Video-based intervention for children with autism: Towards improved assessment of prerequisite imitation skills

Abstract

Objective: To explore the relationship between responses to imitation assessment and video-based intervention (VBI) in children with autism.

Methods: Interview- and observation-based imitation assessments were conducted for five boys with autism prior to VBI across three studies. In two of the three studies, the boys’ imitative responses to videos with an animated model and a human model were also compared.

Results: Participants who were assessed to have strong imitation skills were also those who responded more positively to VBI. No clear differences were reported in the boys’ responses to the equivalent videos with the animated model and the human model.

Conclusion: The level of imitation skills required for successful VBI is relative to the target behaviour. Revision of existing imitation assessment measures, as well as development and validation of more comprehensive measures is warranted for use in conjunction with VBI.

Key words: autism, video modelling, video prompting, video-based intervention, imitation assessment, animated model.
**Introduction**

Video-based interventions (VBI) involve the presentation of video footage as the independent variable for a teaching or treatment procedure [4]. Primary forms of VBI are now relatively well documented for individuals with autism. For example, Bellini and Akullian [5] argued that video modelling and video self-modelling met criteria for designation as an evidence-based practice. Reichow and Volkmar [6] concluded that video modelling should be classified as a promising evidence-based practice for improving the social skills of individuals with autism. Also, the review of Kagohara [7] provided support for the use of video-based instruction in the rehabilitation of children with autism spectrum disorders.

A broad range of target behaviours have been targeted by VBI, including recent studies focusing on communicative social skills [8], numeracy skills [9], checking the spelling of words [10], and physical activities [11]. Over the last three decades, the technologies used to implement VBI have evolved; from VHS videotapes and televisions screens [12], through the use of digital cameras and laptops [1], to the more current use of tablet computer devices [9, 10]. These changes in popular technology have no doubt made VBI more accessible to practitioners and parents of children with autism. From this background, the current research agenda for VBI has moved from a focus on exploring the general efficacy of VBI, as exemplified by the study of Charlop-Christy, Le, and Freeman [13], to a focus on determining the contexts in which VBI is more or less likely to be effective, such as in the comparative studies of Cihak and colleagues [14-17]. Some attention has been given to the relative efficacy of procedural variations such as the model type [18, 19], particularly in relation to the use of video-self modelling [4, 5, 20-24].
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Despite the general success of VBI for individuals with autism, the reported variability of outcomes across contexts and participants has justified research on the participant characteristics and pre-requisites for successful VBI [4]. Given the relationship between imitation and modelling [25, 26] and, logically, between imitation and the primary forms of VBI [27], it has been assumed that imitation skills are an important prerequisite of successful VBI for individuals with autism [18]. This assumption would seem to be well founded, with studies having now provided preliminary evidence to support the idea that stronger imitation skills increase the likelihood of successful VBI [1-3]. There is also now some emerging evidence to support a related hypothesis: that forms of VBI, such as video modelling, can be used to improve the imitation skills of individuals with autism [28-30].

In bringing together literature on imitation and of VBI studies in which pre-intervention assessments of imitation skills have been conducted, Lindsay, Moore, Anderson, and Dillenburger [31] highlighted the relevance of research into the relationship between imitation skills and VBI. They argued that the development and implementation of imitation assessments specifically designed for use in conjunction with VBI could help determine: (1) whether VBI is a suitable intervention approach; (2) which specific procedural types of VBI (e.g. modelling or prompting) are likely to be most successful; and (3) whether training of imitation skills prior to intervention is advisable with reference to particular individuals for specific target behaviours. With these potential benefits in mind and in support of the call for further research into the relationship between imitation skills and VBI, this paper reports on previously unpublished details and data from three of the six studies reviewed by Lindsay et al. [31] that included pre-assessment of imitation skills [1-3]. Although more general summaries of the project are outlined elsewhere [32, 33], the novel purpose of this paper is to: (a) explain the rationale for the
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imitation assessment procedures implemented; (b) describe variations of the protocol, such as the use of interview-based assessments of imitation and animated models; (c) synthesise the imitation assessment data from the three studies; (d) provide a revised version of the intervention assessment procedures; and (e) discuss arising issues related to the assessment of imitation in conjunction with VBI for individuals with autism spectrum disorder.

