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Keywords: Video modelling, imitation, autism, imitation training, imitation assessment

Abstract

Objective*:* The aim of this paper is to bridge the gap between the corpus of imitation research and video based intervention (VBI) research, and consider the impact imitation skills may be having on VBI outcomes and to what extent this can be utilised to improve outcomes.

Method*:* A review of the imitation literature was conducted focusing on imitation skill deficits in children with autism followed by a critical review of the video modelling literature focusing on pre-intervention assessment of imitation skills and the impact imitation deficits may have on VBI outcomes.

Results*:* Children with autism have specific imitation deficits which may impact VBI outcomes. Imitation training or procedural modifications made to videos may accommodate for these deficits.

Conclusions: There are only six studies where VBI researchers have taken pre-intervention imitation assessments using an assortment of imitation measures. More research is required to develop a standardised multi-dimensional imitation assessment battery that can better inform VBI.

The role of imitation in video-based interventions for children with autism

Video-based interventions (VBI) are an efficient and effective treatment for many of the behaviour issues that arise for children with autism [1-5]. However, for some children, VBIs have little or no effect, wasting valuable time, energy and resources with limited benefit for the child [6, 7, 8]. There are still many unanswered questions regarding what prerequisite skills are necessary to enable children with ASD to benefit from VBIs. For obvious reasons, imitation has often been identified as one of the fundamental skills necessary for VBI [9, 10], i.e., children are expected to imitate the behaviour of the video model. Many children with autism have particular difficulty with imitation skills [11] but there is limited knowledge on how these difficulties impact VBI outcomes. Recently, pre-intervention imitation skill tests have been used in an attempt to establish what level of imitation skill is required for successful VBI outcomes [12 -17], however, to date no clear pattern has emerged from this work. If certain imitation competencies are indeed fundamental to successful VBI outcomes, the corpus of imitation research may provide insight into what functions to improve imitation skills and resultant VBI outcomes.

Before embarking on a discussion of imitation and the benefits of connecting imitation research with VBI research, clarification of the terms imitation and copying behaviours is necessary. Some inconsistency is evident in the imitation literature with imitation being variously used to incorporate 'true imitation' and a number of copying behaviours including mimicry and emulation [18]. Sevlever and Gillis [18, p. 977] refer to 'true imitation' as being a process whereby both the form and intention (goal) of a behaviour, i.e, the topography and function are evident, following demonstration, in an environment where the probability of that novel behaviour being performed without the preceding demonstration is very low. On the other hand, mimicry is the precise reproduction of the

topography of the modelled behaviour without regard for the function of the behaviour [18]; e.g., copying facial expressions or vocal intonations, sometimes also referred to as the Chameleon Effect [19] is often categorised as mimicry. The term 'emulation' is used when the goal, i.e., the function of a behaviour is the focus rather than the topography [20]. Thus, emulation equates to imitation of an 'operant', rather than to topographical correspondence. For the purpose of this paper the term imitation is used to include all three of these categories of copying behaviours, however specific aspects of these different copying behaviours are at times the focus as they contribute to our understanding of the importance of imitation as it relates to VBIs.

It is well established that children with autism have difficulty imitating and until recently this deficit was thought to be a broad, general deficit in imitative ability [21] and generalised imitation [22]. However, advances in neuroimaging technology and particularly functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) have allowed more precise mapping of the mirror neuron system, and led to the realisation that while some imitation pathways are limited others remain intact [23, 24]. Hamilton [23] proposed distinctions in Emulation/Planning-Mimicry (EP-M) in the mirror neuron system that differentiate between an indirect, parietal route for goal emulation and planning (EP), and a direct occipital-frontal route for mimicry (M). There are indications that in children with ASD the mimicry pathway is more limited than the emulation/planning pathway [23]. In other words, if the goal or function of the behaviour is clear the modelled behaviour is more likely to be emulated and the goal/function is more likely to be achieved without necessarily reproducing the topography of the behaviour [25, 26]. On the other hand, if the goal/function of the behaviour is not clear the behaviour is generally less likely to be mimicked [27, 28]. This contrasts with typical children who will mimic behaviours even when they are unsure of the goal of the behaviour. For example, Meltzoff [29] presented 36 typically developing

