un TSA, dont l'âge variait entre trois et six ans. Comparativement à l'enseignement dispensé par un intervenant, les enfants ont appris plus de mots, étaient plus attentifs et plus motivés à apprendre par le biais du logiciel. Cependant, les chercheurs n'ont pas évalué la généralisation de concepts à de nouveaux exemples non enseignés, ce qui est d'ailleurs le cas d'autres études dont notamment celles d'Allen, Hartely et Cain (2015). En effet, comme l'étude de Moore et Calvert (2000), Allen, Hartely et Cain (2015) ont comparé l'efficacité de l'apprentissage par ordinateur avec l'enseignement avec des livres d'images. Toutefois, Allen et al. (2015) ont évalué la généralisation de concepts enseignés à des objets de différentes couleurs. Bien que les résultats de l'étude représentent une extension de ceux de Moore et Calvert (2000), s'attendre à ce que tous les objets inclus dans l'environnement aient la même forme est irréaliste.

Compte tenu de l'efficacité de la méthode d'enseignement par essais distincts conjuguée aux besoins humains et financiers assez importants qu'elle nécessite, la pertinence d'utilisation des tablettes comme outil d'enseignement à la fine pointe de la technologie est accrue. Or, les études ayant abordé la problématique d'enseignement avec la technologie numérique accusent des lacunes méthodologiques importantes. De plus, très peu d'études ont comparé l'efficacité de l'apprentissage avec une tablette à celui dispensé par un intervenant.

Considérant le taux de prévalence élevé du TSA, des ressources financières et humaines limitées pour intervenir auprès de ces enfants ainsi que l'utilisation croissante d'ordinateur et de tablettes dans les écoles et les cliniques, les trois expériences de thèse visaient à pallier ces limites perçues.

Objectifs de la thèse doctorale

La présente recherche doctorale vise donc à : (a) déterminer l’efficacité de l’utilisation de tablettes afin d’évaluer la préférence de vidéos auprès d’enfants ayant un TSA; (b) évaluer l’efficacité de l’enseignement de concepts sur une tablette auprès d’enfants ayant un TSA et (c) comparer l’efficacité de l’enseignement de concepts par le biais d’une tablette à celui dispensé par un intervenant.

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Chapitre 2. Article 1

Using Computer Tablets to Assess Preference for Videos in Children With Autism

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Cet article a été publié dans *Behavior Analysis in Practice*:
Chebli S. S., Lanovaz, M. J. (2016). Using computer tablets to assess preference for videos in children with autism. *Behavior Analysis in Practice*, *9*, 50-53. doi:10.1007/s40617-016-0109-0

Résumé

À l'aide de tablettes tactiles, nous avons évalué la préférence de vidéos de cinq enfants ayant un trouble du spectre de l'autisme (TSA). Suite à l'évaluation de la préférence, nous avons permis aux enfants de visionner la vidéo préférée ainsi que la moins préférée à condition d'être assis sur une des deux chaises et ce dans le cadre d'un programme de renforcement concurrent. Tous les participants ont systématiquement passé plus de temps assis sur la chaise associée avec la vidéo choisie le plus fréquemment durant l'évaluation de la préférence. Les résultats indiquent donc que les intervenants pourraient adopter des procédures d'évaluation de la préférence sur tablette afin d'identifier des renforçateurs vidéos auprès d'enfants ayant un TSA.

Mots-clés : autisme, évaluation de la préférence, renforçateur, tablette, vidéo.

1. Avant d'utiliser des enregistrements vidéo comme renforçateurs, les intervenants devraient procéder à une évaluation de la préférence.
2. Les intervenants pourraient utiliser les tablettes tactiles afin d'évaluer la préférence de vidéos auprès d'enfants ayant un TSA.
3. Afin d'évaluer la préférence, les intervenants pourraient diviser l'écran de la tablette en deux parties verticales et présenter les vidéos simultanément dans le cadre de présentation par paires, et ce, sans avoir recours à un logiciel spécialisé.
4. La vidéo choisie le plus fréquemment pourrait être utilisée en tant que renforçateur potentiel afin d'enseigner de nouveaux comportements.

Abstract

Using computer tablets, we assessed preference for videos in five children with autism spectrum disorder (ASD). Then, we provided access to most preferred and less preferred videos contingent on sitting on one of two chairs within a concurrent schedule design. All participants spent consistently more time sitting on the chair associated with the video selected the most often during the preference assessment, indicating that practitioners may use the tablet-based assessment procedure to identify potential video reinforcers for children with ASD in applied settings.

Keywords: autism, preference assessment, reinforcer, tablet, video

1. Prior to using video recordings as reinforcers, practitioners should assess preference.
2. Practitioners may use computer tablets to assess preference for videos in children with autism spectrum disorder.
3. To assess preference, practitioners can vertically split the screen of a tablet in two and present the videos within a paired-choice format without the need for specialized software.
4. The video selected the most often may be used as a potential reinforcer to teach novel behavior.

Using Computer Tablets to Assess Preference for Videos in Children with Autism

Researchers have shown that providing contingent access to videos may be effective at teaching and maintaining behavior in children with autism spectrum disorder (ASD; Davis, Fuentes, & Durand, 2014; Mechling, Gast, & Cronin, 2006; Roxburgh & Carbone, 2013). As such, evaluating procedures to effectively assess preference for videos appears important. Given their increased availability and affordability, computer tablets are an interesting option for practitioners aiming to identify preferred videos. That said, research on assessing preference for videos is currently scarce. In a notable example, Dattilo (1986) conducted a computerized preference assessment using two microswitches to compare preference for auditory, visual, and tactile stimulation in children with intellectual disability. Each child showed clear preference for one type of stimulation, but the results are limited insofar as the researchers only provided visual and auditory stimulation separately (i.e., the videos were soundless) and did not conduct a subsequent reinforcer assessment.

More recently, studies have shown that preferred videos may be more effective reinforcers than tangible items (Clark, Donaldson, & Kahng, 2015; Mechling et al., 2006) and that video-based preference assessments may produce results consistent with tangible assessments (e.g., Snyder, Higbee, & Dayton, 2012). However, the previous studies did not compare the effects of highly preferred videos with less preferred videos, limiting conclusions that may be drawn from the data. Thus, the purpose of our study was to replicate and extend prior research by comparing the effects of most preferred and less preferred videos identified using a tablet-based preference assessment in children with ASD on the duration of time spent sitting on the chairs associated with the two videos.

Method

Participants, Data Collection, and Interobserver Agreement

Five children with ASD between the ages of four and eleven years old participated in the study. All participants attended a specialized school for children with ASD who are not integrated in inclusive settings due to their low level of adaptive functioning or high level of problem behaviors. The first author conducted all the sessions in two rooms within the school. During the preference assessment, two independent observers recorded which video the participant selected on each trial. Selection was defined as the participant touching the screenshot of the video on the computer tablet's screen. Both observers agreed on 100% of the video selections. During the reinforcement assessment, we videotaped the sessions and subsequently measured the duration that each child spent sitting on each of the two chairs. Sitting was defined as having one's buttocks on the chair. A second observer reviewed at least 33% of the sessions for each participant. We calculated interobserver agreement (IOA) using the block-by-block method with 10-s bins. Mean IOA was 99.4% (range, 98.7% to 100%) for Amy, 99.7% (range, 99.0% to 100%) for Fanny, 100% for Axelle, 100% for Carine, and 99.7% (range, 98.9% to 100%) for Corey.

Procedures

Preference assessment. First, each child participated in a modified paired-choice preference assessment (Fisher et al., 1992; Snyder et al., 2012) with a 25.7-cm (10.1-inch) touch computer tablet using the Windows 8.1 operating system. We used a paired-choice format because (a) the participants did not necessarily have the skills to make choices from a larger array and (b) the screenshots of the videos would have been difficult to discriminate if we attempted to fit more than two on the screen. We assessed preference for six different 2.5-min videos on the following themes: animals, soldiers, Minnie Mouse, princess, Minions, and trains. We chose videos that varied in terms of themes and animations in order to accommodate children of different ages and gender. Each preference assessment lasted approximately 60 to 80 min in total; hence, we divided the assessment into two to four 20- to 30-min sessions depending on child availability. With the exception of Axelle, we conducted each session on a different day. During the preference assessment, we presented each video with each other video twice and counterbalanced the side of presentation during the second presentation. The trainer presented the pairs in a random order, but made sure to present all possible combinations once before introducing pairs for a second time. During each trial, we loaded two videos using free media players for Windows 8.1 and then split the screen vertically into two areas of equal size so that the child saw two screenshots simultaneously.

At the beginning of the trial, we prompted the participant to touch one of the two screenshots resulting in the video displayed on that side to play immediately for 30 s. We then prompted the participant to touch the other screenshot, resulting in the second video playing immediately for 30 s. Following exposure to both videos, we asked the participant to choose one of the two videos by touching the associated screenshot. Touching one of the screenshots allowed the participant to view the associated video playing on its side of the screen for an additional 30 s. If the participant did not select a screenshot within 10 s, we repeated the previous sampling procedures. Failure to choose one of the two videos following resampling resulted in the trainer recording no choice and presenting the next pair in the same manner.

Reinforcer assessment. Following the preference assessment, we provided access to most preferred and less preferred videos contingent on sitting on one of two chairs within a concurrent schedule design. The most preferred video was the one selected the most often during the preference assessment and the less preferred video was the one selected the least often. Due to a procedural error, the less preferred video used for Axelle was not the one selected the least often, but actually a moderately preferred video. For Carine, two videos were identified as less preferred. Thus, we randomly chose the one used as part of the reinforcer assessment in order to minimize the duration of assessment.

During each 5-min session, two identical chairs were placed 2 m apart, facing each other. Prior to starting the session, we prompted the participants to sit on the chair on one side and handed them a tablet playing the most preferred video for 30 s. We then prompted the participants to sit on the other chair and handed them another identical tablet displaying the less preferred video for 30 s. Following the presentation of both videos, we prompted the participants to stand up exactly between the two chairs. The two identical tablets were then placed on each chair and we asked the participants to choose a chair to sit on. Following the instruction, the participants were free to sit on either chair or remain standing in the room; participants could also switch chairs to access the other video. The position of the tablets playing the most preferred and less preferred videos was counterbalanced from one session to the next. Exposure to the video was conditional on sitting on the chair; when participants stood up from a chair, we took the tablet away, stopped the video and placed it back on the chair. When the video finished playing before the end of the session (as the videos only lasted 2.5 min), the trainer restarted it from the beginning. Each session was followed by a 3-min break during which the participants either ate a snack or played with toys. Depending on availability, each child participated in one to three sessions per day. We continued conducting the reinforcer assessment sessions until we obtained three data points spread on at less two different days showing a clear and stable differentiation of sitting behavior.

Results and Discussion

Figure 1 presents the percentage of trials the participants selected each video (left panels) and the percentage of time spent sitting on the chairs associated with the most and less preferred videos (right panels). Amy selected the Minions video the most often and the animals video the least often, and spent nearly all of each session sitting on the chair associated with the most preferred video (*M* = 99%). Fanny preferred the Minnie Mouse video the most and the animals video the least. She also spent most of the sessions sitting on the chair associated with the Minnie Mouse video (*M* = 96%). Axelle chose the Minnie Mouse video the most frequently and the Minions and train videos the least frequently. We inadvertently used the soldiers video, which was a moderately preferred video selected on 50% of trials in our preference assessment, as the less preferred video. Axelle spent all her sessions sitting on the chair associated with the Minnie Mouse video (*M* = 100%). Similarly, Carine selected the Minnie Mouse video the most often, but the Minions and princess videos the least often. We randomly selected the Minions video as the less preferred video for the reinforcer assessment. Carine spent all her sessions sitting on the chair associated with the Minnie Mouse video (*M* = 100%). Finally, Corey also chose the Minnie Mouse video the most often and the train video the least often. With the exception of one session, he spent nearly all his time sitting on the chair associated with the Minnie Mouse video (*M* = 86%). During session 5, Corey did not sit on the chairs for a long duration: he mostly ran around the room, lied on the floor while asking the trainer to play with him.

In sum, all participants spent a higher percentage of time sitting on the chair associated with the most preferred video than on the chair associated with the less preferred video. The present study extends previous research on using assessments to identify preferred videos for individuals with developmental disabilities (Dattilo, 1986; Mechling et al., 2006; Snyder al., 2012). That is, we extended prior studies by showing that the results of a tablet-based video preference assessment predicted responding within a concurrent operant arrangement: the video selected the most often produced higher levels of sitting than a less preferred video. From a clinical standpoint, practitioners may thus consider adopting the procedures to identify preferred videos for use prior to implementation of reinforcement-based treatments. With the increased presence and affordability of tablets and their use for educational purposes, using computer tablets to assess preference may expose children to a tool (i.e., tablet) that may also be used for other purposes, which may eventually reduce the clients' dependence on practitioners and favor greater social and educational integration.

Nevertheless, our study has some limitations that should be noted. First, we used a touch tablet with the Windows 8.1 operating system, which is less popular than the iPad and Android-based operating systems. However, practitioners should note that similar split screen functions are now available on some more recent Android-based tablets and on the new version of the operating system for iPad (i.e., iOS 9). Second, the preference assessment typically lasted 60 to 80 min, which may limit its application in certain contexts. In applied settings, one potential solution to this concern may be to present each possible pair only once, cutting the duration of the assessment in half. Alternatively, researchers could run a multiple stimulus without replacement to reduce the duration of the assessment (e.g., Brodhead, Al-Dubayan, Mates, Abel, & Brouwer, 2015). Third, we did not measure collateral behaviors during the assessments (e.g., problems behaviors, watching the video). Anecdotally, the participants nearly continuously looked at the tablet while videos were playing. However, we occasionally observed problem behaviors following the removal of the tablet, but escalation was usually avoided by redirecting the child’s attention towards the next activity. Fourth, even though a participant's Intellectual Quotient (IQ) could influence his learning and consequently the results of our study, we did not evaluate it in the study but would recommend future researchers to do so.

As part of our study, we used an arbitrary behavior (i.e., sitting) as a dependent variable within a concurrent operant arrangement as all children already engaged in this behavior at school. In order to extend our results, researchers should examine the effectiveness of our procedures to identify reinforcers used within single-operant teaching conditions (e.g., discrete trial instruction). Future research could also replicate our experiment with a larger number of participants and by varying the ranking of the videos compared within the concurrent operant arrangement in order to further examine the utility of the assessment procedures. Finally, researchers should consider assessing preference for other technology-based activities such as playing video games, watching online videos, and using social media in future research.

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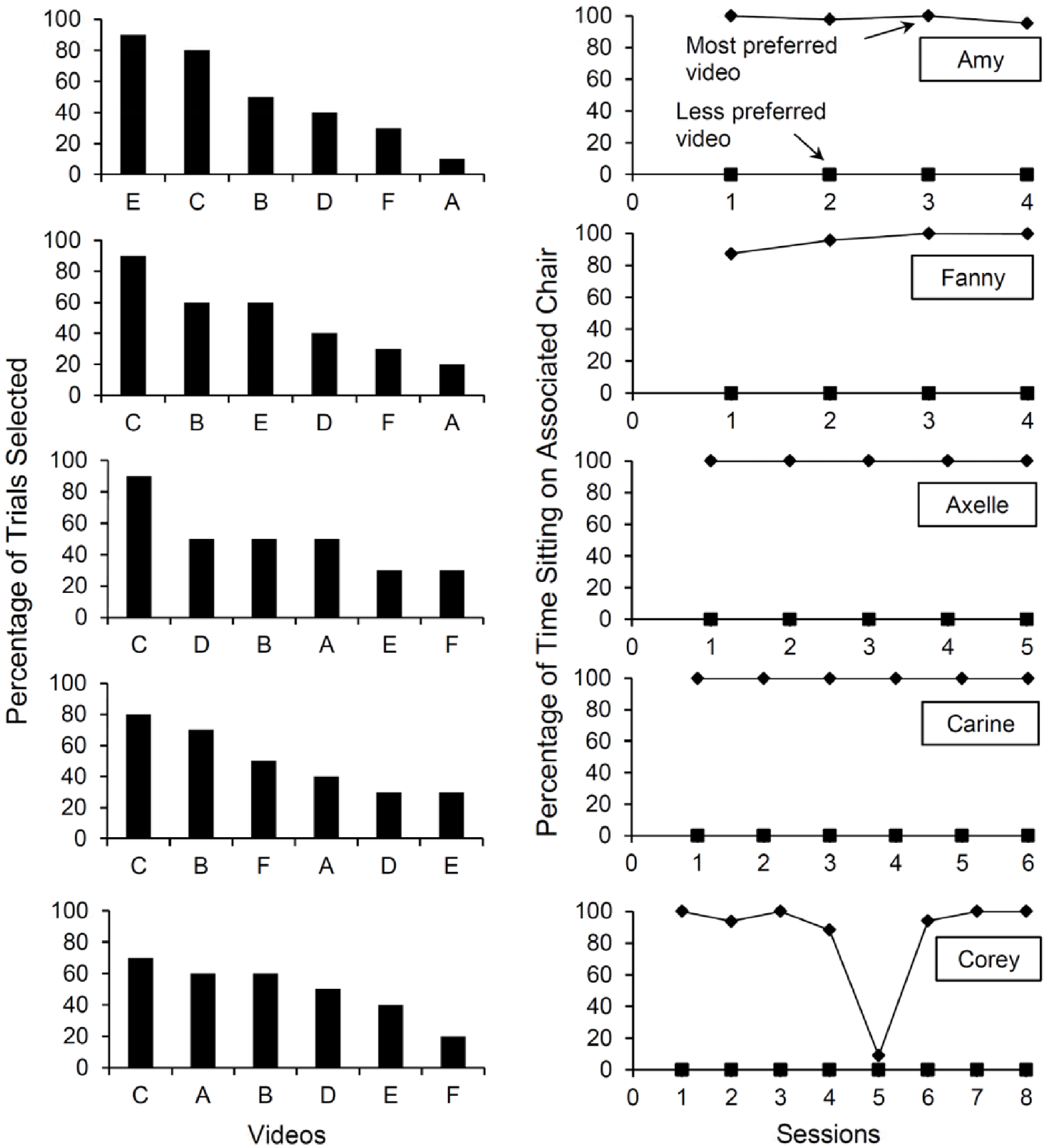

Figure 1. Percentage of trials the participants selected each video (left panels) and percentage of time spent sitting on the chairs associated with the most and less preferred videos (right panels). A = animals, B = soldiers, C = Minnie Mouse, D = princess, E = Minion, F = trains.

