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Refining a Games Testing Tool for Various Cultural, Social, and Geographic Situations to Evaluate Preschool Children's Bioaffinity

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ABSTRACT

Studies have used psychological games testing to measure children's bioaffinity (a child's love of/for or connection to nature) as a result of time spent in nature enriching children's well-being. Discrepancies found between two studies in different countries (Sweden and Canada) informed this research. Both studies used the same bioaffinity testing tool with children who had more than average nature-exposure and were enrolled in preschools using the same nature-based philosophy (Reggio-Emilia approach). While the Swedish study found positive bioaffinity amongst the children (aged 5), the Canadian children's (aged 3-5) affinity with nature was weak. The inconsistencies between the Swedish and Canadian studies led to recommendations for further research and testing to determine the following: 1) the appropriateness of the measure for younger children, 2) the need to modify the test to be more culturally and geographically relevant for the participants, and 3) whether such revisions would increase participant understanding and completion of the test while producing more accurate results. As such, this study sought to modify the testing tool to be more culturally, geographically and developmentally appropriate for young Canadian children and then test it with a cohort of 3-5-year-old Canadian preschoolers. Interviews with early childhood education experts and current child development psychology literature informed the modification of the games testing tool. Reduction in the time needed to complete the testing and an increase in child engagement indicate that the new tool's revisions effectively enhanced the children's understanding of the game's testing.

***Keywords**:* Early childhood environmental education, early childhood education, environmental education, early childhood development, bioaffinity, games testing, psychological testing, Reggio-Emilia, connection to nature

Nature is undoubtedly necessary for the survival of the human race. In particular, nature is a crucial component for the appropriate physical and psychological development of children. The balance of scholarly evidence demonstrates that direct contact with nature enhances children's cognitive, emotional, attitudinal, and physical development (Driessnack, 2009; Giusti et al., 2014; Bratman et al., 2015; Kardan et al., 2015; McClain and Vandermaas-Peeler, 2016; Broom, 2017). However, human interaction with nature, especially for young children, is continuously diminishing (Driessnack, 2009; Soga and Gaston, 2016). For example, in Canada, 70% of children spend one hour or less per day outdoors (David Suzuki Foundation, 2012). Additionally, Canadian children (aged 7-14) spend more than 8.3 hours per day engaging in sedentary activities (Statistics Canada, 2016). In addition, according to research, an increase in the use of technology is a primary barrier to a child's ability to connect and interact with nature (Driessnack, 2009; Louv, 2005; Soga and Gaston, 2016). Kabali *et al*. (2015) showed that 72% of children surveyed in the United States between the ages of 0-to-8 years used a mobile device regularly, and 38% of children aged two years or less have used a mobile device. These and many other studies are beginning to paint a picture of children spending less time outdoors, and increasingly staying indoors and using electronics.

As a consequence, children lack the many health benefits associated with spending time in nature including lower infant mortality (Dzhambov, Dimitrova and Dimitrakova, 2014), a lower rate of asthma and allergies (Lovasi et al.,

2008; Hanski et al., 2012; Ruokolainen et al., 2015), reduced chance of anxiety and depression (Maas et al., 2009), better concentration (Faber Taylor and Kuo, 2009), and better development of imagination, creativity and problem-solving skills (Malone and Tranter, 2003; Chawla, 2015).

A lack of nature exposure can also have long-term consequences for environmental sustainability on a societal level. Nature exposure in childhood positively correlates with developing pro-environmental attitudes, knowledge and beliefs as an adult (Chipeniuk, 1995; Ewert, Place & Sibthorp, 2005; Rickinson, 2001), influencing education, recreation and work preferences (Bixler, Floyd & Hammitt, 2002), as well as increasing the probability of conservation behaviours and attitudes later in life (Zhang, Goodale & Chen, 2014). Therefore, a strong relationship with nature is beneficial not only for the individual but also of great benefit for society.

Psychological Analyses

Several psychological testing tools developed seek to document the impacts of nature exposure concerning children's relationships with nature. In 1984, Edward Wilson aided in pioneering the exploration of the relationship between the environment and biophilia or bioaffinity (a child's love of/for or connection to nature). More recently, Lincoln et al. (2009), Mayer and Frantz (2004), and Nisbet et al. (2009) utilized a self-reporting itemized Likert scale to measure children's affinity with nature, such as Mayer and Frantz' Connectedness to Nature Scale that measures a child's emotional connection to nature. Pell and Jarvis (2001) went on to integrate pictures into the Likert scale method, using smiley faces instead of numbers. Other studies by Giusti et al. (2014), Omidvar (2018), and Omidvar et al. (2019) use games testing (involving pictures and games) to measure children's bioaffinity and to analyze a child's relationship with nature within the context of nature-based curriculum and schooling. Giusti et al. (2014) avoided the use of self-reporting questionnaires due to the explanation that young children are "incapable of deep self-exploration and have very limited capacity to express the complexity of their emotions and beliefs" (p. 21). The study found that 5-year old children in Reggio-Emilia schools (which have a pro-nature curriculum and educational philosophy associated with the curriculum) in Sweden had increased bioaffinity over those in less nature-based schools (Giusti et al., 2014).