infants with modelled actions on novel objects that they were required to imitate. One of the

novel actions was the task of illuminating a light box by pressing the button with the

forehead, which the infants mimicked even after a 1-week delay; emulation of the action on

the other hand could have had the infants more efficiently use a hand for the task rather than

their foreheads. The difficulty with mimicry for children with ASD is significant particularly

when teaching social or pretend play skills where the function of the behaviour is not always

clear. Apple, Billingsley, and Schwartz [6] used VBI to teach compliment-giving skills to two

five-year-old boys with high functioning autism. Videos were produced with adults giving

explicit instructions on compliment giving skills, followed by multiple examples of peers

giving compliments to peers. After watching the video the boys were placed in a 15-minute

play session where there were opportunities to give compliments as seen on the video. The

boys did not attempt to give compliments until the researchers added a fixed ratio

reinforcement schedule (FR4; i.e., a prize after four compliments), which resulted in

immediate successful elicitation of the target behaviour. Arguably, in this experiment prior to

the implementation of the FR4 schedule, complimenting behaviours, a complex social skill,

had had no salient goal or function. The argument here is not simply to add a reinforcer to the

task, but rather to consider if the child is able to follow an obvious function or end-goal to the

task that he/she can emulate. For example, when washing dishes, the goal or purpose is clean

dishes; this is not an extraneous 'reward' but a clear end-result (product of behaviour). A

reinforcer as a proxy end-result or goal is added when there is no 'obvious' function to the

task, which can be the case with social, academic or play skills, as children with ASD

oftentimes do not respond to naturally occurring social reinforcers.

A second imitation skill deficit commonly demonstrated by children with ASD

concerns <u>when</u> to imitate. If a child imitates spontaneously in response to a modelled action

the imitation is described as spontaneous imitation. On the other hand, if the child does not

imitate spontaneously, but is given an instruction to imitate ('do as I do') the imitation is referred to as elicited imitation. Ingersoll [30] conducted an in-vivo modelling study comparing elicited imitation and spontaneous imitation in children with ASD. The elicited imitation task included a demonstration with instructions 'Watch closely and do what I do' and more specifically 'you do it'. The spontaneous imitation task involved the researcher saying 'Can we play together' (there were 2 identical sets of toys); the researcher imitated the child for two minutes then said 'Watch me' and if the child imitated without further prompts this was considered spontaneous imitation. Typical children tended to spontaneously imitate and 'join' with the researcher while children with ASD tended not to spontaneously reciprocate the recently modelled action [30]. Ganz, Bourgeois, Flores, and Campos [31] conducted an in-vivo study to increase spontaneous imitation in four children with ASD using visual aids and prompting. Children were required to imitate a peer who was identified as the 'leader'. If they did not spontaneously imitate the peer they were verbally prompted 'do the same', shown a picture of doing the same, or physically prompted. This improved imitation, and as imitation improved, there was a decrease in the level of prompting required across all participants, indicating that generalization had taken place.

It may be useful for VBI researchers to recognise that children with autism (particularly if they have especially poor imitation skills) may perform better with an elicited imitation task rather than a spontaneous imitation task; i.e., when an instruction is given to the child about <u>when</u> to imitate. Nikopoulos, Canavan, and Nikopoulou-Smyrni [32] used VBI to establish instructional stimulus control over a simple behaviour (cleaning up after play). Three children with ASD watched a video of a child putting away toys after playing with them. No instruction was given to put the toys away only the instruction 'play is finished', in other words the children were expected to spontaneously imitate what they had watched on the video. Two of the three children reached criterion. Given Ingersoll's [30]

findings described above, the child who did not reach criterion may have benefited from being given specific instructions to imitate (elicited imitation).