**Methods**

*The Imitation Disorders Evaluation (IDE) scale*

To study the relationship between imitation ability (as a prerequisite) and the effectiveness of VBI, the three studies of this research project assessed participants’ imitation skills with procedures based on the *Imitation Disorders Evaluation* (IDE) scale of Malvy, Barthelemy, Lenoir, Damie, Bodier, and Roux [34]. This brief clinical scale is a validated tool for evaluating imitation specifically for children with autism. The IDE procedure described by Malvy et al. [34] includes an assessment of the child’s imitation behaviours based on a 20 minute session. The session includes structured and non-structured imitation sequences primarily between the examiner and the child which are video-recorded for analysis. Specifically, the session is examined for: (1) the imitation of facial expressions; (2) visual pursuit; (3) the imitation of gestures; (4) repeating sounds, words or sentences; (5) the imitation with objects; (6) the imitation of amusing actions; (7) the stereotypical nature of gesture imitations; (8) the frequency of echolalia language; and (9) the variability of imitation.

The IDE scale has been described as ‘validated’ by Receveur et al. [35] and ‘potentially very useful’ by Loddo [36]. Smith, Lowe-Pearce, and Nichols [37] noted that the scale
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has strong internal validity, on the basis that performance on the IDE differentiated typical children and children with autism, and that following nine months of treatment, children with autism increased their IDE scale scores. Furthermore, they noted that the retrospective study of Receveur et al. [35] reported good reliability for the IDE ratings [37], which is consistent with the inter-rater reliability and factor analysis for content validity data reported by Malvy et al. [34].

In critique of the IDE, Smith et al. [37] suggested that one weakness in the scale is the absence of standardisation and normative information provided. This absence has been noted for other imitation assessment scales, such as the scales of Stone, Ousley, and Littleford [38] as well as those of Beadle-Brown [39]. The *Multidimensional Imitation Assessment* (MIA) discussed by Smith et al. [37] to address this issue was not published prior to the commencement of this research. The IDE involves a broader evaluation of imitation than does the *Motor Imitation Scale* [38] as used by Hine and Wolery [40], which focused on imitation of body movements and imitation with objects.

It was therefore proposed that an assessment procedure based on the items of the IDE scale of Malvy et al. [34] would represent a suitable means to evaluate the imitation skills of children with autism and predict their suitability for VBI. It was hypothesised that the children who demonstrate stronger imitation skills are more likely to respond to VBI with more rapid acquisition and/or with more positive alteration of the target behaviour than those who are assessed as having less-developed imitation skills.

*The interview-based imitation assessment procedure*

Once approval was granted from the relevant Human Research Ethics Committee (HREC) and informed consent was provided for the participants, the first approach to assessing imitation involved separate interviews with participating children’s parents,
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their teachers, and their primary teacher aide about the child’s imitative behaviour. This interview took approximately 10 minutes to conduct. In these separate interviews, the respondents were asked nine questions (each corresponding to an item of the IDE), such as ‘Does (Name) imitate facial expressions such as smiling, grimacing and putting out his tongue that you or others are displaying?’ Options for responses included ‘Never’, ‘Sometimes’, ‘Often’, ‘Very Often’, or ‘Always’; representing an estimated zero, one, two to three, four, or five imitations for every five opportunities respectively. Associating the terms (such as ‘Very Often’) with a corresponding number (such as four times out of five opportunities) allowed the interview respondents to draw on their experiences to predict the child’s responses to imitative opportunities. This allowed some comparison between scores from the interview-based (predicted) and video-based (observed) imitation assessment procedures.

The video-based imitation assessment procedure

Because a key aim of the project was to explore the relationship between imitation assessment and VBI, a measure involving direct observation of the children’s imitative responses to behaviours presented via video was developed and used. The video produced consisted of two sets of five opportunities for the participant to demonstrate imitative behaviours relating to the first six items of the IDE [2]. The video featured only the author, who was unfamiliar to the children prior to the commencement of the study. The videos were recorded using a Panasonic SDR-H250 digital video camera and edited using Windows Movie Maker program software. Brief written and verbal instructions were provided as an introduction to the video, which was 9 minutes and 57 seconds of duration in total. The video was presented using Windows Media Player on a Dell Latitude D620 laptop computer. If the participant stopped looking at the computer screen, the author paused the video and prompted them to attend by saying, ‘Okay
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(Name), watch this' or words to similar effect, before resuming the video. The number of appropriate imitations (IDE items 1-6) and atypical imitative behaviours (IDE items 7-9) were recorded.