Chapitre 3. Article 2

Generalization of One-Word Concepts Following Tablet-Based Instruction in Children with Autism Spectrum Disorders

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Cet article est sous presse à la revue *Journal of Special Education Technology:*

Saade Chebli, S., Lanovaz, M.J., & Dufour, M.M. (sous presse). Generalization following tablet-based instruction in children with autism spectrum disorder. *Journal of Special Education Technology.*

Résumé

Étant donné que les enfants ayant un TSA nécessitent souvent une intervention dispensée individuellement, l'utilisation de tablettes tactiles à des fins d'enseignement pourrait représenter une option intéressante dans des classes d'écoles avec un ratio étudiants : enseignants élevé. Cette étude visait ainsi à contribuer à la littérature en évaluant l'efficacité de l'intervention dispensée par le biais d'une tablette sur la capacité d'enfants ayant un TSA à généraliser les concepts enseignés. En adoptant des devis à niveaux de base multiples, nous avons évalué l'efficacité de l'application à des fins d'enseignement de mots de vocabulaire à un seul mot auprès de cinq enfants ayant un TSA dont l'âge variait entre quatre et onze ans. Nos résultats indiquent que trois des cinq enfants ont réussi à généraliser au moins deux concepts enseignés avec la tablette. Bien que l'application permette de promouvoir la généralisation de concepts auprès de certains enfants ayant un TSA, nos résultats suggèrent qu'il ne s'agit pas pour autant d'une solution qui convienne à tout le monde. L'étude permet ainsi de souligner l'importance de procéder à une évaluation individualisée de la préférence avant de passer à l'enseignement.

Mots-clés : autisme, tablette, généralisation, enseignement, identification de mots de vocabulaire sur le plan réceptif.

Abstract

Given that children with autism spectrum disorders (ASD) often require one-to-one individualized instruction, using tablets as teaching tools may represent an interesting option in classrooms with high student to teacher ratios. The purpose of our study was to extend research by evaluating the effects of tablet-based instruction on the generalization of children with ASD. Specifically, we used multiple probe designs to assess the effectiveness of using an app to teach one-word receptive identification to five children with ASD between 4 and 11 years old. Our results indicated that three of five children displayed generalization on at least two concepts following tablet-based instruction. The tablet-based app may promote generalization of learned concepts in some children with ASD, but our results suggest that it is not a one-size-fits-all solution. As such, our study underlines the importance of conducting individualized assessment prior to using tablet-based instruction with children with ASD.

Keywords: autism, tablet, generalization, instruction, receptive identification.

Generalization of One-Word Concepts Following Tablet-Based Instruction in Children with Autism Spectrum Disorders

According to recent estimates, approximately 1 in 68 children is diagnosed with autism spectrum disorders (ASD) in the United States (US Department of Health and Human Services Centers for Disease Control and Prevention, 2016). Children with ASD encounter difficulties with their social and communication abilities, and engage in atypical and repetitive behaviors to various degrees (American Psychiatric Association [APA], 2013). Because of the previous difficulties, children with ASD often require individualized teaching (Eikeseth, Smith, Jahr, & Eldevik, 2002; Iovannone, Dunlap, Huber, & Kincaid, 2003; Lovaas, Koegel, Simmons, & Stevens, 1973). However, providing one-to-one instruction to children with ASD is not always feasible in school settings due to unfavorable staff to student ratios, especially in inclusive classrooms (Hess, Morrier, Heflin, & Ivey, 2008).

To address this issue, researchers and educators have been increasingly turning to technology as an instructional tool. For example, diverse sets of abilities such as spelling, mathematics, reading, vocabulary acquisition, sentence imitation, matching, answering questions, sentence production, social skills, motor skills, adaptive skills and employment skills have been taught using computer-assisted instruction (CAI; Alzrayer, Banda, & Koul, 2014; Heimann, Nelson, Tjus, & Gillberg, 1995; Hetzroni & Tannous, 2004; Kagohara et al., 2013; Knight, McKissick, & Saunders, 2013; Lorah, Parnell, Schaefer Whitby, & Hantula, 2015; Ploog, Scharf, Nelson, & Brooks, 2012; Ramdoss et al., 2011; Sansosti, & Powell-Smith, 2008; Smith, Spooner, & Wood , 2013; Stephenson & Limbrick, 2015). With the increased availability and affordability of tablets, researchers have also evaluated their effectiveness as instructional tools targeting a multitude of abilities such as employment skills (Burke et al., 2013), language and communication skills (Chien et al., 2015; Wadhwa, & Jianxiong, 2013), social skills (Hourcade, Bullock-Rest, & Hansen, 2012), academic engagement, and problem behavior (Neely, Rispoli, Camargo, Davis, & Boles, 2013). Tablets may thus represent interesting instructional tools for individuals with ASD because they offer (a) unlimited teaching opportunities children can access on their own, (b) the reliance and targeting of visual strengths often associated with ASD (Shane & Albert, 2008), and (c) increased structure, predictability and controllability compared to direct intervention (Golan & Baron-Cohen, 2006).

Among the numerous articles published on using computers for teaching purposes, a seminal study by Bosseler and Massaro (2003) taught vocabulary words to children with ASD whose ages varied between seven and twelve years old. Their results indicated that the computer program was effective at teaching new words to children with ASD. Furthermore, the children showed generalization of these new words to untaught exemplars. While this study represents a great example of the use of technology as a teaching tool, it has some specificities that require further investigation. Chief among those is the amount of support provided by a trainer during teaching. Specifically, Bosseler and Massaro used trainers to provide food reinforcement during computer instruction, therefore integrating a human component to the intervention. This form of human interaction applies to nearly all other studies that have used CAI to teach concepts to children with ASD (e.g., Heimann, Nelson, Tjus, & Gillberg, 1995; Sansosti & Powell-Smith, 2008; Schery & O' Connor, 1997). For example, Sansosti and Powell-Smith (2008) made use of peer confederates and trainers to prompt and help the participants generalize communication skills. In a study conducted by Schery and O' Connor (1997), the trainers provided children with the objects that they requested while using the computer and occasionally played with them during this time. While we do not think that including a human component to the CAI is inadequate, this level of involvement may be counterproductive in certain settings. For example, it would be important to minimize human involvement during computer instruction in settings in which an educator is unavailable to provide one-to-one support.

Another issue highlighted in the Bossler and Massaro (2003) study is the reduced functional control between the computer program and the acquired vocabulary words. Some participants were already learning before the start of training as manifested by the increasing acquisition trends during baseline. Other studies seem to share the same limitation because they provided the lessons on the computer program in addition to the traditional teaching curriculum at school, or additional intervention with a parent or trainer (Heimann, Nelson, Tjus, & Gillberg, 1995; Schery & O' Connor, 1997; Wainer & Ingersoll, 2011).

A noteworthy concern when teaching new concepts to children with ASD is related to their difficulty with generalization. Children with ASD often have more difficulties than others applying newly learned concepts to novel stimuli or situations (Brown & Bebko, 2012; Froehlich et al., 2012; Carr & Kologinsky, 1983; Stokes & Baer, 1977). For example, a child may learn to label the color "red" when shown a red car image used during teaching, but may fail to identify the same concept when shown a red pencil. As a result, targeting and evaluating generalization with children with ASD is crucial in any intervention program. However, not all studies evaluated the generalization of taught concepts with a computer to new untaught exemplars (e.g., Moore & Calvert, 2000) and those that have, typically used images of the concepts (e.g., Bosseler & Massaro, 2003; Whalen et al., 2006).

Studies on the validity of preference assessments have shown that some children with ASD may readily show generalization across modalities from pictures (or videos) to objects when identifying potential reinforcers (Brodhead et al., 2016; Clark, Donaldson, & Kahng, 2015;

Snyder et al., 2012). That said, it is was not always the case, and to our knowledge, no study has evaluated whether children with ASD were able to generalize between concepts taught using a two-dimensional modality (e.g., images) to their corresponding objects outside the context of reinforcement. In view of the difficulties individuals with ASD often showing generalization from one stimulus to another and from one context to the next, it would not be surprising to find the same difficulties between modalities. From a clinical standpoint, learning to name concepts on images, but not on real-life objects, has limited practical utility, which is why evaluating generalization while teaching individuals with ASD is very important.

While computer technology seems to represent an interesting instructional tool and intervention medium for children with ASD, studies targeting language with those individuals share several limitations: (a) nearly all relied on a trainer to provide reinforcement, (b) only a few demonstrated functional control, while decreasing the amount of trainer interference, and (c) most evaluated generalization with images rather than objects. The above mentioned limitations may therefore require further investigation. The purpose of our study was to extend research on teaching one-word concepts to individuals with ASD (Bossler & Massaro, 2003; Heimann, Nelson, Tjus, & Gillberg, 1995; Sansosti & Powell-Smith, 2008; Schery & O' Connor, 1997) by evaluating generalization to both pictures and objects while simultaneously minimizing threats to internal validity and trainer involvement.

Method

Participants and Settings

Five children diagnosed with ASD (based on the DSM-IV or DMS-5 criteria [APA, 2000, 2013]) by an independent multidisciplinary team participated in our study. We recruited participants from a French-instruction specialized school in Montreal, Canada, for children with

ASD whose level of functioning or problem behaviors prevented their inclusion in integrated school settings. To participate in this study, the students had to: (a) already have a diagnosis of ASD, (b) currently be learning one-word concepts, and (c) show challenges with generalization as reported by their teachers. The research project was approved by the school board as well as by the researchers' university research ethics board. After presenting the research project to the teachers, we asked them to refer students meeting our inclusion criteria. Based on teacher referrals, we then explained the research project to the children's parents and secured their written informed consent. After observing the children at school, we scored the Childhood Autism Rating Scale – Second Edition to provide an estimate of the severity of their autistic symptomatology (CARS-2; Schopler, Van Bourgondien, Wellman, & Love, 2010). It is worth mentioning that the CARS-2 score is not based on a normal distribution but rather on the scores' distribution of children with ASD. As such, the score obtained allows the rater to identify whether the child is non autistic, mildly autistic, moderately autistic or severely autistic.

Table 1 presents the age, gender, CARS-2 *T*-score, and the concepts we taught to each participant in the study. Since the children were French speakers or learners, the instruction was provided in French. To preserve confidentiality, all names were pseudonyms. Axelle was 10 years old at the beginning of the study, had mild-to-moderate symptoms of ASD on the CARS-2, and had no formal means of communication. Similarly, Carine who was 7 years old, had mild-to-moderate symptoms of ASD, and did not have a means of communication other than informal gestures. Corey on the other hand, was 4 years old, had mild symptoms of ASD, and displayed meaningful speech with often unclear pronunciation (four- to five-word sentences). Lastly, Aden was 5 years old and had mild-to-moderate symptoms of ASD whereas Amy was 11 years old and had severe symptoms of ASD. Both participants could use one-word concepts to make simple requests to others. All participants had prior experience with tablets, which were often used to provide access to reinforcing activities (e.g., games, videos) in their classrooms.

<Insert Table 1 about here>

All sessions were either conducted in an empty auditorium or in a private room within the school. We conducted all sessions with one child at a time; only the participant and the first author were present during those sessions. The participants were seated at a large table with the first author sitting on their right. The third author was present occasionally to measure interobserver agreement (IOA). When she was present, she sat in front of the first author.

Teaching Materials

To teach the concepts, we used an Android-based Samsung Galaxy Note 10.1 tablet with a 25.4-cm screen on which we installed an app, the OpenSource Discrete Trial Instructor, designed to teach one-word concepts**.** The OpenSource Discrete Trial Instructor was developed by the research team and was based on the principles of applied behavior analysis; that is, the app provided instruction in a discrete trial format, integrated video reinforcement, and included a prompting procedure. Since the app is still being improved, it is not presently available to the general public. The details regarding the presentation of the teaching trials by the app are described in the procedures section below.

The app can teach different one-word concepts from seven categories (i.e., colors, animals, prepositions, food, clothes, musical instruments and letters). Each category included five different concepts and each concept included five different examples. For example, the categories “clothes” included five different clothing concepts (i.e., dress, skirt, pants, coat, and shoes) and the concept “dress” included five different examples of the concept (e.g., long dress, short dress, blue dress, red dress, green dress).

Experimental Design and Procedures

We used a multiple probe design across concepts to evaluate the effectiveness of teaching one-word concepts with our app. Since the multiple probe design involves the repeated application of the intervention targeting different concepts, the recurrent evaluation of the intervention effect strengthens our conclusions regarding the functional relation between the intervention and the acquired behavior (Smith, 2012). Furthermore, we also integrated periodic generalization and follow-up probes to the research design. Each child participated in four to eight sessions per day, three days per week (depending on their availability) for a period of 15 to 30 min. We selected three concepts to teach each child based on their teachers' and parents' reports. Due to time restrictions (i.e., end of the school year), we only taught two concepts to two of the children. Concepts taught were based on the child's lack of knowledge of those words and reduced risk of exposure to them outside of the experimental setting. For example, we taught Corey the skirt concept because he was a boy and was therefore less exposed to it on a daily basis. We also chose to teach Corey letters because he mastered nearly all the other concepts already programmed on the app. Similarly, Axelle rarely wore any dresses or skirts (based on her mother's report), which is why we taught her the dress concept. We stopped teaching a concept when the child showed correct responding on 80% or more of trials on three consecutive generalization probes spread on at least two different days. In order to control for extraneous variables, we asked the children's teachers and parents not teach the concepts targeted in our intervention during the course of the study.

Data Collection and Interobserver Agreement

To examine the effects of the app, we measured the children's responding during baseline, teaching, generalization, and follow-up sessions. A correct response was defined as the child touching the image or object corresponding to the named concept within 3 s of the concept being named. An incorrect response was defined as touching an image or object other than the one associated with the named concept within 3 s, and finally the absence of a response (non-response) was defined as the child not touching an image or object within 3 s. We calculated the percentage of correct responding by dividing the number of correct responses by the number of trials (i.e., always 5) and multiplying the quotient by 100. To inform us about the involvement of the trainer during instruction, we also measured the number of times the trainer prompted the child to sit down. A second research assistant was present for at least 33% of the sessions to score interobserver agreement (IOA). We calculated the IOA by dividing the number of agreements by the number of agreements and disagreements and multiplying the result by 100, which resulted in mean IOAs of 99% or above for each participant. For instance, while teaching Axelle the dress concept, the two observers agreed 100% of the time on her rate of correct responding, incorrect responding, and non-responding.

Conditions

Baseline. We conducted all baseline sessions on the tablet and begun by conducting baseline probes of the target concept in order to evaluate pre-intervention knowledge. We conducted at least three baseline sessions for each child on at least two different days. We also assessed pre-intervention knowledge of the two other concepts targeted for later teaching. Every session included five trials. During each trial, three images (either colored photographs or colored drawings of the concept) were concurrently presented on the tablet’s screen with one image depicting the target concept and two others depicting distractors (images of associated categories not currently taught). An automated voice named the concept and the child had to choose the image associated with the concept by selecting it on screen. The app randomized the position of the correct responses to avoid rote memorization. The app did not provide any reinforcement or feedback to the participant during baseline. To minimize non-responding, the instructor told the participant to listen to the instruction and select an image and moved on to the next trial (presenting a different example of the concept) if the child did not choose an image within 3 s of the instruction. If the child stood up from the chair, the investigator asked him to sit down within 3 s. If the child did not sit down following the vocal prompt, the instructor repeated the vocal instruction and pointed to the chair. If the child still did not sit down following the verbal and gestural prompt, the instructor manually guided him to the chair by placing his hand on his shoulder until he sat down.

Training. The training sessions were similar to the baseline sessions with the following exceptions. First, the app played a preferred video for 10 s contingent on correct responses. The trainer identified the preferred video prior to teaching using a modified paired-choice preference assessment and re-evaluated preference every 20 training sessions to maintain the child's motivation (see Chebli & Lanovaz, 2016, for detailed preference assessment procedures). Second, an incorrect response was immediately followed by a prompting procedure whereby the correct image of the concept grew larger while the name of the concept was repeated simultaneously. The prompting procedure was implemented automatically by the app following incorrect responses (i.e., without input from the trainer). We collected no data during the prompted trials, but correct responses on these trials produced access to the video reinforcer. During all training sessions, we did not provide social reinforcement: The only reinforcer was the preferred video provided automatically by the app contingent on correct responding. Lastly, we only began teaching the second and third concepts after the participant demonstrated generalization of the previous concept (scored 80% or more on three consecutive generalization probes).

Generalization. In order to assess generalization to new examples, we evaluated the child's knowledge of five different untaught examples of the target concept. These examples were all different than the ones used during training. The generalization probes were conducted periodically after each series of five sessions of taught exemplars. Since we were interested in evaluating generalization to real-life examples, we used both real objects and untaught images of the target concept. Generalization probes were similar to baseline probes except that a human trainer conducted them instead of an app. In order to assess generalization of a concept, we simultaneously placed three items on a large table facing the child. We placed the target concept and two other random items. The trainer named the target concept and the child had to manually select the item representing the concept. We did not provide any reinforcement or prompts during generalization probes as the purpose of our study was to examine whether the children would respond correctly on untaught exemplars. For each concept, we conducted five generalization trials, every trial presenting a different example of the target concept. If the child responded correctly on 80% of trials during the session, two more sessions were conducted on the following day in order to obtain three data points spread on at least two different days. As for the untaught concepts, we also conducted generalization probes when the child first began participating in the study and following 10 teaching and generalization sessions of the target concept in order to ensure the child had not learned the untaught concept in another context prior to the start of computer instruction.

Finally, it should also be noted that, after approximately one month of intervention, we noticed that some participants were not responding during generalization probes. We hypothesized that responding was not occurring as the participants never received reinforcement during probes with the trainer. We therefore modified the generalization procedure for all participants to conduct five mastered trials during generalization probes. The mastered trials were simple instructions that the child already performed correctly prior to their inclusion in the study (e.g., imitation of clapping). Correct responding on mastered trials was followed by both edible and social reinforcement (e.g., excellent, well done!) on a continuous reinforcement schedule (i.e., fixed ratio of 1). The sole purpose of the interspersed mastered trials was to maintain responding during the generalization probes; thus, we did not collect data on these trials. This change occurred after session 79 for Axelle, 40 for Carine, 55 for Corey, 65 for Aden and 71 for Amy. Despite this change, we never provided edible or social reinforcement on the generalization trials.

Follow-up probes. Once the child had met the generalization criterion for a concept, we attempted to conduct follow-up probes every two weeks. However, we were not able to assess follow-up for some concepts due time constraints (e.g., end of schoolyear). The follow-up probes were identical to baseline.

Data Analysis

First, we depicted the percentage of correct responding on multiple baseline graphs for each participant separately (see Figure 1 for example). Each figure is composed of two panels per concept. For example, a figure contains four panels when two concepts have been taught. For each concept, the upper panel of the pair represents the percentage of correct responding on the taught exemplars whereas the lower panel represents the same measure for generalization probes on the concept. Our decisions regarding whether the child had showed generalization were based on the lower panel. Then, we computed means and examined trends for both taught exemplars and generalization probes for each concept. Finally, we computed the percentage of non-response during tablet instruction to provide an indicator of participant engagement and the number of prompts to sit down per session during tablet instruction to estimate trainer involvement. These measures are reported directly in text as descriptive measures.