In another study, Nikopoulos and Keenan [8] used VBI to teach social initiation skills to seven children with autism aged between nine and 15. The participants watched a video of an adult requesting a child to engage in play. After watching the video, the children were placed in the same room, with the same arrangement of toys; the children were not given any prompts or instructions to imitate. Of the seven children, four achieved criterion in initiating social interaction, three children did not. Consideration was not given to structuring the task as an elicited imitation task (with explicit instructions to imitate) for these three children. Interestingly though, four of the higher functioning children with ASD did perform to criterion on the spontaneous imitation task, and in a similar, later study by Nikopoulos and Keenan [33] a further three children with ASD performed to criterion on a task requiring spontaneous imitation skills. Compared to imitation research using in-vivo modelling [30, 34, 35] these video-based outcomes are impressive. Video modelling technology seems to have some advantages over in-vivo modelling. The video monitor/device itself may act as a non-verbal prompt, providing visual cues to engage in the behaviour demonstrated in the video while the in-vivo setting may provide less obvious prompts of when to imitate. Video technology, by design, can restrict the field of focus of the viewer by selectively focusing his or her attention on the relevant stimuli with extraneous auditory and visual stimuli excluded [36]. Children with ASD may be more motivated to attend to video technology [37] which may improve overall effectiveness. Additionally exact replications of the modelled behaviour can be shown to the child repeatedly using video technology providing a consistent model.

Another factor that improves spontaneous imitation in children with ASD are tasks that produce sensory effects. Ingersoll, Schreibman, and Tran [38] compared spontaneous imitation of play skills using toys with sensory effects and toys with no sensory effect on

children with ASD and typically developing controls. Typically developing children performed equally well on spontaneous imitation tasks involving both sensory and non-sensory toys. However, improved spontaneous imitation was observed in children with ASD when toys had sensory features, such as a blinking lights, sirens, and songs. Hine and Wolery [17] used VBI to teach pretend play skills to two children with autism and found that modifying the pretend gardening task by adding coloured rice (to replace potting soil) improved outcomes for one of the children. These findings have implications for stimulus presentation in VBI, as adding a sensory component (where possible) may function to improve spontaneous imitation skills.

McCoy and Henderson [9] identified imitation as a logical and critical pre-requisite skill to VBI, however, a review of the VBI literature identified only six studies where researchers have taken pre-intervention imitation skills assessments [12-17]. Hine and Wolery [17] administered the Motor Imitation Scale (MIS) [28] to two girls (30 and 43 months of age) with autism prior to their point-of-view video modelling procedure targeting pretend play skills. The MIS consists of 16 items; four items on one-step actions with objects that are meaningful (i.e. shake a noisemaker, push a car etc.), four one-step actions with objects that are not meaningful (push a teacup across a table, place a block on head), and eight body movements (clap hands, wave, bend index finger etc.). The participants, Christine and Kaci, scored 29 and 30 respectively out of 32 on the MIS. On the pretend play cooking task, both girls reached criterion, on the gardening task, Christine reached criterion, but Kaci required the addition of verbal instructions (elicited imitation) and a reinforcement schedule to reach criterion. It is difficult to make a comparison between video modelling outcomes and the imitation pre-assessment score as Hine and Wolery [17] only report the MIS total score for each of the girls. A more differentiated analysis would have been useful, for example, a two point loss on non-meaningful tasks would indicate 50% deficit in this area. A more fine-

tuned assessment and reporting of pre-existing imitation skills may contribute to explaining differential VBI outcomes.