Data consistency and reliability for imitation assessments

The video-based imitation assessment session in the first study was video-recorded, allowing an independent observer to score the session. Interobserver agreement (IOA) for the session was calculated (using the formula: % agreement = points of agreement / number of items X 100) at 83%, with differences relating primarily to IDE items 7, 8, and 9.

In the second study, to ensure that Matthew's performance in the 2pm video-based imitation session was sufficiently representative of his imitative behaviour, a second session was conducted five days later at 9am. Using the formula for IOA (as above), agreement across data from these two video-based imitation assessment sessions was 83%, with overall scores being exactly the same in both sessions. Similarly, agreement was 92% comparing the animated versus human model imitation assessments across the afternoon and morning sessions.

Due to staff availability, IOA for the video-based imitation assessment sessions was available for only one of the three participants in the third study. Agreement between the author and a second observer was 98%.

In order to evaluate their consistency, the percentage of agreement was calculated for between the various interview-based and observation-based measures, using the formula for IOA. Details on the percentage of agreement within one level are presented in tables 1, 2, and 3.
Considerable variation in the levels of agreement was found when comparing data from the interview-based measures with each other and with the observation-based imitation assessment measures. Agreement to within one level on the measures ranged from 44% between the parent interview and the observation-based imitation assessment scores for Matthew, to 100% between data from the parent and teacher interviews for Nick. In contrast, assessment scores were quite consistent across the sets and sessions of the observation-based (responses to video) imitation assessment protocol.

*Imitation of animated versus human models*

Animated models have long been demonstrated to affect the behaviour of children [41]. According to observational learning theory, highly preferred models are more successful in promoting attention and imitation by the learner [42, 43]. The increase in the availability of animated models through popular media [44] and in the availability and capabilities of software to customise animated models, together with the demonstrated efficacy of VBI for individuals with autism, has warranted investigation into the use of animated models for educational purposes with this population. Thus, in addition to the interview-based and observation-based assessments informed by the IDE, the imitation assessment procedures for children in the second [2] and third study [3] also involved presenting them with a video featuring an animated model performing 12 gross motor movements, as well as an equivalent video with a human model (the author).
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The video featuring the animated model was produced using a trial version of the 
CodeBaby® production studio (see http://www.codebaby.com/). This software enables 
the user to synchronise the mouth movements of the animated model with audio files 
imported by the user, enabling speech (such as greetings, brief directions and voice-
overs for the gross motor movements produced by the author) to be embedded 
appropriately into the video. The video produced with the animated model was 2 minutes 
and 31 seconds in duration. The comparable video with a human model was 2 minutes 
and 30 seconds in duration. The same gross motor movements and the same speech as 
in the animated model video were presented with a similar white background.

<INSERT FIGURE 1 HERE>

While the sequence of movements in these two videos did not represent the spectrum of 
behaviours of the IDE, the purpose of assessing the children's imitative responses these 
shorter videos was to provide an initial exploration into the relative efficacy of animated 
models in comparison with real adult models. The children's attention was maintained by 
verbal prompts as in the IDE based assessment procedure. For each gross motor 
movement in both videos, the author recorded whether the participating child performed 
the movement, partially performed the movement or did not perform the movement. In 
order to minimise any order effects, the animated model video was presented before the 
real adult model video in the first session and vice versa for the second session in the 
second study. The order was alternated across participants in the third study.

Results

The results across the three studies were consistent with the hypothesis in that children 
who demonstrated stronger imitation skills in the assessments based on the IDE were
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also reported to have responded more positively to the VBI intervention. A summary of the results is presented in Table 4.

<INSERT TABLE 4 HERE>

In particular, given the similarities in the VABS and CARS assessment data for Regan and Matthew, a comparison between their imitation assessment scores could be used to support the idea that sufficient imitation skills is a prerequisite for VBI [2]. To highlight the differences in Regan’s and Matthew’s imitation assessment scores, Regan responded appropriately 34 times from 60 imitative opportunities, while Matthew responded appropriately 10 times; if visual pursuit was excluded, the scores would be 25 and 0 appropriate imitative responses out of 50 opportunities respectively. Although Sean’s VABS and CARS assessment data was markedly different than that of Nick and Kayden, the differences in their respective imitation assessment scores was again consistent with the hypothesis that a child’s imitation skills influence the effectiveness of VBI [3].