Results

Figures 1 to 4 display the percentage of correct responding on the concepts for each child during baseline, training, generalization and follow-up sessions. Axelle (Figure 1) initially displayed stable correct responding for the dress concept during baseline sessions on taught exemplars (*M* = 20%) and on the generalization probe (20%). Following the baseline sessions, Axelle's correct responding on taught exemplars (*M* = 47%) increased gradually across sessions. The patterns were similar for generalization probes (*M* = 45%): Axelle required 64 training sessions to show generalization of the dress concept. As for follow-up probes, Axelle continued to show correct responding two weeks after training (100% for taught exemplars and 80% for generalization probes). After showing variable responding during the baseline phase on taught exemplars of skirt (*M* = 45%), correct responding increased almost immediately to 100% when the concept was taught (*M* = 98%). In contrast, generalization probes during baseline showed an increasing trend (*M* = 31%), but Axelle showed generalization only following 47 training sessions (*M* = 60%). Overall, Axelle's percentage of non-response was 1% and she never required prompts to sit down.

<Insert Figure 1 about here>

Figure 2 displays Carine's results. Following no correct response on taught exemplars (*M* = 0%) and a single correct response on the generalization probe (20%) during baseline for cow, her correct responding became variable, but higher, on taught exemplars (*M* = 62%), and gradually increased on generalization probes (*M* = 53%). She showed generalization on untaught exemplars after 36 training sessions. Regarding follow-up, Carine was able to maintain adequate levels of correct responding on cow for taught exemplars a month following the end of training (*M* = 100%), but she did not maintain the same level of correct responding on generalization probes (*M* = 40%). As for horse, her correct responding on the taught exemplars remained stable the last three sessions of baseline (*M* = 33%) and varied between 20% and 60% during the initial generalization probes (*M* = 30%). Subsequent responding on taught exemplars was variable and only marginally higher (*M* = 38%) whereas correct responding on generalization probes (*M* = 75%) increased to meet the criterion within only 11 training sessions. Similarly, she did not maintain her high levels of correct responding on the horse concept (20% for the untaught exemplars and 60% for the generalization probe). Finally, Carine's overall percentage of non-response was 17% and she needed on average 0.04 prompts per session to remain seated.

<Insert Figure 2 about here>

Figure 3 shows that, for the letter E, Corey had a decreasing level of correct responding on taught exemplars (*M* = 20%) and no correct responding on the generalization probe (0%). Despite variable and similarly low levels of correct responding on the taught exemplars during training (*M* = 25%), Corey showed a variable trend on generalization probes (*M* = 62%) and displayed generalization after 39 training sessions. At follow-up, correct responding remained low on the taught exemplars (*M* = 33%) and variable on the generalization probes (*M* = 60%). For the letter D, his correct responding during baseline was stable on taught exemplars (*M* = 34%) and variable on the generalization probes (*M* = 40%). Both training and follow-up correct responding remained low on taught exemplars (*M* = 25% and 20%, respectively). Contrarily, his responding during training and at follow-up on generalization probes met our criterion (*M* = 55%

and 80%, respectively) after 25 training sessions. As for skirt, his correct responding on taught exemplars had a decreasing trend across the last five baseline sessions (*M* = 30%) and remained relatively stable and on average lower during training (*M* = 14%). On generalization probes, Corey initially had similar levels of correct responding during baseline (*M* = 36%), but correct responding gradually increased during training (*M* = 53%). He showed generalization after 35 training sessions. His overall percentage of non-response was 10% and he required on average 0.30 prompts per session to remain seated.

<Insert Figure 3 about here>

Unlike other participants, Aden (upper panels of Figure 4) never showed generalization of the red concept to objects following three months of training. His correct responding on taught exemplars was low during baseline (*M* = 30%) and remained low, albeit variable, during training (*M* = 38%). His generalization probes showed similar patterns (*M* = 26%). Aden had a non-response rate of 7% and the average number of prompts for sitting was 1.13 per session. Finally, Figure 4 (lower panels) presents the results for Amy. She never showed generalization of the concept blue to new untaught exemplars. Similarly to Aden, her correct responding remained low during both baseline and training sessions for taught exemplars (*M* = 13% and 27%, respectively) and generalization probes (*M* = 40% for both). On average, Amy had a non-response percentage of 31% and the average number of prompts for sitting was 0.43 per session.

<Insert Figure 4 about here>

Discussion

Overall, three of five children with ASD showed generalization on at least two concepts following tablet-based instruction. Our results are consistent with previous studies (Bosseler & Massaro, 2003; Moore & Calvert, 2000; Schery, & O' Connor, 1997) and extend them in several ways. By integrating video reinforcement within the app in order to promote learner independence, we minimized trainer involvement, which would allow the implementation of the procedures with multiple students simultaneously. Furthermore, we reduced threats to internal validity by informing parents and teachers not to teach the target concepts to participants while the study was taking place and by regularly probing the participants' knowledge of untaught concepts to make sure that increases in correct responding could be attributed to the app. In addition, most children were able to maintain correct responding on those concepts for several weeks post-training, which may decrease the need for further instruction.

Two of five children never displayed generalization even though we conducted more than 60 training sessions. Compared to the other participants, Aden and Amy required a greater number of prompts to sit down and continue working, which could in part explain why they were not benefitting from the app. Amy also had the highest levels of non-responses amongst all the participants. Requiring a greater number of prompts and higher levels of non-responses may indicate a lack of interest for tablet-based instruction, which could possibly hinder the learning process. These results underline the importance of assessing generalization to real-life objects and that using tablet-based instruction is not a one-size-fits-all solution that will be effective with every child. From a clinical standpoint, individualized assessment prior to using tablet-based instruction appears paramount to ensure that children will benefit from CAI. More specifically, children needing a large number of prompts to sit down and continue working (or high levels of non-responding) may be less likely to learn on their own from the app. In the future, researchers could examine whether children stop benefitting from tablet-based instruction beyond a certain threshold of off-task behavior, which could potentially be used as an assessment. Alternatively, practitioners could use a similar design as our study wherein educators evaluate whether the child is learning and displaying generalization within a pre-set number of sessions (e.g., 40), after which it would be advisable to switch to instructor-based training.

The effectiveness of the intervention for three participants might be attributable to several factors. First, the tablets were often used in each child's classroom for providing reinforcing activities (e.g., games, videos). The teaching medium (i.e., tablet) may have been a conditioned reinforcer, which could have supported learning. Second, the structure, predictability and controllability of tablet instruction may have facilitated the acquisition of the concepts (Golan & Baron-Cohen, 2006). Third, the teaching procedures relied on the principles of applied behavior analysis, which have strong empirical support for teaching children with ASD (Eikeseth, 2009). In contrast, the lack of effectiveness with some participants could be attributable to factors that are unique to each. Amy's absence of generalization might be due to the fact that teaching with an app might not be the best method for her. As for Aden, he might have overgeneralized the color red to other colors (i.e., failure to discriminate). Therefore, his lack of success might be due to overgeneralization, a phenomenon whereby a "learner emits the target behavior in the presence of stimuli, that although similar in some way to the instructional examples or situation, are inappropriate occasions for the behavior" (Cooper, Heron, & Heward, 2007, p. 622). The presentation of only one image (without distractors) prior to teaching with others may be an option to deal with this issue in the future.

An interesting observation was that Corey showed generalization even though his correct responding during training (taught exemplars) sessions remained low. One potential explanation is that Corey responded arbitrarily during training as the video reinforcement was available for an equal duration following both prompted and unprompted correct responses. To address this issue, future studies should differentially reinforce correct responding following prompts and independent responding; the participant would thus receive a smaller magnitude of reinforcement (e.g., 3 s rather than 10 s of video) following a prompted response as opposed to independent responding in order to encourage the latter. Another observation is that it took Axelle more than 45 sessions to show generalization on both her concepts, which indicates that the procedures were not as efficient as for other participants. To determine whether CAI would still be a viable option for participants who require a great number of sessions, it would be necessary to compare its efficiency with trainer-delivered instruction in the future. There is a paucity of studies comparing tablet-based and trainer-based instruction. Only a handful of studies compared the relative effectiveness of the two teaching modalities and much more work remains to be done in that area (Bryant et al. 2015, Moore & Calvert, 2000).

Despite the fact that the app offered both the instruction and reinforcement to the participants, our results are limited insofar as a trainer still had to occasionally prompt the child to continue completing the task and sit down, therefore introducing a human component to the intervention. However, compared to traditional instruction, the frequency of trainer involvement was considerably reduced and the trainer could readily work with several children at the same time. A second limitation is that we introduced interspersed mastered trials one month after the start of study in order to encourage responding during generalization probes, possibly introducing threats to internal validity. That said, this modification did not coincide with immediate changes in correct responding for any of the participants, we continued to provide no reinforcement or prompting on the untaught exemplars, and we replicated the effects across at least one other concept, which suggest that the observed effects were the results of the tablet instruction. Third, we were unable to implement a multiple probe across concepts design for Aden and Amy as none showed generalization and we had to stop training due to the end of the school year. For these two participants, we used a quasi-experimental AB design that was not repeated across more than one concept. Because of our experimental design, we were unable to put the “red” concept on hold while teaching Aden a completely different concept such as “pants” and reverting to the “red ” concept later on. In a clinical setting, we would have done just that. The same also holds for Amy. We did not inquire whether Aden or Amy had been tested for colorblindness and whether this medical condition could have explained their inability to generalize colors, which should be considered in future research.

The study should be replicated with a larger number of participants while directly comparing the CAI to a trainer-delivered intervention. Because we wanted to evaluate the effectiveness of tablet-delivered instruction with all children having ASD instead of focusing solely on the higher-functioning kids, we did not adopt an exclusion criterion for a participant's level of functioning. Although a child's IQ could influence his speed of learning and his ability to benefit from tablet-delivered instruction, we did not evaluate this variable in this study but would recommend future researchers to do so. Based on the same reasoning, we recruited participants whose age varied between four and eleven. Since a participants' age could potentially influence his preference for a teaching medium, we would recommend future researchers to group participants based on their age and evaluate whether this variable plays a role in the children's preference for a teaching medium and its effectiveness.

Given that not all children benefited from tablet-based instruction, future studies should evaluate which variables such as IQ, problem behaviors, and autistic symptomology moderate the association between tablet-based instruction and generalization. Future studies should also incorporate several levels of difficulties in terms of distractors presented at the same time as the target concept in order to avoid problems with overgeneralization that some children may have encountered in the current study. In sum, teaching children with ASD using a tablet might represent an interesting avenue for educators and teachers, especially given the current prevalence of ASD and the challenges of providing individualized one-to-one instructions to multiple children in classrooms with high student to staff ratios.

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Table 1

Participants' Characteristics, CARS-2 T-Scores, and Concepts Taught

Participant	Age	Gender	CARS-2 *T* score	Concepts taught
Axelle	10	Female	48	Dress Skirt
Carine	7	Female	48	Cow Horse
Corey	4	Male	36	E D Skirt
Aden	5	Male	44	Red
Amy	11	Female	50	Blue

Note. CARS-2: Childhood Autism Rating Scale, Second Edition.

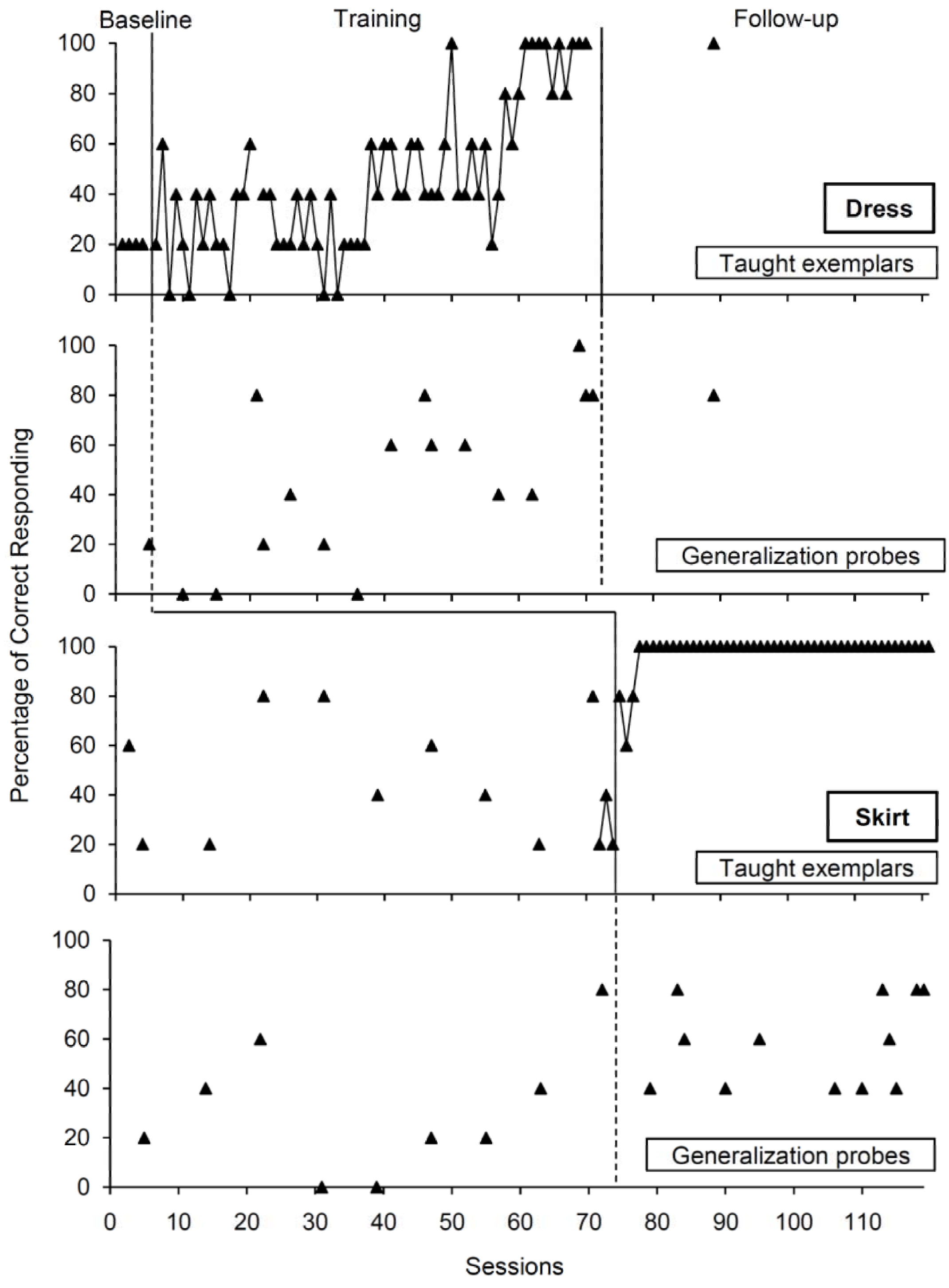

Figure 1. Axelle's percentage of correct responding on taught exemplars and generalization probes for dress and skirt.

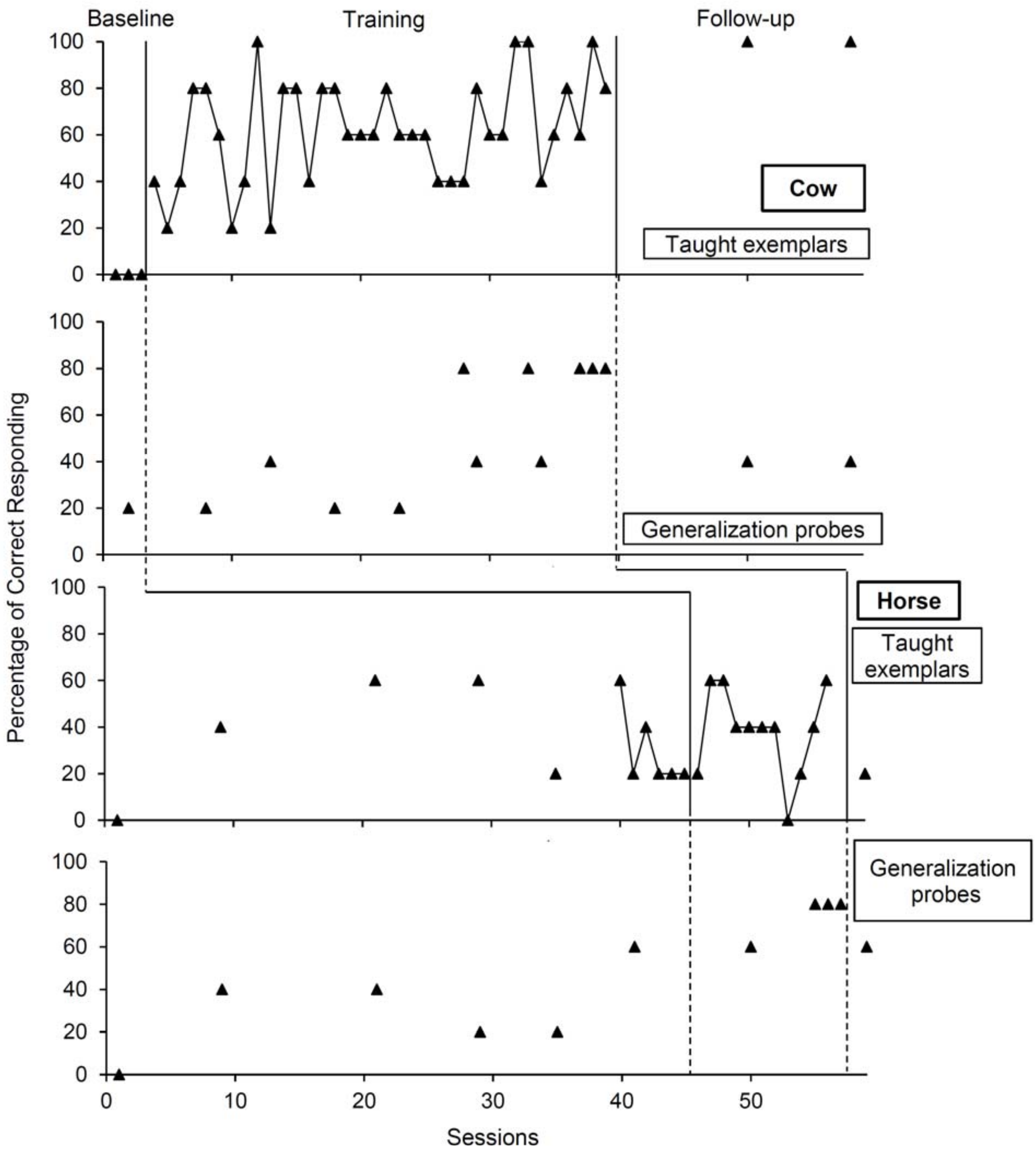

Figure 2. Carine's percentage of correct responding on taught exemplars and generalization probes for cow and horse.