Rayner [12 -14] used a modified version of the Imitation Disorders Evaluation scale (IDE) [39] to measure imitation prior to VBI. This scale consists of an observation-based assessment delivered via video that includes 10 opportunities for the demonstration of various imitative acts, such as facial expressions, gestures, and one-step actions with objects. In Rayner [12], Regan, a 12-year-old boy with severe autism, scored above 80% on the imitation assessment and on introduction of the VBI quickly achieved criterion on unpacking his school bag, however he did not achieve criterion on brushing his teeth (he chewed the toothbrush instead, i.e., potentially seeking sensory stimulation). In Rayner [13] Matthew, a 15 year old boy with severe autism was found to have very poor imitation skills in pre-assessment and subsequently did not succeed in the video modelling intervention designed to teach him academic (matching coins) and daily living skills (making noodles). In Rayner [14] a video prompting procedure with backward chaining was used to teach three boys how to tie a shoe-lace. Two of the boys had moderate autism and the third had severe autism. Their performance on the IDE indicated that all three had good imitation skills however, none of the boys reached criterion on this shoelace-tying task and only one of them reached criterion when the shoelace task was made easier by using two different colour laces. Apparently then, imitation skills may be a necessary but not sufficient pre-requisite factor for VBI and a more differentiated measurement of imitation skills levels is necessary.

Tereshko, Macdonald, and Ahearn's [16] pre-assessment scale for measuring imitation and matching ability consists of motor imitation (example: clap hands), one-step actions with objects (example: put a fork in a cup), motor skills, picture to object matching, computerised picture to object matching, and delayed matching and imitation skills (consisting of a three second delay after viewing the modelled behaviour or sample before

imitation). Once pre-requisite skills were measured four children with ASD were required to watch a full-sequence (the full video is viewed, before opportunity to imitate is provided) point-of-view video (only the model's hands are shown on the video from the point-of-view of the child) of an adult slowly assembling an 8-step toy. This was followed by the instruction 'It is time to play' thus expecting the child to spontaneously imitate what was viewed in the video without further prompting. In the subsequent treatment condition the participants were shown a video (of a similar toy construction) broken down into single step segments presented in a forward chain before being given the opportunity to spontaneously imitate. The researchers reported that three children who had difficulty with delayed identity-matching-to-sample skills on the pre-assessment task and subsequently struggled with the full-sequence video modelling condition reached criterion in the video-chaining condition. The fourth child did not have delayed identity-matching-to-sample difficulties and reached criterion on the full-sequence video modelling condition. Identity-matching-to-sample and imitation are both conditional-discrimination procedures. In identity-matching-to-sample the subject selects one stimulus amongst two or more comparison stimuli that is identical to the sample stimulus. If other potential controlling variables are controlled (e.g., reinforcement) the chosen stimulus is said to be under the control of the sample stimulus [40]. Similarly, in imitation, the behaviour of the actor comes under the control of the model (again if other potential controlling variables are controlled for) and the model becomes the controlling stimulus [41]. Thus, identity-matching-to-sample and imitation both evoke a controlling relation between the presented model or sample and the action that follows. Tereshko, Macdonald, and Ahearn's study suggests that VBI outcomes can be improved by making procedural modifications to the VBI based on the participant's skill level at entry.

Delayed-matching-to-sample is a more complex skill than matching-to-sample without a delay; additionally sequential imitation is more complex than one-step imitation

because there is an inherent delay due to the sequence of steps. For example a one-step

imitation task would be 'put the block on the box', while an example of a four-step sequential

imitation task from the Preschool Imitation and Praxis Scale [42, p.471] is 'take the block

from the bottom of the box, turn the box in normal position again, close the box, put the

block on the lid of the box'. Many VBIs require the child to imitate long sequences of steps

such as those involved in making noodles or following routines. A child who struggles with

multi-step imitation is likely to struggle with imitating a full-sequence video and may well

benefit from a video-chaining procedure. No researchers to date have included multi-step

imitation in their pre-intervention measure, and further research is required to determine if for

example three-step imitation difficulty would provide indications of potential difficulty with

full-sequenced-video modelling procedures.

Robinson [15] used the same pre-assessment imitation tasks as Tereshko, Macdonald,

and Ahearn [16] in a study with 12 participants diagnosed with ASD. The participants were

required to watch a full-sequence point-of-view video of an adult slowly assembling an eight-

step toy. After two viewings, the children were given an instruction ('do this') to complete

the toy construction, thus elicited rather than spontaneous imitation was assessed. Robinson

[15] found that eight of the 12 children demonstrated mastery on all pre-assessment imitation,

delayed imitation and matching skills and reached criterion on the full sequence video

modelling condition. The other four children performed poorly on the imitation and matching

assessment, particularly on the delayed imitation task and delayed matching tasks. The same

children also did not reach criterion on the full-sequence video modelling task. This study

provides further evidence of differential video modelling effects as a function of the imitation

skills of the participants.