There were no differences in the imitative responses of Nick or Kayden to the video featuring the animated model and the human model. Given the sample and methods, any reported differences in the imitative responses of Matthew and Sean to these videos do not seem clear or substantial enough to argue that the former was more effective than the latter, or vice versa.

Discussion

Together with other VBI studies that have involved an assessment of participants’ imitation skills [40], attention skills [45, 46], and other study specific prerequisites [47-50], the findings of this research should encourage practitioners to evaluate prerequisite imitation skills prior to deciding if and how to use VBI for specific
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individuals. If a child does not respond to the majority of imitative opportunities presented in the assessment, it may not be advisable to use a VBI in which imitation is central. Alternatively, there may be value in targeting imitation skills directly prior to implementing a VBI [31], or using VBI itself to teach imitation skills [29].

The studies conducted as part of this project did not identify differences between the imitative responses of the children with autism to the animated or robot model compared with the human model. These findings are consistent with those of Tapus et al. [51], who evaluated the responses of four children with autism to a robotic and a human model in a motor imitation task. It is also consistent with other studies in which comparisons between model types in VBI have not identified clear or consistent differences [2, 3, 18, 52]. This finding initially seems somewhat at odds with predictions based on observational learning theory [43], but might be explained by the nature of the target behaviours under consideration. That is, the child’s performance of the target behaviours which afforded a comparison of different model types may not have depended on their self-efficacy [53]. The children’s motivation to perform the behaviours may have been influenced by factors other than the identity of the model; but this may not be the case for all other behaviours targeted by VBI [20].

Limitations of the individual studies are provided in the relevant case reports. Given the number of studies (three) and total number of participants (five), not all of which provide comparisons of the key variables (participant suitability and intervention model type), the findings of this project synthesis should be considered preliminary and suggestive rather than final and conclusive. That being said, the focus of this section is to explore the limitations of the imitation assessment procedures with a view to inform future practice and research.
Several of the educators and parents had difficulty answering questions in the interview-based imitation assessment that corresponded to items 7, 8 and 9 of the IDE (atypical imitation). For item 7 (stereotyped gestures), it was difficult for respondents to distinguish between general stereotyped gestures and imitative behaviours that were stereotyped. There was some confusion between item 4 (imitation of words and sounds) and item 8 (echolalia), although contextually appropriate imitation is quite different from echolalia [34, 36]. Some respondents found it difficult to conceptualise item 9 (imitation variability), which may simply have reflected the fact the participants in question rarely performed these kinds of behaviours. It was also more difficult to be objective in quantifying items 7-9 in the observation-based assessment measures. Removing IDE items 7, 8, and 9 from the imitation assessment measure may alleviate difficulties in quantifying these atypical imitation behaviours and may make the assessment procedures more accessible for use by parents and educators in conjunction with VBI without clinical training in the use of the actual IDE.

Given the variability of assessment scores using the interview approach and the differences in scores between the interview and observation-based assessment protocols, data yielded from the interview-based assessment procedure may not be as helpful for predicting a child’s suitability VBI as observation-based assessment procedures. Indeed, the IDE scale of Malvy et al. [34], which informed this procedure, was developed and validated for implementation through clinical observations.

Further simplification of the video-based imitation assessment procedure may also enhance its use. One alteration could involve removing item 2 (‘visual pursuit’). Visual pursuit has been identified as an important precursor to imitation skills [34], but the item did not seem practical in the context of a video-based imitation assessment to predict the effectiveness of VBI. It was quite difficult to assess visual pursuit by
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observing and recording whether the participant’s eye movements corresponded to the movement of the model and objects on the computer screen. The visual pursuit item assessed the participant’s attention to important elements on the screen, but as attention to the screen was prompted if necessary as part of the procedure protocol, other measures, such as those used by Nikopoulos and Keenan [45, 46], may be more informative in assessing a participant’s ability to attend. In light of the above suggestions, a revised version of the video-based imitation assessment video (see http://www.youtube.com/watch?v=PaftjytCcpM) and form (see Appendix 1) has been provided. It should be acknowledged that in deviating from the IDE procedures in the imitation assessment measures used in the three studies of this project, and in further simplifying the procedures in the proposed revisions, the validity demonstrated for the IDE should not be claimed for this modified imitation assessment measure.