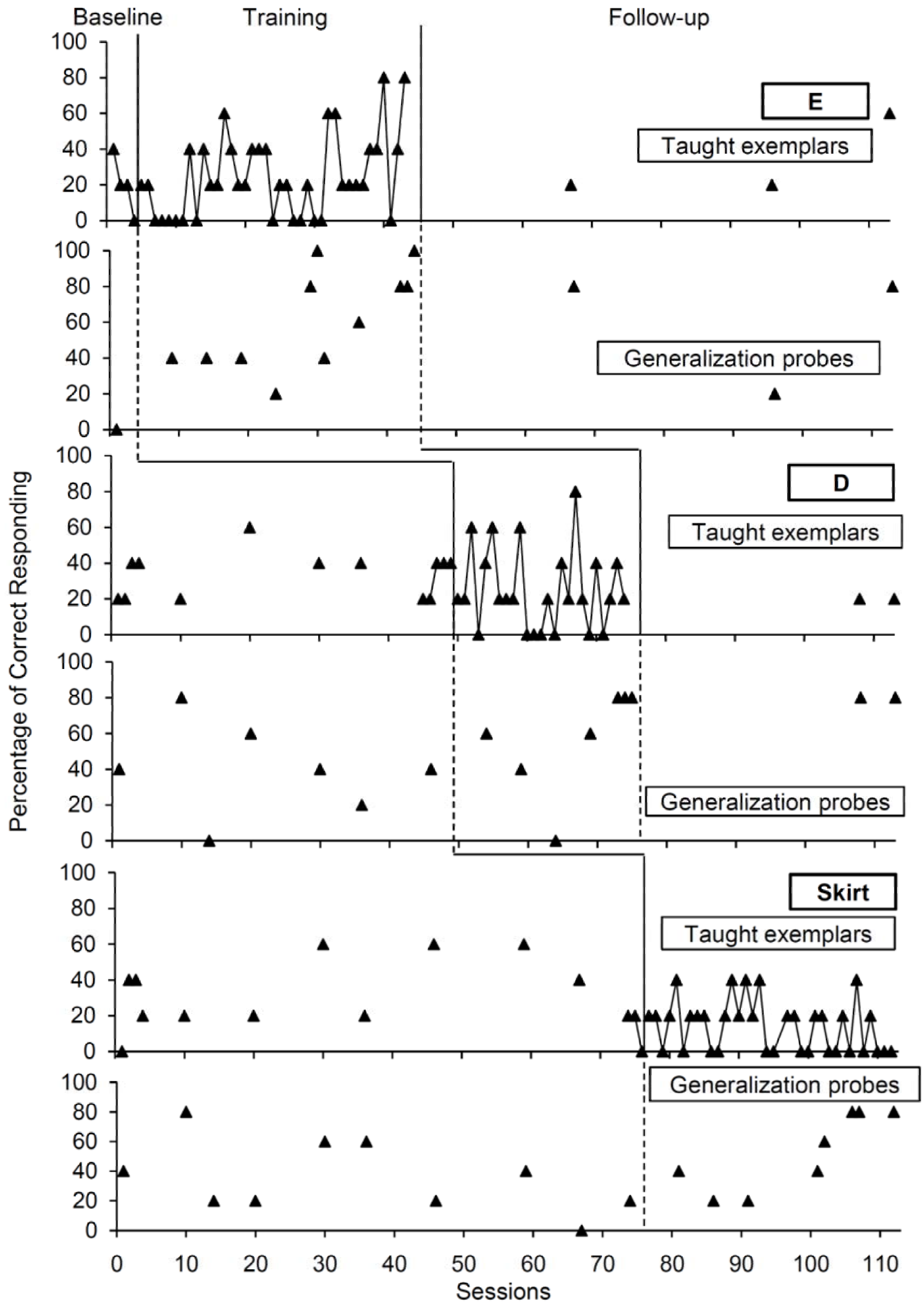

Figure 3. Corey's percentage of correct responding on taught exemplars and generalization probes for E, D, and skirt.

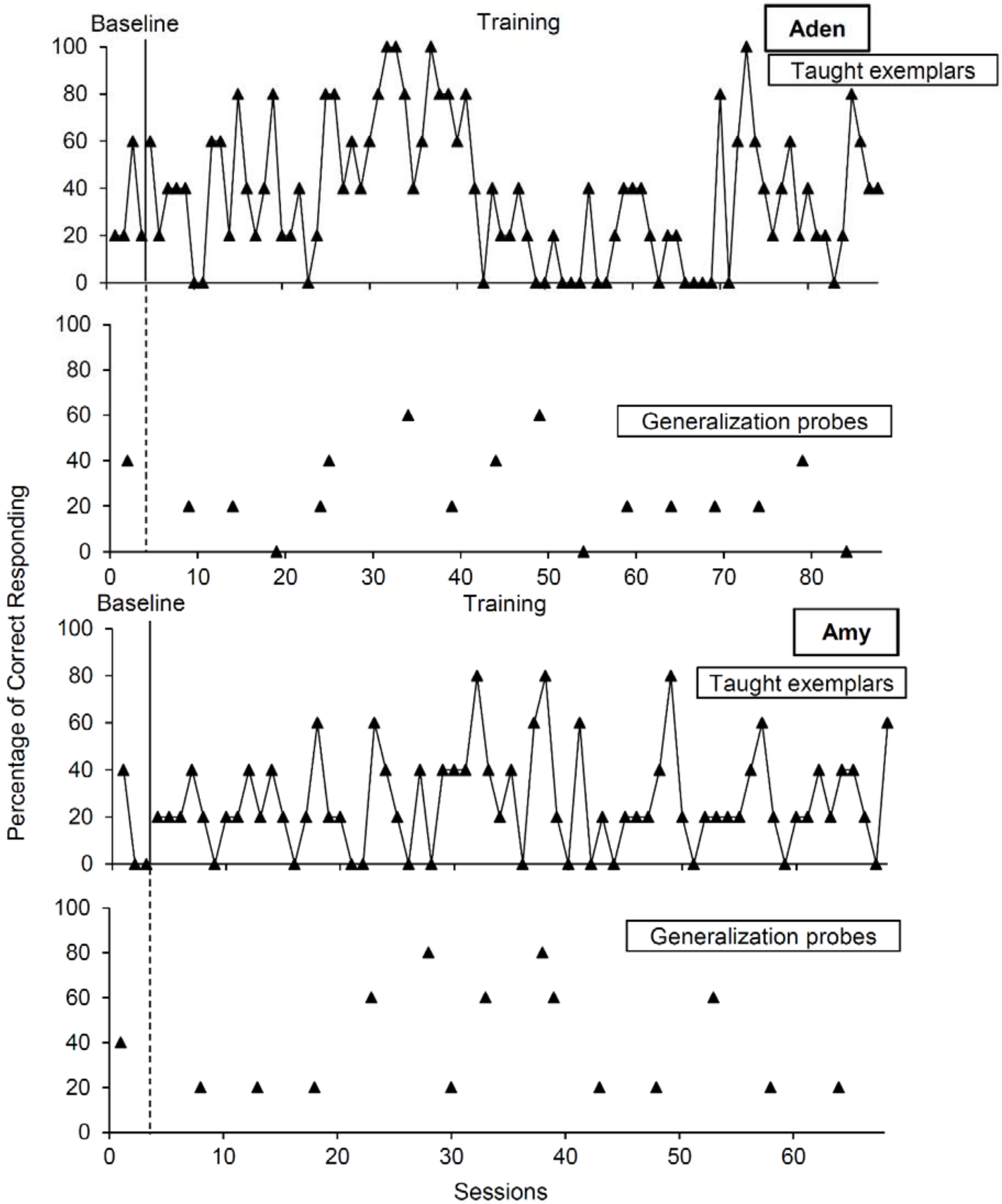

Figure 4. Aden's (upper panels) and Amy's (lower panels) percentage of correct responding on taught exemplars and generalization probes.

Chapitre 4. Article 3

Comparison of Tablet-Delivered and Instructor-Delivered Teaching on Receptive Identification in Children with Autism Spectrum Disorders

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Cet article a été soumis pour publication.

Résumé

Étant donné que la plupart des enfants ayant un TSA requièrent un enseignement individualisé, les tablettes pourraient servir d'outils d'enseignements dans les classes caractérisées par des ratios étudiants : enseignants élevés. Cette étude visait à comparer l'efficacité de l'enseignement dispensé par le biais d'une tablette à celui dispensé par un intervenant sur l'identification réceptive de concepts à un seul mot. Pour ce faire, nous avons intégré un devis à niveaux de base multiples à un devis avec alternance de traitement afin de comparer l'efficacité des deux modes d'enseignement auprès de sept enfants ayant un TSA. Nos résultats indiquent que deux des sept participants ont réussi à généraliser tous les concepts enseignés avec moins d'essais alors que les résultats des cinq autres participants variaient selon le concept enseigné. Au total, les participants ont généralisé plus rapidement 14 des 19 concepts enseignés par l'intervenant. Nos résultats suggèrent donc que les tablettes ne devraient pas remplacer l'enseignement dispensé par un intervenant mais qu'elles pourraient plutôt servir de complément lorsque l'enseignement offert un à un n'est pas viable.

Mots-clés : autisme, tablette, généralisation, enseignement, identification de mots sur le plan réceptif.

Abstract

Because most children with ASD require individualized teaching, using tablets as instructional tools represents an interesting solution in classrooms with high student to teacher ratios. The purpose of our study was to compare the effectiveness of tablet- and instructor-delivered teaching on the receptive identification of one-word concepts. To this end, we embedded a multielement design within a multiple probe design to compare the effectiveness of the two instructional modalities in seven children with ASD. Two of seven participants showed generalization on all concepts with fewer instructional trials after receiving instructor-delivered teaching whereas the remaining five participants had mixed results depending on the concept. In total, the participants showed more rapid generalization with the instructor for 14 of 19 concepts taught. Our results suggest that tablets should not replace instructor-delivered teaching, but that they may serve as a complement when one-to-one instruction is unfeasible or impractical.

Keywords: autism, tablet, generalization, teaching, receptive identification

Comparison of Tablet-Delivered and Instructor-Delivered Teaching on Receptive Identification in Children with Autism Spectrum Disorders

In recent years, researchers and practitioners have been increasingly turning to technology as instructional tools for children with autism spectrum disorders (ASD; Alzrayer, Banda, & Koul, 2014; Kagohara et al., 2013; Knight, McKissick, & Saunders, 2013; Lorah, Parnell, Schaefer Whitby, & Hantula, 2015; Ploog, Scharf, Nelson, & Brooks, 2012; Ramdoss et al., 2011; Sansosti, & Powell-Smith, 2008; Stephenson & Limbrick, 2015). Even though the literature abounds with examples validating the effectiveness of computer technology with this population, few studies have compared the effectiveness of technologically-delivered instruction with traditional teaching (i.e., one that is delivered by a human instructor). Because of the dearth of studies comparing the two modalities, not much is known about the effectiveness of computer-delivered instruction relative to traditional teaching. Given their increased use in educational and clinical settings, comparing the effectiveness of tablet-delivered teaching with that of a human instructor warrants our attention.

Among the handful of studies having compared the effectiveness of computer- and instructor-delivered teaching, Moore and Calvert (2000) examined the effects of both modalities on the acquisition of vocabulary words in fourteen children diagnosed with ASD. Results of the study indicated that children had more favorable outcomes with the computer-delivered condition: They learnt more words, were more attentive, and were more motivated during the computer-delivered instruction. While this study represents a great illustration of the importance of comparing the relative effectiveness of computer- and instructor-delivered teaching, it has some limitations. Chief among those is the lack of generalization probes verifying whether children were able to generalize concepts learnt from both conditions to real-life settings.

In a more recent study, Allen, Hartley, and Cain (2015) compared the effectiveness of instructor- and computer-delivered language instruction. The authors evaluated whether the children generalized the concepts taught on a computer program and on picture books to real-life objects, but they only examined generalization to differently colored objects. Although Allen et al.'s study represents an improvement over Moore and Calvert's (2000) design, one cannot expect all objects taught on a computer program to be similarly shaped in the environment, highlighting the need to examine generalization to differently colored and shaped objects. This lack of generalization probes to real-life objects is shared by multiple studies having examined the effectiveness of computer-delivered instruction alone (Bosseler & Massaro, 2003; Whalen et al., 2006) and in comparison with traditional teaching (Schery & O'Connor, 1997). From an educational standpoint, examining responding on untaught exemplars is important because children with ASD often have difficulties with generalization to novel materials, contexts, and individuals (Carr & Kologinsky, 1983; Plaisted, 2001; Stokes & Baer, 1977). Another limitation often shared by studies is the lack of maintenance measures over time (Allen et al., 2015; Bernard-Opitz, Sriram, Sapuan, 2001). Even when maintenance was evaluated in prior research, it was only monitored over a short period of time. For example, Moore and Calvert conducted probes only one week following the termination of computer instruction. In sum, monitoring both generalization and maintenance appears important as the lack of either would seriously limit the ecological validity of the teaching procedures.

One of the reasons tablet-delivered instruction holds promise as an instructional tool for children with ASD is attributed to the reduced labor requirements it entails as opposed to instructor-delivered teaching. Based on this premise, instructors and teachers should be able to use tablet-delivered instruction to facilitate working with several students at the same time. In most studies dispensing computer-delivered instruction, some sort of instructor mediated reinforcement was provided (Bernard-Opitz, Sriram, & Nakhoda-Sapuan, 2001; Bosseler & Massaro, 2003). The same holds for comparison studies: Both the Allen et al (2015) and Schery et al. (1997) relied on the instructor to deliver reinforcement to the students. The reliance on an instructor prevents us from concluding that the technological tool is effective by itself since this added level of support could be facilitating learning. While we do not think that including a human component to the computer-delivered instruction is inadequate, this level of involvement may be counterproductive in certain settings, such as when an educator is unavailable to provide one-to-one support. To address the previously noted limitations, the present study aims to extend the literature by (a) comparing the effectiveness of tablet-delivered to instructor-delivered teaching, (b) evaluating generalization of concepts taught to real-life objects, (c) assessing maintenance of correct responding up to a few months following the instruction, and (d) comparing engagement and off-task behavior across modalities.

Method

Participants and Settings

We recruited seven children diagnosed with ASD (based on the DSM-IV or DSM-5 criteria [APA, 2000, 2013]) by an independent multidisciplinary team. Those children attended a French-instruction specialized school for children with ASD in [removed for blind review] because they presented a low level of functioning or problem behaviors preventing their inclusion in integrated classroom settings. To participate in this study, the students had to: (a) already have a diagnosis of ASD, (b) currently be learning one-word concepts, and (c) be capable of sitting for at least 5 minutes. The school board and the researchers' university research ethics board approved our research project. Following approval, we presented the project to teachers of this school and asked them to refer students meeting our inclusion criteria. Based on teacher referrals, we then presented the project to the children's parents and obtained their written informed consent.

Sam was 8 years old at the start of the study, had severe symptoms of ASD[1], and did not have a means of communication other than squeals and informal gestures. Similarly, Carine was 9 years old, had severe symptoms of ASD, and did not have a means of communication other than informal gestures. Nancy was 5 years old, had mild to moderate symptoms of ASD, and used one-word statements to communicate. Ian was 6 years old, had minimum symptoms of ASD, and made one-word statements mainly in an echolalic form. Alex was 7 years old, had mild to moderate symptoms of ASD, and displayed meaningful speech (four- to five-word sentences) but would often interchange certain words. Adam was 8 years old, had severe symptoms of ASD, and sometimes used one-word statements with unclear pronunciation. Lastly, Antoine was 9 years old, had mild to moderate symptoms of ASD, and used one-word statements to communicate. All participants had prior experience with tablets, which were often used to provide access to reinforcing activities (e.g., games, videos) in their classrooms.

Instruction was provided in French for all participants. All sessions were either conducted in a small conference room or in a private room within the school. Most of the time, only the participant and the first author were present during those sessions; a research assistant was only occasionally present to measure interobserver agreement (IOA). When she was present,

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[1] Our description of the severity of the symptoms of ASD are based on the Childhood Autism Rating Scale – Second Edition (CARS-2; Schopler, Van Bourgondien, Wellman, & Love, 2010). See Data Collection and Results sections of the manuscript for detailed procedures and scores.

she sat in front of the first author or on her left. Participants sat at a large table with the first author sitting next to them on their right.

Data Collection and Interobserver Agreement

To characterize our sample, we scored the Childhood Autism Rating Scale-second edition (CARS-2; Schopler et al., 2010) based on our school observation to provide an estimate of the severity of their autistic symptomatology for each participant. The CARS-2 is a 15-item behavioral rating scale designed to help identify children with ASD and determine symptom severity on a spectrum. The 15 items are scored on a seven-point Likert-type scale and each item relates to behaviors and symptoms associated with ASD such as repetitive behavior and inconsistent eye contact. The score obtained therefore allows the rater to identify whether the child is non autistic, mildly autistic, moderately autistic or severely autistic. We also administered the Adaptive Behavior Assessment System Second Edition (ABAS-II; Harrison & Oakland 2003) by interviewing their parents (usually the mother). The ABAS-II which is a norm-referenced tool, targets ten skill areas of adaptive functioning (communication, community use, functional pre-academics, home living, health and safety, leisure, self-care, self-direction, social and motor abilities). The General composite score (GAC) therefore reflects a child's level of adaptive functioning compared to a normative sample.

To compare the effects of the tablet-delivered and the instructor-delivered teaching, we measured the children's responding during baseline, instruction, generalization, and follow-up sessions. A correct response was defined as the child touching the image or object corresponding to the named concept within 3 s of the concept being named. An incorrect response was defined as touching an image or object other than the one associated with the named concept within 3 s, and finally the absence of a response was defined as the child not touching an image or object within 3 s. We calculated the percentage of correct responding by dividing the number of correct responses by the number of unprompted trials (i.e., always 5) and multiplying the quotient by 100. To measure the child's off-task behavior, we measured the number of times the instructor prompted the child to sit. All sessions were videotaped and a research assistant was present for at least 33% of the sessions in order to calculate the IOA. The IOA was calculated by dividing the number of agreements by the number of agreements and disagreements and multiplying the result by 100, which resulted in mean IOAs of 99% or above for each participant.

Instructional Materials

We used an Android-based Samsung Galaxy Note 10.1 tablet with a 25.4-cm screen on which we installed an app designed to teach receptive identification of vocabulary words. The OpenSource Discrete Trial Instructor is an app developed by the research team, which uses discrete trials, integrated video reinforcement and prompting to teach one-word concepts. The app is not available to the public at this time as it is mainly used as a research tool. The app can be used to teach one-word concepts from seven categories (i.e., colors, animals, prepositions, food, clothes, musical instruments and letters). Each category included five different concepts and each concept included five different exemplars. For example, the categories "animal" included five different animal concepts (i.e., dog, cat, bear, horse, and cow) and the concept "dog" included five different exemplars of the concept (e.g., Dalmatian, Beagle, Cane Corso, Chihuahua, Boston terrier). The details regarding the presentation of the instructional trials by the app are described in the procedures section below. Instructor-delivered teaching was similar to tablet-delivered teaching except that the instructor offered the instructions and prompts as opposed to the tablet.

Experimental Design and Procedures

In order to compare the effectiveness of instructor-delivered and tablet-delivered instruction, we used a multielement design while staggering the introduction of subsequent pairs in a multiple probe design. We also integrated periodic generalization and follow-up probes to the research design. Each child participated in six to twelve sessions per day, three days per week (depending on their availability) for a total period of 15 to 30 min daily. The experiment took six months to conduct. We selected six concepts to teach each child based on teacher and parental reports. We taught each child three pairs of concepts: Three with the tablet and three with the instructor. In addition to randomly assigning a concept to an instructional modality, we selected pairs of concepts composed of examples with similar levels of difficulty. For example, we taught Nancy the "horse" concept using the tablet and the "duck" concept with the human instructor. Both concepts are animals and included a similar level of variations in the examples presented.