Robinson [15] extended her study further by proceeding to train the four children who

performed poorly in delayed matching and imitation skills. This training involved

systematically increasing the time delay between sample and comparison stimuli from less than one second to a three-second delay. Following training, two of the four children achieved criterion on the full-sequence video modelling task and two children did not. The two children who achieved criterion after training had shown some learning (50%) in the original video modelling trial whereas the two children whose performance did not improve after training had shown less than 25% improvement in the first experiment. In other words, the performance of the children who achieved some learning in the original video modelling condition improved with delayed matching-to-sample and delayed imitation training while the functioning of the children who achieved only limited learning in the initial video modelling trial did not improve with this training. Focusing on training imitation skills, Nikopoulos and Keenan [43] used a video chaining procedure to teach complex social sequences to four children with autism. The video chaining procedure allowed for training of basic imitation skills to take place on initial tasks before the children moved onto the next sequenced task. Two of the four children acquired the target behaviour quickly, while the other two children needed more practice sessions before the target behaviour was acquired. Nikopoulos and Keenan suggest that using video chaining to teach imitation skills in the first short sequence facilitated generalised imitation of the new behaviours.

Both Robinson's [15] and Nikopoulos and Keenan's [43] research indicates that imitation training may be useful to improve VBI outcomes. Though imitation training may be time consuming, imitation is an important pivotal skill for children with ASD [30]. Cardon and Wilcox [44] trialled both video based and in-vivo technologies in teaching imitation skills. Six participants were matched across various domains and compared in two treatment conditions; Reciprocal Imitation Training (RIT) [45] and imitation training using video modelling. In the RIT condition, the experimenter contingently imitated the child while providing verbal descriptions of the action, before giving the child the opportunity to imitate

the experimenter. In the Video Modelling condition, the child viewed a video of the

experimenter performing an action with the toys, followed by an opportunity to imitate what

was viewed on the video with an identical set of toys. The video based procedure resulted in

faster acquisition of imitation skills than did in-vivo modeling. Therefore, video-based

technology could be an efficient method of teaching imitation skills prior to VBI.

In sum, bridging the gap between the corpus of imitation research and video based

intervention research brings into focus the impact that imitation skill deficits may have on

VBI outcomes and further highlights potential areas for improving efficacy. Clearly more

research is required as questions are raised regarding the extent generalised imitation training

and procedural modifications may achieve sufficient levels of imitation. Further questions

regarding effective imitation pre-assessment batteries also need consideration. For example,

imitation scales used to date in VBI do not include multi-step imitation, do not differentiate

between mimicry and emulation, and have been primarily developed for children under four

years of age. The large body of imitation research, presently mainly focussing on diagnostics,

can inform development of an imitation measure which could be specifically tailored for

video based interventions. Initially a tool of this nature could provide more understanding of

the impact imitation skills are having on VBI outcomes, and then be further developed as a

tool used to inform the kind of VBIs that would most suit individual children with differing

imitation skills. Children identified by such a tool as having very low imitation skills may

benefit from imitation training before beginning the VBI, or alternatively the video-based

procedure could be modified to suit the child's imitation skill level.

Effecting behaviour change and skill acquisition requires enormous effort and energy

from the child, parents, and professionals implementing the intervention. If certain basic

skills are fundamental to the success of a particular intervention, it seems to make sense to

determine the skill level with which the child enters the intervention in order to appropriately

modify the intervention. For example, a child at beginner reading level would not be expected

to read at an advanced level, nor should a child with limited imitation skills be expected to

succeed in an intervention that requires the child to imitate at an advanced level. Arguably,

imitation assessment and possible training may take up valuable time and effort, however few

would argue with carefully calculated early efforts that lead to maximum gains following

video modelling intervention.

Declaration of interest

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