In reference to these three studies, and others, Lindsay et al. [31] were right in noting that ‘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’ (p. 287). Superficial revisions could be made to the imitation assessment proposed above to make it more appropriate for older children or individuals. For example, the words to be imitated could be drawn from a bank of words (or sentences) that are known to be in the child’s expressive vocabulary. Also, the actions with objects could be personalised to involve age-appropriate materials, or even to include those materials for which the child has a demonstrated preference. The problem with making such revisions is that the tailoring of the assessment protocol limits the extent to which an individual’s assessment scores could then be compared to others’ assessment scores in order to make a judgment about the relative strength of their imitation skills. It may also be costly in terms of time; one purpose of prerequisite skill
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assessment is to reduce the likelihood that a practitioner’s time (and that of the child) will be spent implementing unsuitable intervention procedures. But, as Lindsay et al. [31] have argued, the development of an assessment protocol designed for individuals in middle childhood, adolescence, or adulthood with general applicability would be helpful for use in conjunction with the many VBIs that involve school and post-school aged individuals.

Mimicry, rather than emulation, was the focus of the imitation assessment measures in this project. In contrast, interventions that focus on social skills often require emulation [31]. Thus, imitation assessments such as these may not be as helpful in predicting a child’s response to VBI targeting social skills as their response to other daily living skills, involving independent manipulation of objects (e.g. preparing a meal). Addressing this issue could involve a pre-requisite assessment which included two (or more) individuals in the video and which required social-communicative responses to be performed with another person.

The imitation assessment procedure used in the three studies discussed here, as well as the proposed revised version, involved single-step imitation whereas the interventions generally aimed for multi-step imitation; this would seem to represent an inconsistency. In cases where a child demonstrates single-step imitation (as per the assessment) but does not perform all the steps of a target behaviour in response to a single video clip (i.e. video modelling), practitioners can modify the intervention, presenting video clips of specific sequential segments of the target behaviour with subsequent opportunities for the child to perform the specific step (i.e. video prompting) [4]. Previous research has shown that video prompting procedures can lead to more rapid acquisition of multi-step target behaviours than video modelling [54] and that interventions can be effectively faded by chunking the presentation of the video segments (i.e. from video prompting to
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video modelling) prior to withdrawal [48]. Notwithstanding, an imitation assessment
measure that included multi-step imitation may indeed help inform the decision on
whether to begin with either a video prompting or a video modelling approach.

One challenge with the interpretation of imitation assessment scores in terms of a child’s
suitability for VBI is that the level of prerequisite skills required are always relative to the
target behaviour. As suggested in the discussion of the third study [3], a child’s imitation
skills may be sufficient to benefit from VBI for some target behaviours, but not for others.
Imitation assessment measures that covered simple (single-step, gross motor
movement) through to complex (multi-step, fine motor) imitative responses would be
compatible with a greater range of target behaviours.

Where practitioners or researchers are interested in teaching a specific, independently
performed target behaviour, the imitation assessment procedure proposed here may
provide a quick and helpful indication of the participant’s suitability. But it would still
require the practitioner to judge the level of correspondence between the imitation
assessment items and the target behaviour. In the final analysis, a participant’s
suitability for VBI is most conclusively determined by their actual response to the specific
intervention. Given the rapid response of some participants to VBI and the relative ease
of producing appropriate video footage for some target behaviours, an ‘intervention as
assessment’ approach may be the most efficient in some cases. But in most cases,
spending 10 minutes conducting a generic imitation assessment procedure prior to
implementing the VBI would seem to be time well spent. The investment required for
researchers to develop a more comprehensive, more informative, and validated tool for
assessing imitation and other prerequisite skills for VBI could improve practitioners’
selection and design of intervention strategies to teach the range of behaviours that are
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important for the quality of life of children with autism. Evidently, there is ample opportunity for more work to be done in this regard.

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The three intervention studies under discussion in this paper [1-3] were conducted as part of the author’s doctoral research with the University of Tasmania [32].

Declaration of interest

The author reports no conflict of interests. The author alone is responsible for the content and writing of the paper.
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