Prior to teaching a concept, we conducted baseline sessions in order to make sure that the participant did not already know it. The participant had to demonstrate a rate of correct responding lower than 80% on at least three consecutive data points spread on two different days. In accordance with the multiple probe design, we only started teaching the second pair of concepts when the child demonstrated a rate of correct responding on at least 80% on three consecutive generalization probes of at least one concept of the first pair of concepts. When only one concept from the concept pair was generalized, we conducted five additional teaching sessions of the second concept not yet generalized before introducing the new pair of concepts. Since some participants showed generalization more rapidly for one concept of the previous pair, we introduced the new pair of concepts while pursuing teaching the previous concept on which the participant had not yet shown generalization. We stopped teaching a concept when the child showed correct responding of 80% or more on three consecutive generalization probes spread on at least two different days.

Sam, Nancy, Ian, Alex, and Adam ended their participation in the project when they showed generalization on all three pairs of concepts. As for Carine and Antoine, we terminated their participation earlier prior due to time restrictions (i.e., end of project). At the end of the instructional period, Antoine had shown generalization two pairs of concepts (two taught with the tablet and two with the instructor) and Carine had met the criterion for two concepts taught by the instructor and one with the tablet. Even though we asked the children's teachers and parents not teach the concepts targeted in our instruction during the course of the study, we had to introduce new pairs of concepts not originally tested for several participants as they showed mastery on some concepts prior to teaching, indicating exposure outside of the experimental setting.

Baseline. In order to evaluate a participant's pre-instruction knowledge of the concepts taught, we began by conducting baseline probes. For each concept, we conducted at least three baseline sessions for each child on at least two different days. Additionally, we also assessed pre-instruction knowledge of the four other concepts targeted for later teaching. Every session included five trials. For concepts taught on the tablet, three images (either colored photographs or colored drawings of the concept) were concurrently presented on the tablet screen with one image depicting the target concept and two others depicting distracters (images of associated categories not currently taught). An automated voice named the concept and the child was required to choose the image associated with the concept by manually selecting it on screen. The app randomized the position of the correct responses and did not provide any reinforcement or feedback to the participant during baseline. If the child did not choose an image within 3 s of the instruction, the instructor told the participant to listen to the instruction and select an image while transitioning to the next trial (presenting a different example of the concept). If the child stood up from the chair, the investigator asked him to sit down within 3 s. If the child did not sit down following the vocal prompt, the instructor repeated the vocal instruction and pointed to the chair. If the child still did not sit down following the verbal and gestural prompt, the instructor manually guided him to the chair by placing his hand on his shoulder until he sat down. We followed a similar procedure for concepts taught with the instructor with the first author presenting the instructions and the images presented on paper rather than on the tablet screen.

Teaching with the tablet. The instructional sessions were similar to the baseline sessions with the following exceptions. First, the app played a preferred video for 10 s contingent on correct responding. The instructor identified the preferred video prior to teaching using a modified paired-choice preference assessment and re-evaluated preference every 40 instructional sessions to maintain the child's motivation (see Chebli & Lanovaz, 2016, for detailed preference assessment procedures). Second, when the participant provided an incorrect response, the correct image of the concept grew larger while the name of the concept was repeated simultaneously. The prompting procedure was implemented automatically by the app following incorrect responses (i.e., without input from the instructor). The procedure was repeated until the child responded correctly. Correct responding on prompted trials resulted in access to the video reinforcement. We did not include prompted trials in our calculation of percentage of correct responding as they were almost always followed by correct responses, which would have skewed our results (because there were no prompted trials in baseline and follow-up). As in baseline, we always presented five unprompted trials to remain consistent. During all instructional sessions, we did not provide social reinforcement; the only reinforcement offered contingently on correct responding was the preferred video playing on the app.

Teaching with the instructor. Instructor-delivered teaching was similar to tablet-delivered instruction with some exceptions. In order to reinforce correct responding, we presented four of seven participants (Sam, Carine, Ian, and Adam) with their preferred video displayed on the tablet for 10 sec following a correct response. Alternatively, we presented three of seven participants (Nancy, Alex, and Antoine) with their preferred food choice also contingent on correct responding. Originally, we had decided to vary the types of reinforcement across participants to examine whether a differential pattern of results would be identified. We also decided to present some participants with food reinforcement for practical reasons since this type of reinforcement is usually favored during therapist-delivered intervention. Alternatively, since some participants had food allergies and diabetes, we chose to present those participants with a video reinforcement. Similarly to preferred videos, the preferred food choices were identified using a paired-choice preference assessment and re-evaluated every 40 sessions (see Fisher al., 1992 for detailed preference assessment procedures). All images presented during instruction were presented on paper instead of a tablet screen. Following an incorrect response, the instructor pointed the correct image while simultaneously repeating the name of the concept. We did not provide any social reinforcement (e.g. smiles, signs of approval) during instruction, the only reinforcement were either the preferred video or the food choice.

Generalization. To evaluate generalization to new exemplars, we assessed the child's knowledge of five different untaught exemplars of the target concept. Those exemplars differed from the ones used during instruction. We conducted the generalization probes prior to instruction and then periodically following each series of five instructional sessions of the taught exemplars. We used both real objects and untaught images of the target concept. Generalization probes for both tablet- and instructor-delivered teaching were similar to baseline probes except that they were always conducted by the instructor. During trials, we placed three items (the target concept and two other distracter items) on a table facing the child. The instructor named the target concept and the child was required to manually select the item representing the concept. We did not offer any reinforcement or prompts during these trials because the aim of our study was to examine whether the children would respond correctly on untaught exemplars. For each concept, we conducted five generalization trials, every trial presenting a different example of the target concept.

When a child responded correctly on 80% of target trials during the session, one more session was conducted thereafter and a third final one the next day in order to obtain three data points spread on at least two different days. As for the untaught concepts, we also conducted generalization probes when the child first began participating in the study and following 20 baseline and instructional sessions of the target concept in order to ensure the child had not learned the untaught concept in another context prior to the start of instruction. Due to mail delivery delays, we originally assessed Nancy's generalization to the "drums" concept using images only, but later integrated the object to her follow-up probes.

Between each trial, we presented simple instructions that the child already performed correctly prior to their inclusion in the study (e.g., giving a high five). The purpose of these instructions was to maintain responding during generalization trials as no reinforcement was provided for correct responding. Correct responding on these instructions was followed by edible or social reinforcement (e.g., great job, well done!) or both on a continuous reinforcement schedule (i.e., fixed ratio of 1). We did not collect data on responding on mastered instructions as our purpose was to measure generalization.

Follow-up probes. After having met the generalization criterion for a concept, we conducted follow-up probes every two weeks for up to three months for some concepts. The follow-up probes were identical to baseline (depending on availability).

Analysis

First, we computed the total number of teaching trials (including both unprompted and prompted trials) that each participant required to meet the generalization criterion for each concept. These results were then graphed to compare the effectiveness of instructor- and tablet-delivered teaching within each pair. Second, we depicted the data for each participant individually within single-case graphs to further examine correct responding, generalization, and maintenance. Finally, we reported both engagement and off-task behavior during teaching within a table in order to compare both modalities. The percentage of engagement was calculated by dividing the number of trials on which the child provided a response (i.e. either incorrect or correct) by the total number of trials. As such, the engagement measure excluded non-responses. The off-task measure was the number of times (per session) that the child was prompted to sit down, which was as an indicator of off-task behavior.

Results

Table 1 presents the age, gender, CARS-2 *T*-score, ABAS-II General adaptive composite score*,* the concepts taught, the level of engagement and off-task behavior displayed by each participant according to the instructional modality. Figure 1 shows the number of instructional trials required for each participant to display generalization following tablet-delivered and instructor-delivered teaching. Results show two patterns of responding. First, two of seven participants (Sam and Carine) consistently showed generalization within fewer instructional trials on the concepts taught with the instructor. Second, five of seven participants (Nancy, Ian, Alex Adam and Antoine) had mixed results: The effectiveness of the instructional modality varied depending on the concept being taught.

Among the participants learning more rapidly from the instructor-delivered teaching (see Figures 2 and 3), Figure 2 indicates that Sam required fewer instructional trials to generalize the three concepts taught with the instructor compared to the concepts taught with the tablet. As for his follow-up probes, his rate of correct responding was slightly higher for concepts taught with the instructor compared to those taught with the tablet. Additionally, Sam displayed higher levels of engagement with the instructor. As for Carine, Figure 3 shows a more rapid learning rate while receiving instructor-delivered teaching. Concerning the second pair of concepts, she showed generalization on the concept taught with the instructor, but never reached generalization criterion for the second concept taught with the tablet. Carine also showed better maintenance on the concepts taught with the instructor and was more engaged while receiving instructor-delivered teaching.

As for the remaining five participants (Nancy, Ian, Alex, Adam, and Antoine; see Figures 4 to 8), the effectiveness of the instructional modality in terms of the number of trials required to show generalization differed based on the concept taught. Figure 4 indicates that Nancy met the generalization criterion within fewer sessions following instructor-delivered teaching on two of three concept pairs, while showing generalization more rapidly on the first concept taught with the tablet. Furthermore, Nancy showed better maintenance on concepts taught with the instructor, but displayed a higher level of engagement with the tablet. Figure 5 indicates that Ian displayed more rapid generalization of the first two concepts taught with the instructor compared to the concepts taught with the tablet. He did however display more rapid generalization of the third concept taught with the tablet compared to the one taught with the instructor. Ian also showed better maintenance and displayed higher levels of engagement to instructor-delivered teaching.

Similarly to Ian, Figure 6 reveals that Alex displayed more rapid generalization following instructor-delivered teaching with the first two pairs of concepts. Nevertheless, his results differed for the third pair of concepts because he reached the generalization criterion more rapidly with tablet-delivered instruction. It is also worth mentioning that Alex had similar levels of correct responding on follow-up trials for both modalities. He also displayed higher levels of engagement with the instructor. Figure 7 indicates that Adam was also able to generalize the first two concepts taught with the instructor following fewer trials. That said, Adam's results differed for the third pair of concepts because he was able to generalize more rapidly the concepts taught with the tablet. Adam also showed similar levels of maintenance with the two modalities while displaying higher levels of engagement with the instructor. Lastly, Figure 8 shows that Antoine displayed more rapid generalization following instructor-delivered teaching with the first concept while displaying more rapid generalization of the second concept taught with the tablet. Antoine also showed better maintenance of concepts taught with the instructor and displayed higher levels of engagement to instructor-delivered teaching.

Discussion

In sum, our results indicate that instructor-delivered teaching was the most effective instructional modality at promoting generalization for two of seven participants. As for the remaining five participants, the most effective instructional modality for generalization varied depending on the concept taught. More specifically, nine of fourteen concepts were generalized more rapidly following instructor-delivered teaching and the remaining five concepts more rapidly following tablet-delivered instruction. At follow-up, five participants showed better maintenance of the concepts learned with the instructor and the results were the same across modalities for two participants. Moreover, six of seven participants displayed higher levels of engagement during instructor-delivered teaching whereas only one participant was more engaged with the tablet. Off-task behaviors remained consistently low for all participants and we thus did not observe differentiated levels of responding across modalities.

Overall, our results suggest that instructor-delivered teaching is more effective than tablet-delivered instruction (for 14 of 19 pairs in our study), indicating that tablet-delivered instruction should not replace instructor-delivered teaching. Nevertheless, our results support the use of tablet-delivered instruction as a complement to traditional instruction. Children still showed generalization on nearly all concepts taught using tablets (18 of 19). As such, tablets could still represent an interesting option, particularly in contexts where financial and human resources are scarce or would prevent the delivery of individualized instruction. The reason why some children required fewer instructional trials with the instructor may be related to engagement. Nearly all children engaged in less non responding with the instructor than with the tablet, which is inconsistent with the results of the study conducted by Moore and Calvert (2000). Taken together, our results suggest that being more engaged with the instructional material may lead to be better outcomes, but more research is needed on this topic. The use of two types of reinforcers for some participants may also explain some differential results. Interestingly, the three children who received edibles during instructor-delivered teaching showed mixed results across modalities.

Our study extends prior findings in several ways. By comparing instructor- and tablet-delivered instruction, we were able to evaluate the relative effectiveness of the two modalities. Most importantly, we evaluated whether concepts taught with the two instructional modalities were generalized and maintained over several weeks. Our results therefore extend previous studies that mostly did not evaluate generalization to real-life objects and evaluated maintenance over a short period of time (Allen, Hartley, & Cain, 2015; Moore & Calvert, 2000). Examining generalization to real-life objects as well as maintenance over an extended period of time is important because it may decrease the need for further instruction. By including a video reinforcement component in the app in order to promote learner independence, we decreased instructor involvement, potentially allowing the implementation of the procedures with multiple students simultaneously.

Our results are limited insofar as the difficulty of the concepts taught with the two modalities could have inadvertently differed, which is why we chose to teach three concepts to each participant with both modalities. Furthermore, some participants responded arbitrarily during the instruction as the reinforcement was available for an equal duration of time following both prompted and unprompted correct responses. To address this issue, we recommend that researchers differentially reinforce correct responding following prompts in the future. In order to encourage independent responding, a participant could receive a smaller magnitude of reinforcement (e.g., 3 s rather than 10 s of video) following a prompted response as opposed to an independent correct response. That said, the children's arbitrary responding could also be attributed to their reduced interest in the video reinforcement that may not have been varied frequently enough to maintain their motivation. In the same line of reasoning, even though we limited the number of teaching sessions delivered per day in order to avoid a carry-over effect from one teaching medium to the next and counterbalanced the order of presentation of the teaching tools, the children's responding could still have been influenced by their preference for one type of instruction. For instance, a participant demonstrating a preference for teacher-delivered instruction could potentially be less engaged during tablet-delivered instruction. Some children also demonstrated unstable responding during generalization probes which could be attributed to the lack of reinforcement provided during generalization sessions as opposed to teaching sessions. Finally, our small sample size precluded inferential statistical analyses regarding the contribution of individual characteristics to the modalities' effectiveness (e.g., scores on the ABAS-II, CARS-II, age).

In the future, studies should replicate our study with a larger number of participants and examine whether variables such as IQ, engagement, off-task behavior, and autistic symptoms severity moderate the association between tablet-delivered instruction and generalization. Similarly, researchers should consider examining the effects of preference on the predictive effectiveness of each modality. For example, children may participate in concurrent-chain arrangements to assess the relative preference for tablet- and instructor-delivered teaching prior to comparing both modalities (see Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997). We also recommend that future studies replicate the study with other types of instructors such as parents or paraprofessionals while having the app automatically save the data, therefore reducing the dependency on the individual dispensing the intervention. Researchers could also examine the relative effectiveness of instructor-led group teaching with tablet-delivered individualized instruction. Finally, it would also be relevant to evaluate whether children are showing generalization in novel contexts and with new persons.

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Table 1

Characteristics, Concepts Taught, Percentage of Engagement, and Rate of Off-Task Behavior During Teaching for Each Participant

					Concepts Taught		Engagement (%)		Off-task behavior (per session)	
Participant	Age	Gender	CARS-2 *T* score	ABAS-II *GAC*	Tablet	Instructor	Tablet	Instructor	Tablet	Instructor
Sam	8	Male	49	65	Dog	Cat	79	93	0	0.03
					Shoes	Gloves				
					A	D				
Carine	9	Female	56	55	Red	Yellow	69	92	0	0
					Blue*	Green				
Nancy	5	Female	44	40	Blue	Green	97	76	0.02	0.09
					Horse	Duck				
					Drums	Guitar				
Ian	6	Male	38	77	Red	Yellow	89	96	0	0
					Blue	Green				
					Dog	Cat				
Alex	7	Male	41	77	Horse	Duck	73	99	0.03	0
					Skirt	Socks				

					Drums	Saxophone				
Adam	8	Male	50	Not available	E Shoes Drums	D Gloves Guitar	94	100	0	0.04
Antoine	9	Male	47	52	Cow Inside	Horse On	90	99	0	0.02

Note. CARS-2: Childhood Autism Rating Scale, ABAS-II: Adaptive Behaviour Assessment System - II (Second Edition), GAC: General adaptive composite. The sterisk refers to a concept that the participant never generalized.

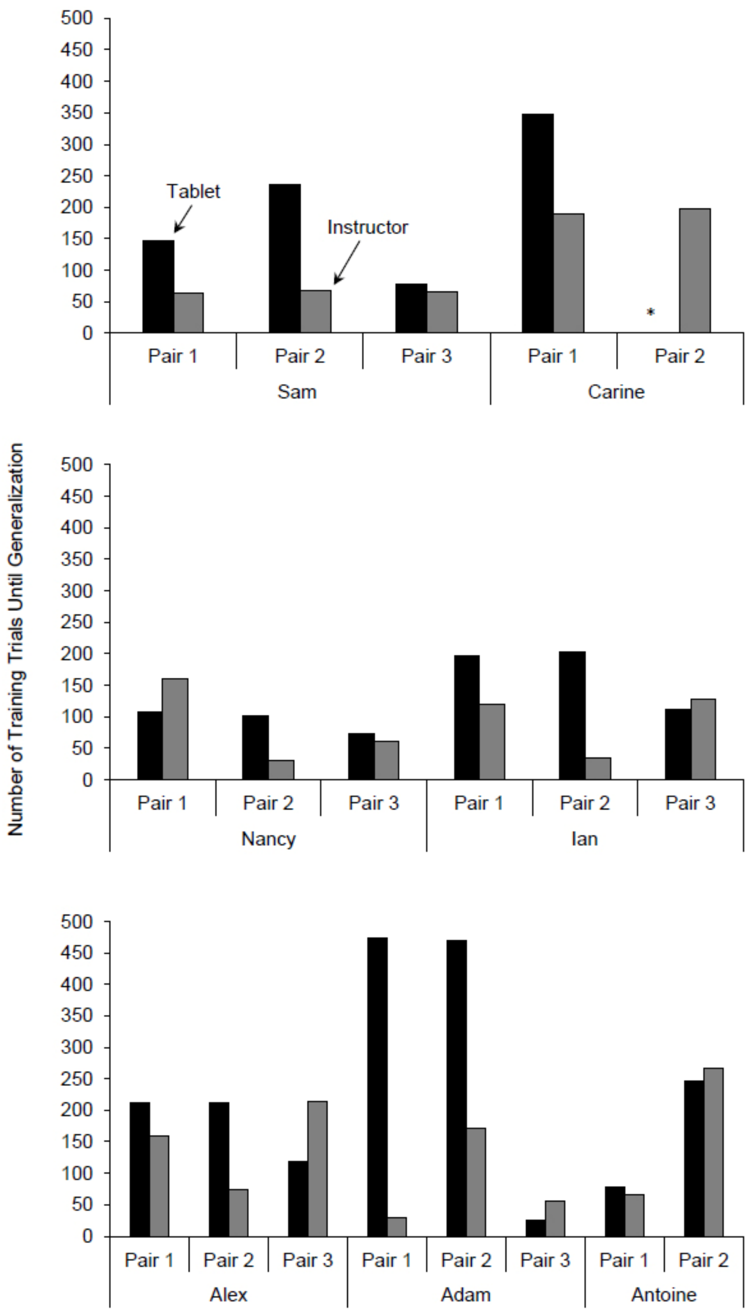

Figure 1. Number of training trials until each participant showed generalization on the concepts' pairs taught with the tablet and the instructor. The asterisk denotes a concept on which the participant never showed generalization.

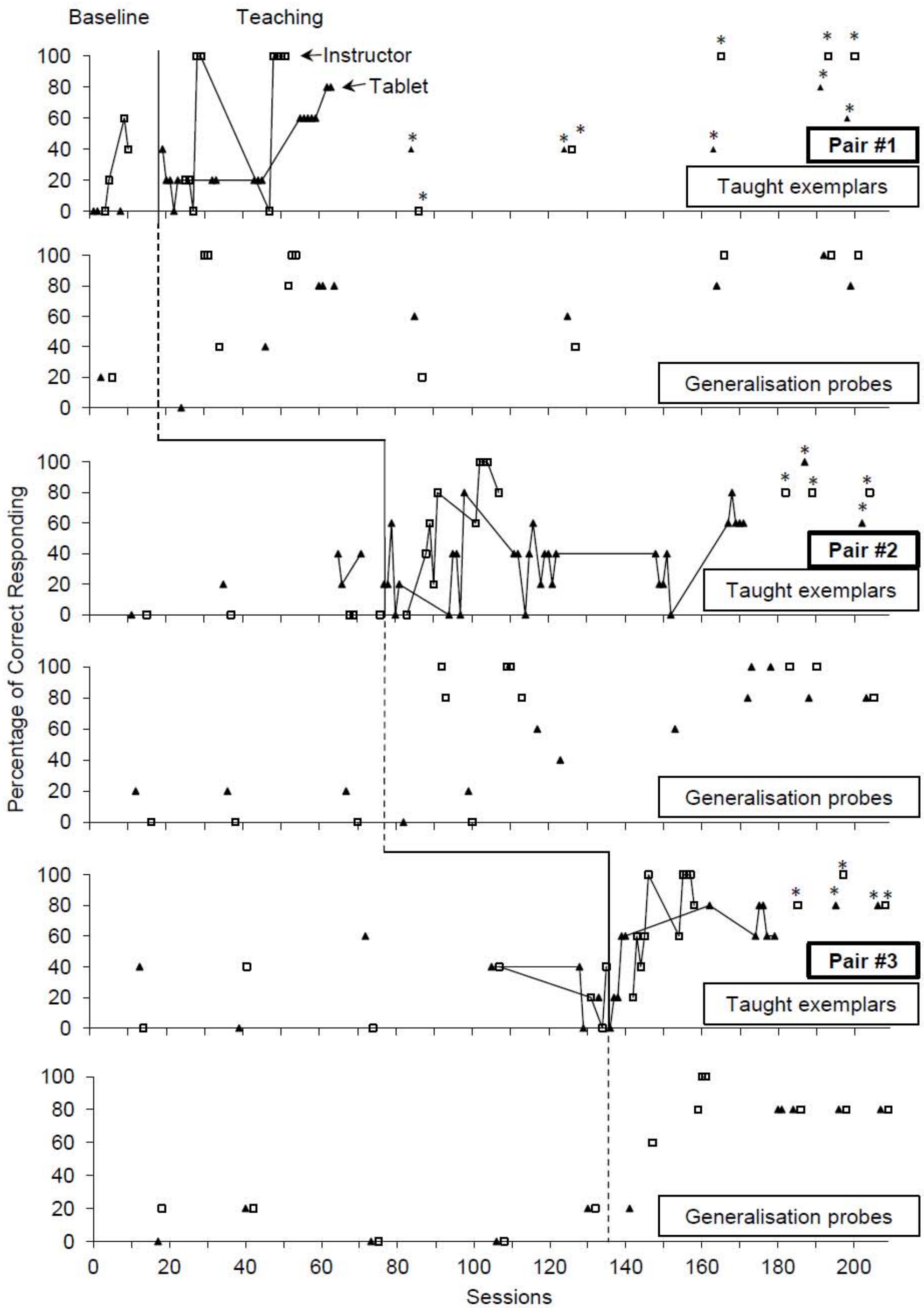

Figure 2. Sam's percentage of correct responding on taught exemplars and generalization probes for each pair of concepts. Asterisks identify follow-up probes.

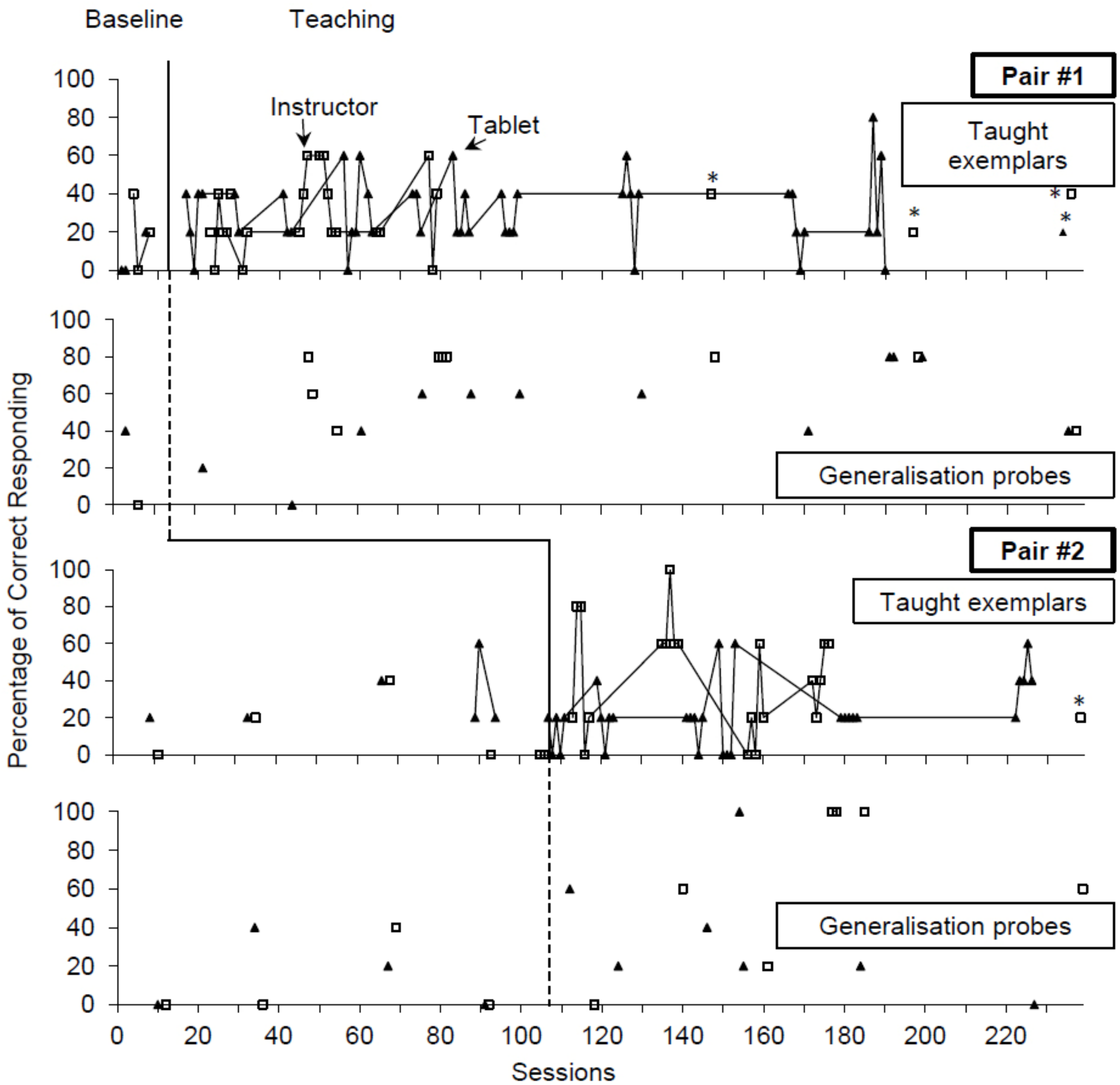

Figure 3. Carine's percentage of correct responding on taught exemplars and generalization probes for each pair of concepts. Asterisks identify follow-up probes.

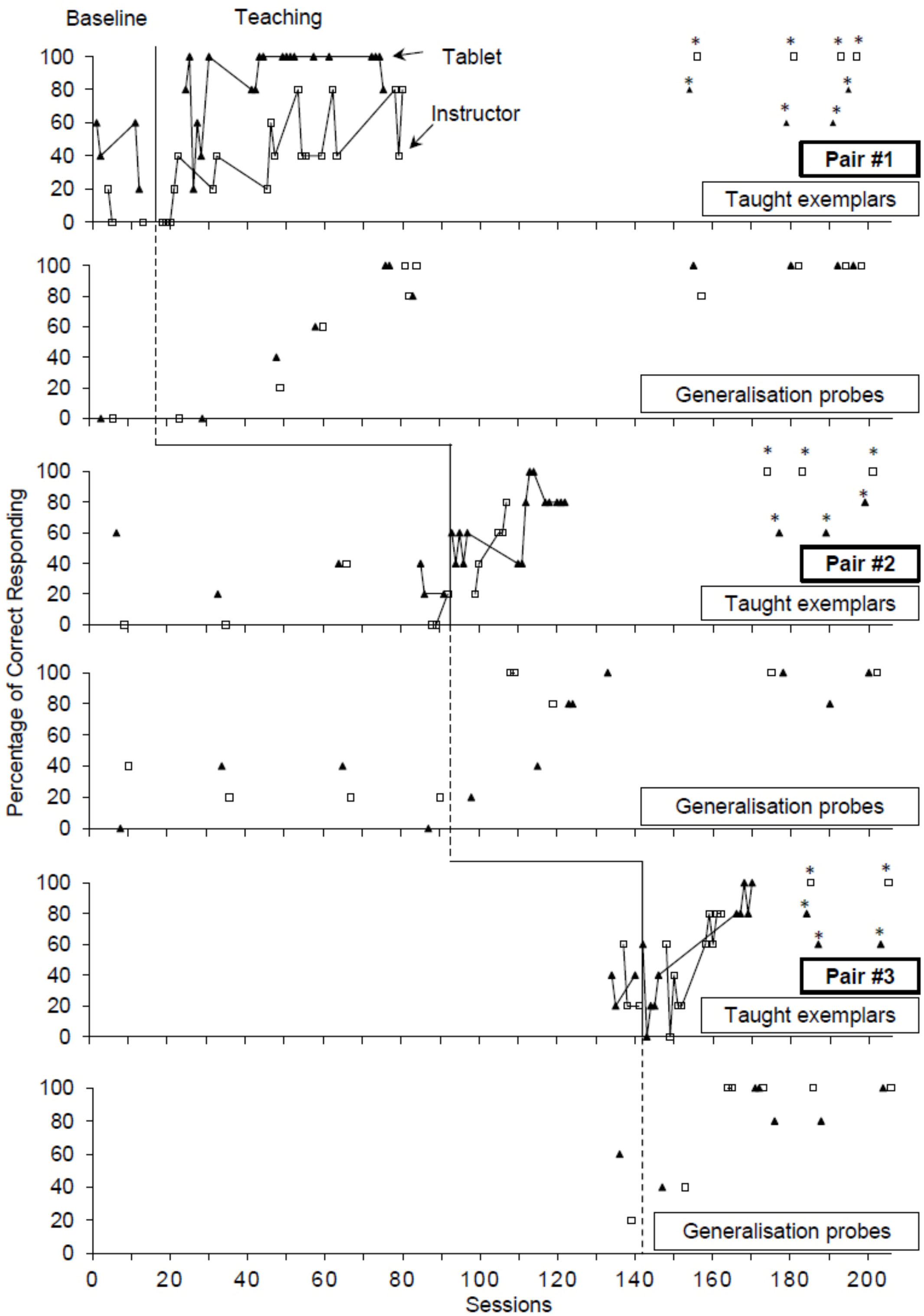

Figure 4. Nancy's percentage of correct responding on taught exemplars and generalization probes for each pair of concepts. Asterisks identify follow-up probes.

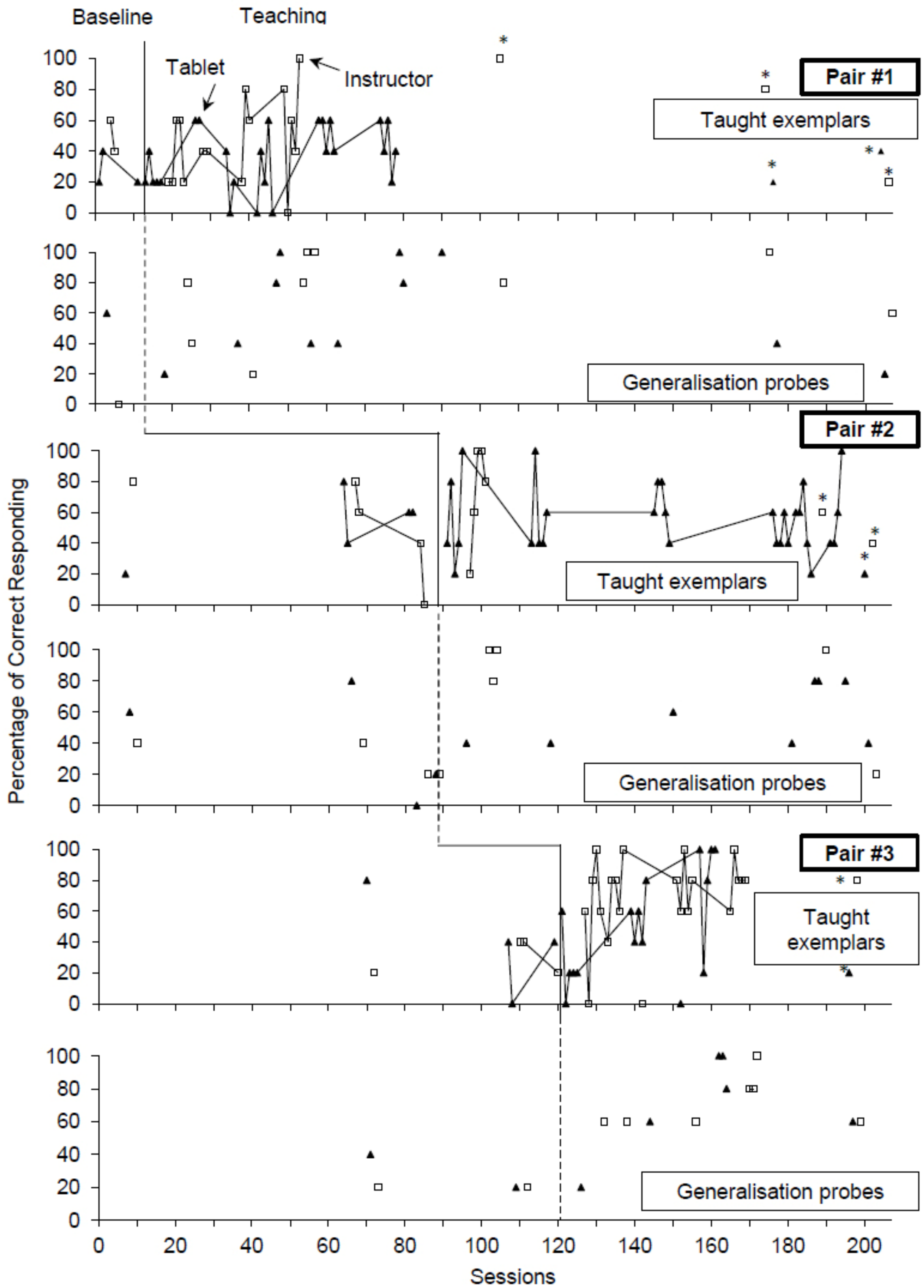

Figure 5. Ian's percentage of correct responding on taught exemplars and generalization probes for each pair of concepts. Asterisks identify follow-up probes.

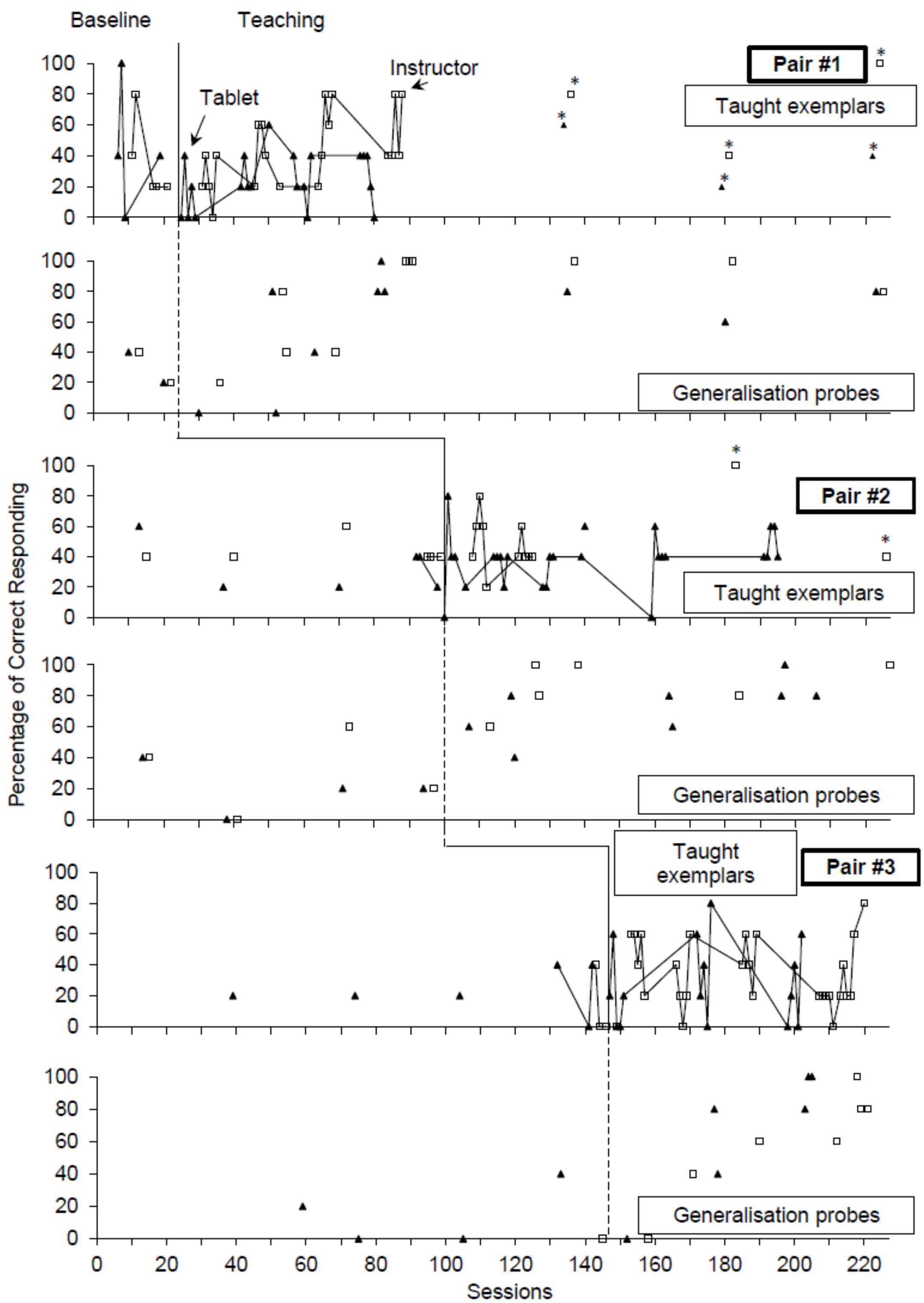

Figure 6. Alex's percentage of correct responding on taught exemplars and generalization probes for each pair of concepts. Asterisks identify follow-up probes.

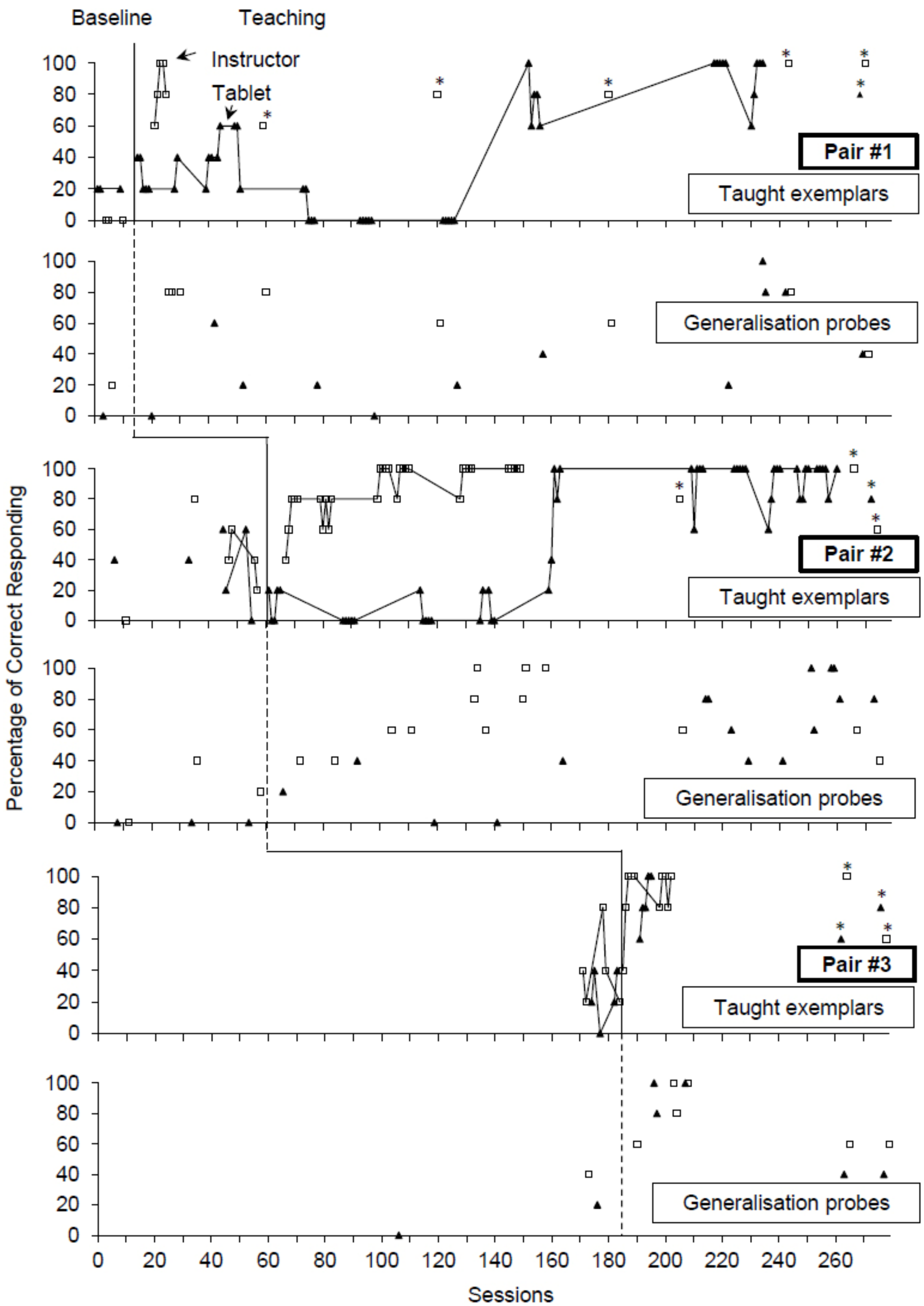

Figure 7. Adam's percentage of correct responding on taught exemplars and generalization probes for each pair of concepts. Asterisks identify follow-up probes.

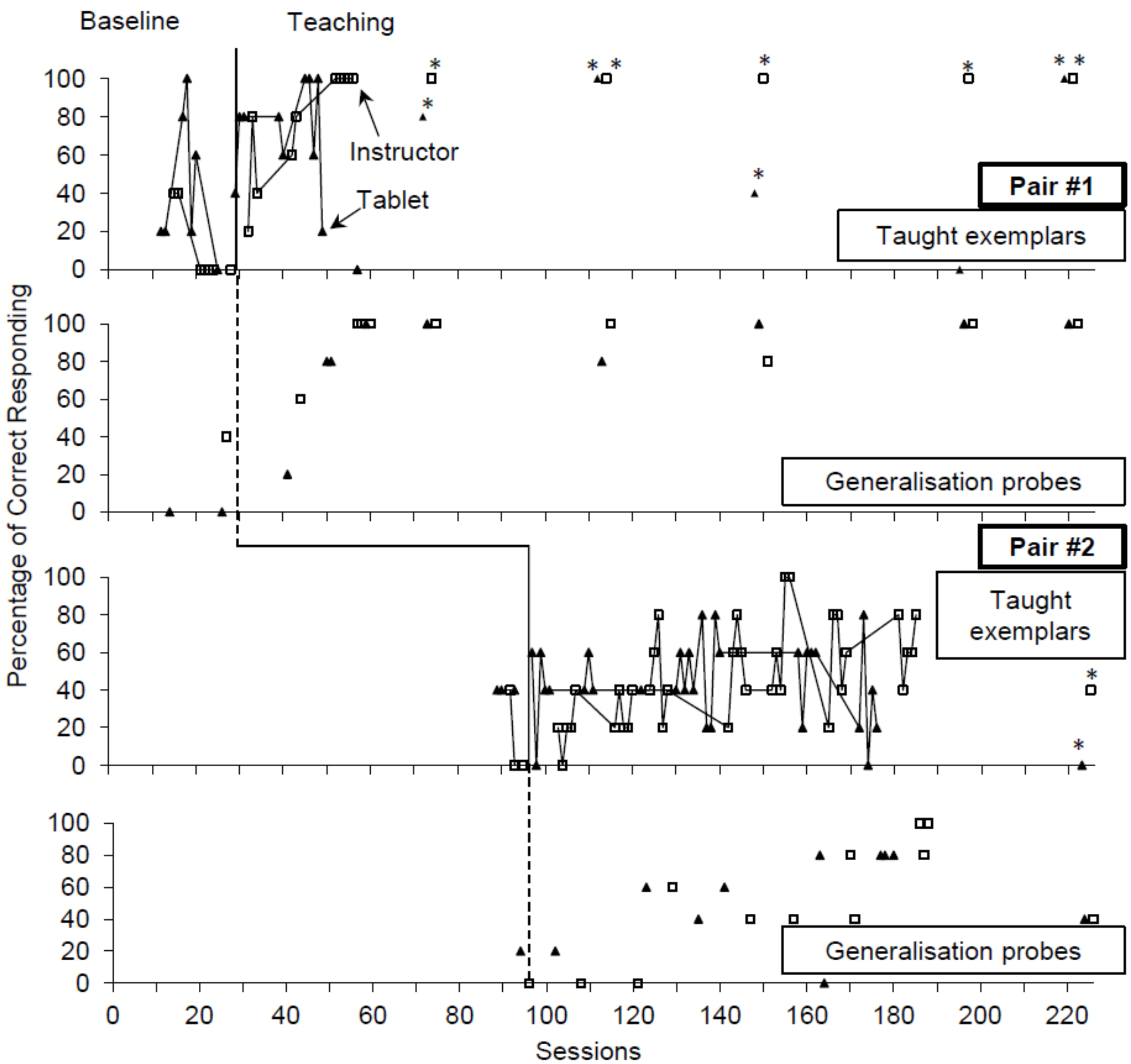

Figure 8. Antoine's percentage of correct responding on taught exemplars and generalization probes for each pair of concepts. Asterisks identify follow-up probes.

Chapitre 5. Conclusion

Résumé des principaux résultats empiriques

En résumé, les trois articles constituant cette thèse doctorale portent sur l'utilisation de la tablette comme outil d'évaluation de la préférence et d'enseignement auprès d'enfants ayant un TSA. Dans le premier article (chapitre deux), nous avons examiné si les tablettes pouvaient être utilisées à des fins d'évaluation de la préférence de vidéos auprès d'enfants ayant un TSA. Les résultats obtenus soulignent l'efficacité d'utilisation des tablettes à des fins d'évaluation de la préférence de vidéos, et ceux-ci pourraient servir de renforçateurs dans le cadre d'une intervention. D'ailleurs, nos résultats s'alignent avec ceux d'études précédentes et y contribuent en comparant l'efficacité de la vidéo préférée à celle moins préférée sur la durée de temps passé assis sur une chaise (Clark et al. 2015; Mechling et al. 2006; Snyder et al. 2012). Les résultats d'une évaluation de la préférence de vidéos sur tablette permettent donc de prédire le taux de réponse dans un arrangement concurrent et opérant puisque la vidéo choisie le plus fréquemment a permis d'augmenter la durée de temps assis sur une chaise comparativement à la vidéo la moins préférée.

Dans le deuxième article (chapitre trois), nous avons pris en compte les limites d'études précédentes afin d'évaluer l'efficacité de l'enseignement de concepts sur une tablette auprès d'enfants ayant un TSA. À cet égard, les résultats de l'étude permettent de confirmer l'efficacité des tablettes comme outil d'enseignement, puisque trois des cinq enfants ayant un TSA ont pu démontrer une généralisation d'au moins deux concepts enseignés à de nouveaux exemples n'ayant pas été préalablement enseignés ; plus encore, ces généralisations ont été maintenues pendant plusieurs semaines suite au retrait de l'intervention. Notre étude contribue ainsi aux résultats d'études précédentes (Bosseler et Massaro, 2003; Sansosti et Powell-Smith, 2008; Schery et O' Connor, 1997) sur plusieurs niveaux. En intégrant le renforçateur vidéo au logiciel informatique, nous avons minimisé la dépendance de l'enfant envers l'intervenant. En vérifiant périodiquement le degré de connaissance des enfants des autres concepts non enseignés, nous avons tenté de minimiser les menaces à la validité interne de l'étude. En évaluant la généralisation des concepts enseignés sur tablette à de nouveaux exemples présentés sur images ou à l'aide d'objets véritables, nous avons contribué à la littérature puisque la plupart des études précédentes ne se sont pas attardées à cette généralisation ou l'ont évaluée sur des images et non pas de vrais objets. Finalement, en créant notre propre application avec l'aide d'une informaticienne, nous avons pu l'individualiser en respectant les principes de l'analyse appliquée du comportement (AAC; essais distincts, procédure d'incitations et renforçateur offert suite à l'obtention d'une réponse correcte).

Pour faire suite aux résultats du deuxième article, nous avons entrepris une troisième étude visant à comparer l'efficacité de l'enseignement sur tablette avec celui dispensé par un intervenant. Les résultats de l'étude suggèrent que l'enseignement dispensé par l'intervenant était plus efficace que celui dispensé par le biais de la tablette afin de favoriser la généralisation de concepts de deux des sept participants. Pour ce qui est des cinq autres participants, l'efficacité de l'outil d'apprentissage variait selon le concept enseigné. Quant au maintien de ces concepts, cinq participants ont maintenu plus longtemps les concepts enseignés avec l'intervenant alors que deux de ces participants ont maintenu également les concepts enseignés avec les deux modes d'enseignement. Six des sept participants étaient aussi plus engagés avec l'intervenant qu'avec la tablette. Les résultats de cette dernière étude contribuent aussi à la littérature (Allen, Hartley et Cain, 2015; Moore et Calvert, 2000; Sansosti et Powell-Smith, 2008) de plusieurs façons : en plus d'avoir démontré une réduction de la dépendance envers l'intervenant en intégrant une vidéo à l'application, nous avons aussi pu comparer l'efficacité d'une intervention dispensée avec la tablette à celle dispensée par un intervenant. Cette comparaison nous a permis d'évaluer l'efficacité relative de ces deux outils d'enseignement en plus d'en différencier le niveau d'engagement des enfants. Plus encore, nous avons pu évaluer si les enfants démontraient une généralisation des concepts enseignés à de nouveaux exemples présentés sur images et à l'aide d'objets véritables, tout en évaluant leur maintien sur une période de plus de trois mois suite au retrait de l'intervention. Or, peu d'études ont tenté de comparer l'efficacité des deux outils, de s'attarder à la généralisation de concepts enseignés à des objets puis d'en évaluer leur maintien sur plusieurs semaines.

Implications pour la recherche

Les résultats obtenus dans le cadre de cette thèse doctorale permettent de contribuer à la littérature en soulignant l'efficacité des tablettes comme outils d'évaluation et d'enseignement auprès d'enfants ayant un TSA. Malgré la disponibilité croissante d'applications et de logiciels commercialisés comme répondant aux besoins des personnes ayant un TSA, la plupart n'a pas l'objet de recherche rigoureuse et systématique ayant mis leur efficacité à l'épreuve. Parallèlement, les études effectuées à ce sujet (Bosseler et Massaro, 2003; Hetzroni et Tannous, 2004; Moore et Calvert, 2000; Knight, McKissick et Saunders, 2013) présentent différentes limites, nous empêchant d'en tirer des conclusions fermes. Ma recherche doctorale permet ainsi de contourner plusieurs de ces limites en vue de faire avancer les connaissances sur le sujet.

Dans le cadre du troisième article, l'instauration d'un devis avec alternance de traitement intégré à un devis à niveaux de base multiples a permis d'évaluer simultanément et rapidement l'efficacité de deux modes d'enseignement. D'autre part, en évaluant la généralisation des concepts à des objets véritables, nous avons amélioré la validité écologique de l'étude et avons ainsi contribué à la littérature qui avait surtout privilégié la généralisation de concepts à des images (Bosseler et Massaro, 2003; Whalen et al., 2006). Par ailleurs, les tests de maintien qui se sont étendus sur plusieurs semaines suite au retrait de l'intervention permettent également d'améliorer la validité de notre intervention. Toujours dans un effort de minimisation des menaces à la validité interne de l'étude, nous avons demandé aux parents et enseignants de ne pas enseigner les concepts ciblés dans le cadre de notre intervention. Finalement, en vérifiant périodiquement le degré de connaissance des enfants auprès d'autres concepts non enseignés, nous nous sommes assurés que les concepts acquis étaient attribuables à notre intervention et non pas à des variables confondantes.

Ceci étant dit, un des apports principaux de cette thèse doctorale au domaine de la recherche a trait à la comparaison de l'efficacité de l'enseignement dispensé par un intervenant à celui dispensé par le biais d'une tablette. Peu d'études avaient entrepris cette démarche et celles qui s'y sont attardées accusent certaines limites recensées précédemment (Moore et Calvert, 2000; Allen, Hartley et Cain, 2015; Schery et O'Connor, 1997). En plus de comparer la rapidité d'apprentissage de concepts enseignés par le biais de ces deux modes d'enseignement, nous avons également comparé le niveau d'engagement des enfants ainsi que leur niveau de travail hors tâche. Ces variables d'engagement et de travail hors tâche, peu explorées dans la littérature, demeurent importantes dans le cadre de l'intervention auprès d'enfants ayant un TSA et nous renseignent quant aux conséquences de ces comportements sur les bénéfices tirés d'une intervention.

Dans un autre ordre d'idées, l'hétérogénéité de notre échantillon permet de faire avancer les connaissances sur les enfants ayant un TSA de différents niveaux (tel qu'identifié par les critères diagnostiques du DSM-5). En effet, la plupart des études précédentes ont surtout favorisé les enfants ayant un TSA de plus haut niveau de fonctionnement, sans s’attarder sur les enfants ayant plus de difficultés. Or, le TSA étant un trouble assez hétérogène, le tableau clinique ainsi que les réponses de chaque enfant à l'intervention pourraient différer d’un cas à un autre, d'où la nécessité de mener des recherches auprès d'enfants de différents niveaux. Grâce à notre approche plus écologique et inclusive, les résultats discutés dans l'ensemble de nos articles permettent ainsi de souligner l'efficacité des tablettes comme outils d'enseignement auprès d'une population assez hétérogène d’enfants ayant un TSA.

Finalement, cette recherche doctorale permet d'illustrer la faisabilité d'implantation d'un projet de recherche dans un milieu pratique. L'idée du projet est née de notre expérience sur le terrain, s'est alimentée de nos connaissances de recherche en lien avec les meilleures interventions à dispenser auprès de ces enfants, puis s'est concrétisée par la conception de l'intervention. Le projet a ensuite été implanté sur le terrain et ses résultats, disséminés dans le milieu académique. Dans le cadre de cette recherche doctorale, des méthodes et des devis de recherche rigoureux ont ainsi été adoptés afin de combler un écart perçu entre la théorie et la pratique. Tandis que le rapport gouvernemental intitulé un geste porteur d'avenir (Ministère de la Santé et des Services sociaux, 2003) souligne la nécessité d'offrir de l'Intervention comportementale intensive (ICI) à tous les enfants ayant un TSA de 18 mois à cinq ans, la réalité sur le terrain contraste avec cette recommandation, en partie à cause des longues listes d'attente pour avoir accès à ces services. Cette thèse étant de nature appliquée, la collaboration du milieu de la recherche ainsi que le milieu pratique s'est avérée essentielle tant pour la conception du projet que pour son application. De ce fait, la collaboration des acteurs de l'École de l'Étincelle s'est avérée cruciale afin de nous fournir un milieu d'intervention et des participants susceptibles de bénéficier de notre intervention. Ultimement, cet arrimage et collaboration entre le milieu pratique et académique constituent l'un des éléments les plus importants sous-tendant l'efficacité de l'intervention.

Implications pour la pratique

Sur le plan pratique, les résultats du premier article démontrent que les intervenants pourraient utiliser les tablettes afin de cerner et d'identifier des renforçateurs vidéos capables d'être utilisés dans le cadre d'une intervention auprès d'enfants ayant un TSA. D'ailleurs avec la disponibilité et présence accrue de ces outils non stigmatisants, les intervenants pourraient s'en servir afin de minimiser la dépendance de l'enfant envers eux, tout en favorisant leurs intégrations sociale et éducative. Comme l'évaluation de la préférence par paire nécessite un logiciel informatique capable de diviser l'écran en deux parties, un logiciel fonctionnant sur Androïde ou sur les nouveaux systèmes d'opération d'iPad (iOS 9+) devrait être priorisés. Considérant les restrictions pratiques qu'impose le milieu, notamment vis-à-vis le temps nécessaire pour effectuer une évaluation de la préférence, il serait pertinent pour un intervenant de présenter chaque paire de vidéos ensemble une fois, ou sinon d'utiliser une évaluation multiple des stimuli sans remplacement (DeLeon et Iwata, 1996).

Considérant les ressources humaines et financières limitées dont disposent les familles de ces enfants, la deuxième expérience démontre que les tablettes pourraient effectivement servir à enseigner des concepts à des enfants ayant un TSA. L'efficacité de l'enseignement sur tablette pourrait d'ailleurs être attribuable à son respect des principes de l'AAC, dont entre autres, le renforçateur intégré et les essais distincts. Puisque l'intégration du renforçateur vidéo à l'application permet de minimiser la dépendance de l'enfant envers l'intervenant, les enseignants et intervenants pourraient profiter d'un tel logiciel pour enseigner le vocabulaire à plusieurs enfants en même temps, notamment dans des classes avec des ratios d'enfants : intervenants élevés. À cet effet, une évaluation périodique de la préférence des vidéos est recommandée puisque les enfants pourraient être plus motivés à apprendre lorsqu'exposés à une nouvelle vidéo, plutôt qu'à celui originalement identifié. Finalement, la tablette demeure un outil d'enseignement efficace et pratique auprès de certains enfants ayant un TSA sans toutefois représenter une solution miracle, dans la mesure où il ne favorise pas nécessairement l'apprentissage de concepts auprès de tous les enfants. C'est la raison pour laquelle les intervenants devraient s'assurer de vérifier si l'enfant est effectivement en train d'apprendre du logiciel informatique (par exemple, après 40 séances d'enseignement) ; le cas échéant, il vaudrait mieux se tourner vers un moyen plus traditionnel d'enseignement, tel que l'intervenant. De plus, un enfant nécessitant plus de deux incitations à s'assoir durant une séance d'enseignement n'est probablement pas le meilleur candidat à recevoir de l'enseignement par le biais de la tablette.

Notons en dernier lieu que les résultats de l'expérience trois rejoignent cette même conclusion, puisqu'ils ont démontré que l'enseignement dispensé par un intervenant est plus efficace que celui dispensé par le biais d'une tablette. C'est la raison pour laquelle l'enseignement avec la tablette ne devrait pas remplacer celui dispensé par un intervenant. Même si la plupart des enfants apprenaient plus lentement avec la tablette, cet outil de travail demeure une option intéressante puisque les participants ont pu démontrer une généralisation de la plupart des concepts enseignés avec cette dernière. Sachant aussi que certains enfants ayant un TSA sont moins motivés à apprendre avec un intervenant, l'utilisation de la tablette devient d'autant plus intéressante, du moins le temps d'établir avec eux une alliance thérapeutique. Dans cette même lignée, l'intégration de renforçateurs vidéo au logiciel d'apprentissage présente également certains autres avantages comparativement à l'enseignement avec un intervenant, soit le fait que le renforçateur soit intégré au logiciel et que la dépendance envers l'intervenant se voit réduite, puis que le ratio coût-bénéfice est amélioré. Il appert donc que cet outil de travail représente tout de même une option attrayante dans un contexte financier et économique similaire à celui du Québec, où les délais d'attente se prolongent et où les ressources demeurent limitées. À cet effet, l'utilisation de cet outil ne devrait pas se limiter uniquement aux enfants ayant un TSA mais devrait également être mise à contribution auprès d'individus ayant une déficience intellectuelle, des retards ou des troubles développementaux ainsi que des enfants neurotypiques.

Implications pour la psychoéducation

Cette thèse doctorale s'inscrit et contribue à la discipline de la psychoéducation pour plusieurs raisons. Parmi celles-ci, figure d'abord notre échantillon qui est constitué d'une population vulnérable. Tel qu'énoncé par Renou en 1998 : « Le contact direct et la relation d'aide déployés auprès des personnes en difficulté demeurent donc toujours essentiels à l'intervention psychoéducative ». La présente thèse est née d'un besoin d'offrir une solution complémentaire aux enfants ayant un TSA qui ne bénéficient pas assez d'heures d'intervention, ainsi qu'aux enfants qui n'y ont plus accès.

Tel qu'avancé par Gendreau et Lemay (1995) : « le potentiel du sujet (ses forces) est appelé à rencontrer le potentiel de l'environnement afin de répondre à ses besoins et lui permettent de s'adapter à des normes sociales culturellement acceptées ». En s'appuyant sur ces principes, nous avons choisi un outil d'enseignement permettant de miser sur les forces visuelles des enfants tout en minimisant ses aspects sensoriels pouvant potentiellement surcharger leurs sens et donc entraver leurs apprentissages. L'intervention par le biais des tablettes a justement été privilégiée en raison de leur disponibilité croissante et leur coût abordable, mais surtout parce qu'elles sont facilement acceptées et non stigmatisantes. Il ressort donc de l'analyse précédente que conformément aux principes de la psychoéducation, nous avons choisi le bon outil de travail afin d'intervenir auprès d'une population vulnérable. D'autant plus que l'application a été conçue afin de répondre aux besoins spécifiques de cette population pour favoriser leur engagement et réduire l'écart entre leur potentiel d'adaptation et leur potentiel expérientiel.

Toujours selon Renou (2005) :

« Les opérations propres à la psychoéducation, impliquèrent une connaissance la plus large possible des différents phénomènes d'inadaptation des individus et de dysfonctionnement des milieux. Elles demandent une maitrise des méthodologies d'évaluation et de diagnostic, de planification et de gestion de l'intervention psychoéducatives. Il s'agit non seulement d'entrer en relation avec les clients dans leur milieu et d'appliquer des stratégies d'intervention, mais de choisir les instruments appropriés d'évaluation des problématiques des personnes et des organisations. »

Prenant appui sur ce modèle, nous avons conçu le premier article afin d'évaluer les préférences de vidéos auprès d'enfants ayant un TSA, pour ensuite dispenser l'intervention dans le cadre des articles deux et trois qui portent directement sur l’opération professionnelle d’évaluation pré-intervention. Dans la même lignée de pensée, le devis à cas unique nous a permis de respecter une des opérations professionnelles de la psychoéducation, soit celle d'assurer un suivi continu des effets de l'intervention (évaluation post-intervention ; Renou, 2005; Lanovaz, 2013). Conformément à ces principes, les données ont été collectées et analysées quotidiennement tout au long de la période de collecte. Cette collecte et analyse de données continue nous a d'ailleurs permis de faire des ajustements en cours de route afin d’optimiser l'efficacité de l'intervention. Finalement, les résultats obtenus de cette recherche doctorale ont une implication directe sur l'ICI. Considérant que les psychoéducateurs au Québec sont responsables du développement de ce type de programme, nos résultats pourraient potentiellement informer les pratiques adoptées ainsi que les activités mises en place par les professionnels en psychoéducation.

Forces et limites de l'étude doctorale

Bien que les forces et les limites individuelles de chaque étude aient été étayées dans chacun des trois articles constituant cette recherche doctorale, nous élaborerons ci-dessous les forces et limites principales qui en ressortent.

(a) L'application

La force principale de cette recherche doctorale a trait à la mise à profit d'une technologie facilement accessible, peu dispendieuse et surtout non stigmatisante afin de combler un besoin perçu en milieu de pratique. De ce fait, nous avons mis au point une application conçue spécifiquement pour répondre aux besoins des personnes ayant un TSA. Cette application permet d'ailleurs de miser sur les forces et préférences des individus ayant un TSA afin de cibler leurs faiblesses, soit leurs difficultés au niveau du langage. Reposant sur les fondements de l'AAC; la méthode d'enseignement par essais distincts constitue la méthode ayant reçu le plus de soutien empirique auprès d'individus ayant un TSA (Caroll, Joachim, St Peter et Robinson, 2015; Carroll, Kodak et Adolf, 2016; Downs, Conley, Downs, Fossum et Rau, 2008; Eikeseth, 2009; Leaf, Taubman, McEachin, Leaf et Tsuji, 2011; Lovaas, 2003; Smith, 2001; Sepulveda, 2015; Sturmey et Fitzer, 2007). L'application ainsi conçue permet à des non professionnels de mettre à profit une méthode d'enseignement validée empiriquement afin d'enseigner des concepts à des enfants ayant un TSA.

Ceci étant dit, l’application présente également certains désavantages qui méritent d'être mentionnés. Parmi ces désavantages figurent des obstacles inhérents à l'utilisation de la technologie. Étant donné que les concepts avaient déjà étaient programmés avant le début de l'expérimentation, nous nous sommes retrouvés limités par ces concepts. Bien que nous ayons pu enseigner d'autres concepts à certains enfants, les spécificités de l'application ont donc dicté son utilisation. De plus, nous avons relevé certains aspects qui auraient pu être améliorés, dont entre autres, l'intégration d'un renforçateur différentiel suite à une réponse correcte et autonome vs. une réponse correcte offerte suite à une incitation. Toutefois, la modification de ces procédures aurait nécessité encore plus de temps et avoir possiblement généré d'autres bogues informatiques qui auraient ralenti le déroulement de l'expérimentation. C'est la raison pour laquelle nous n'avons pas attendu de régler ces problèmes avant de continuer l'expérimentation avec l'application. En résumé, la conception d'une application constitue certainement une des forces principales de cette étude doctorale, mais s'accompagne également de certaines limites.

(b) L'échantillon

L'hétérogénéité de notre échantillon représente un avantage indéniable de cette recherche doctorale puisqu'il permet d'étendre les résultats à la plupart des personnes ayant un TSA peu importe leurs niveaux de sévérité; mais celui-ci présente également certains désavantages. Parmi ces désavantages, nous relevons l'inclusion de participants ne possédant pas les prérequis optimaux pour favoriser leurs apprentissages ainsi qu'un échantillonnage non aléatoire. À titre d'exemple, Amy (expérience deux) présentait des comportements problématiques, dont de l'automutilation, de l'agressivité envers l'intervenant ainsi que le jeu avec ses excréments. Ces comportements ont significativement entravé son processus d'apprentissage. Considérant l'ampleur de ces comportements problématiques, cette participante aurait pu être exclue de l'étude puisque l'apprentissage de concepts n'était pas une priorité. Dans un cadre clinique, il aurait été préférable de cibler ces comportements problématiques avant d'enseigner de nouveaux concepts. De même, des comportements présentés par d'autres participants tels qu'Aden (expérience deux) qui ne restait pas assis plus de cinq minutes consécutives et Ian (expérience trois) dont l'attention était très variable ont également entravé leur processus d'apprentissage. Plus encore, notre échantillon n'était pas aléatoire, mais plutôt de convenance, ce qui pourrait put avoir engendré un certain biais. En somme, les contraintes imposées par le milieu ainsi que la richesse des tableaux cliniques des participants présentaient des défis.

(c) Le devis

Afin d'atteindre les objectifs de la recherche doctorale, des devis expérimentaux à cas unique ont été adoptés. L'avantage majeur des devis expérimentaux à cas unique est le fait que leur mise en place nécessite peu de participants, tout en conservant une bonne validité interne (Barlow, Nock et Hersen, 2009; Kazdin, 2001). Étant donné que les effets du traitement sont comparés de façon répétée auprès du même participant, les devis expérimentaux à cas unique permettent de contrôler les caractéristiques individuelles pouvant influencer l'apprentissage (Barlow et al., 2009; Cooper, Heron et Heward, 2007; Kazdin, 2011). Contrairement aux devis de groupes qui permettent d'obtenir une performance moyenne des individus inclus dans un groupe, un devis expérimental à cas unique permet d'évaluer et de suivre la progression de chaque individu. Considérant que les enfants ayant un TSA présentent une grande hétérogénéité de leurs symptômes et de leurs réponses aux interventions dispensées, des devis expérimentaux à cas unique sont donc mieux adaptés. Bien que ce suivi quotidien des résultats individuels de chaque enfant en vue de planifier l'intervention du lendemain nécessite beaucoup de temps et d'énergie devant être déployés quotidiennement, il permet de suivre le progrès de chaque enfant et de s'assurer de ne pas continuer une intervention non efficace. C'est d'ailleurs la raison pour laquelle l'adoption du devis à cas unique ainsi que le suivi continu que ce choix implique a permis de constater que certains enfants ne démontraient pas de généralisation des concepts enseignés un mois après avoir débuté l'expérience deux à cause de taux de non-réponses élevés. Nous avons donc dû apporter des modifications aux procédures de généralisation en cours de route afin d'ajouter des essais maitrisés à des essais cibles (voir article deux).

Un devis de groupe évaluant les résultats pré et post intervention n'aurait pas nécessairement permis de déceler cette nuance et l'intervention aurait pu se solder par un échec. Ceci étant dit, l'utilisation d'un devis de groupe nous aurait toutefois permis de faire des analyses statistiques supplémentaires en vue d'établir des inférences capables d'améliorer la validité externe de nos résultats. Finalement, ce devis nous aurait également permis d'identifier les variables à l'origine de l'efficacité de la tablette, ce qui n'était malheureusement pas possible en raison de notre devis et échantillon actuels.

Futures études

Les conclusions tirées des trois articles permettent d'ouvrir un chantier de réflexion quant à des pistes de recherche à adopter dans le futur. Même si nous avons uniquement évalué l'efficacité de la vidéo sur le comportement de s'assoir dans la première expérience, les futures études gagneraient également à y intégrer l'évaluation des comportements collatéraux (tels que des comportements problématiques) ayant pu être déclenchés dans le cadre de l'intervention (tels que ceux résultants du retrait de la tablette). Nous recommandons aussi aux futurs chercheurs de reproduire l'expérience un avec un plus grand nombre de participants, tout en évaluant l'efficacité relative de vidéos en fonction de leur niveau de préférence. Compte tenu du virage technologique dont notre société est témoin, il serait également intéressant d'évaluer l'efficacité auprès d'autres types d'activités technologiques telles que des jeux vidéo et l'utilisation de médias sociaux sur tablettes.

Dans une optique de validité sociale, il serait pertinent de reproduire l'expérience trois avec des parents d'enfants ayant un TSA ou du personnel avec peu de formation utilisant la tablette pour comparer son efficacité à l'intervention dispensée par un intervenant spécialisé. Afin de favoriser l'utilisation de la tablette par les parents d'enfants ayant un TSA, l'intégration de différents autres renforçateurs et incitations individualisés à l'enfant dans l'application pourrait également être utile. À titre d'exemple, sachant qu'un enfant pourrait être plus motivé à travailler en visionnant des vidéos de lui-même, l'application pourrait offrir aux parents la possibilité de pouvoir changer eux-mêmes et à leurs fréquences les vidéos ou incitations offertes à leurs enfants. Finalement, pour réussir à attribuer le bon outil d'enseignement à un enfant, nous recommandons aux futurs chercheurs de faire participer les enfants à des arrangements à chaines concurrentes afin de déterminer leur préférence relative pour les deux modes d'enseignement. Plus encore, nous suggérons aux futurs chercheurs de reproduire les études deux et trois avec un échantillon plus large et plus hétérogène (en termes de QI, habiletés adaptatives, comportements problématiques, niveau d'engagement ainsi que de potentiel motivateur de la tablette) afin d'identifier les variables associées à l'efficacité de l'application.

Sur le plan technique, nous recommandons aux futurs chercheurs d'implanter plusieurs niveaux de difficulté intégrés aux programmes d'apprentissage afin d'éviter un phénomène de surgénéralisation dans le cadre duquel un enfant émet une réponse apprise suite à la mauvaise consigne. Plus précisément, il serait plus prudent de présenter une image représentant le concept cible sur l'écran d'abord puis de s'assurer que l'association entre le concept et la consigne soit bien établie avant de rajouter des images de concepts différents. Autrement, geler l'écran durant au moins deux secondes suite à la sélection d'une réponse afin d'éviter qu'il ne réponde de façon aléatoire (tel qu'était le cas de Corey) aiderait à cet égard, en plus de favoriser l’engagement de l’enfant. Pour encourager un enfant à sélectionner la bonne image dès le début, nous recommandons de lui offrir un renforçateur différentiel : en d’autres mots, sélectionner la bonne image sans aide devrait permettre à l'enfant de visionner sa vidéo préférée alors que le choix de la bonne réponse suite à une aide offerte par le logiciel devrait être accompagné d'une récompense moins puissante (ex., durée de visionnement de la vidéo plus courte ou applaudissement). De plus, une forme de rappel pourrait être intégrée au logiciel, suite à un délai de réponse afin d’inciter l’enfant à continuer à travailler et de réduire sa dépendance envers l’intervenant.

Finalement, nous croyons aussi bon de continuer à mener de telles études comparatives pour vérifier laquelle des deux méthodes d’enseignement permettrait de favoriser le développement d’habiletés autres que le langage réceptif. Parmi ces habiletés, nous relevons les habiletés sociales et la motricité (ex., écriture) afin d’évaluer si l’enseignement par tablette pourrait aussi être efficace pour différents types d’habiletés et compétences. Compte tenu des difficultés de généralisation des enfants ayant un TSA, il serait intéressant d’évaluer si les enfants démontrent une généralisation des concepts enseignés sur tablette dans un contexte différent que celui de l’intervention, par exemple en classe ou à la maison. À noter cependant que nous avons utilisé des vidéos comme renforçateurs auprès de certains enfants et des renforçateurs alimentaires auprès d'autres. Or, cette procédure aurait pu ajouter une variabilité entre les participants et c'est la raison pour laquelle nous recommandons aux futurs chercheurs de dispenser un renforçateur uniforme avec les deux outils d'enseignement.

Conclusion

Étant donné que la prévalence du TSA prend de nos jours une ampleur considérable et que les enfants ayant ce trouble ne bénéficient pas nécessairement d'interventions leur étant destinées, les tablettes pourraient représenter une solution attrayante. Sur la base de ce postulat, cette thèse doctorale a permis de démontrer l'efficacité d'utilisation des tablettes pour évaluer la préférence de vidéos et pour enseigner des concepts à des enfants ayant un TSA. Toutefois, les tablettes demeurent tout de même moins efficaces que les intervenants. Nos trois expériences contribuent ainsi à la littérature en déterminant l'efficacité de la tablette auprès d'enfants ayant un TSA, tout en ouvrant en même temps un chantier de réflexion pour les futures études. À cet effet, nous encourageons les futurs chercheurs à continuer à explorer cette problématique afin de soutenir les enfants ayant un TSA dans le déploiement de leur plein potentiel. Finalement, nous encourageons les professionnels en psychoéducation à mettre à profit cette technologie afin de s'assurer que tout enfant ayant un TSA et nécessitant des services d'intervention puisse en bénéficier.

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