However, results from both Omidvar (2018) and Omidvar et al. (2019) concluded that while the 3-5-year-old children at Reggio-Emilia Inspired preschools were exposed to nature more than the average Canadian child, the children's cognitive, emotional, and attitudinal affinity with nature was much weaker than hypothesized. The outcomes of Omidvar (2018) and Omidvar *et al*. (2019) led to two questions: (1) did the Reggio-Emilia curriculum have no impact on the participant children's bioaffinity, or (2) was the Giusti *et al.* (2014) tool unable to measure the children's bioaffinity? Omidvar et al*.* (2019) recommended that further research is needed using the Giusti *et al*. (2014) games testing to determine whether the tool can become more culturally, geographically, and developmentally appropriate for a 3-5-year-old Canadian audience (Omidvar *et al*., 2019). With significant differences (cultural and geographic) between Sweden and Canada, such as locational difference and linguistic (phenomes, syntax, and pragmatics) exposure, modifications made to the tool sought to address these gaps. Additionally, this study investigates whether refining the tool to account for an earlier psychological developmental stage could facilitate more accurate bioaffinity results based on an increase in participant understanding and ability to complete the test due to cultural and geographic modifications (Omidvar et al., 2019).

METHODS

To achieve the above goals, the game's testing tool was first critically examined and subsequently modified after a thorough examination of childhood developmental literature used to gain an understanding of how to modify the tool culturally and geographically based on the developmental characteristics of 3-5-year-olds and interviews with Early Childhood Education (ECE) experts. Secondly, the modified bioaffinity tool was then pilot tested with a cohort (n=9) of 3-5-year-old preschoolers to assess its appropriateness for this group.

Step 1: Modification of the Game's Testing Tool

This portion of the research focused on modifying the Giusti et al. (2014) games testing tool in order for it to be more culturally and geographically appropriate for a Canadian context, based on the developmental characteristics of 3-5-year-old preschool participants. The modification of the tool took place in two stages, as described below:
Stage One involved a thorough review of recent ECE literature, including environmental psychology (testing and analysis) and preschool (3-5-year-old) children's developmental psychology (cognitive, emotional, attitudinal) to inform critical analysis of the Giusti et al. (2014) tool. Appropriate literature to review was identified through consultation with subject experts and information management specialists. Literature was then reviewed, and significant supporting information was noted (i.e. typical attention span of 3-5-year-olds, use of cartoons versus real images of nature, etc.). This information was used to critically analyze the original Giusti et al. (2014) tool, and suggested modifications were noted in table-format.

Stage Two included key interviews with four ECE experts (including scholars and practitioners). The recruitment for interviewees was carried out through a non-probabilistic and purposive sampling technique, specifically focusing on a combination of stakeholder and criterion sampling to allow for identification and interviewing of significant stakeholders who are intimately involved in the matter at hand; ECE experts and educators involved in child psychology or early childhood education (Payls and Atchison, 2014). The interview structure was face-to-face, and the questions were semi-structured due to the advantages and flexibility of this type of interview. Additionally, all four of the interviewees provided consent to have the session recorded, allowing the interviewer to pay increased attention to the discussion in real-time and to allow for data accuracy (Payls and Atchison, 2014). The interview results were analyzed using *a posteriori* coding to determine major themes and concerns that emerged in the interview process.

Once Stage One and Stage Two were complete, a master list of suggested modifications was developed and recorded in a table format, and the original Giusti et al. (2014) games testing tool was modified to be used in our Canadian pilot study (see results section for more detailed information on the outcomes of the interview and literature review stages).

Step 2: Pilot Test the Modified Game's Testing Tool

As outlined above, the modified test was created based on a review of the literature and interviews with ECE experts. The new tool was then pilot tested at a small nature-based preschool in Halifax, Canada, with 3-5-year-old's to allow for comparison between the Omidvar studies and this study.

The focus of the pilot testing was to determine whether the modified tool could be effective in allowing younger Canadian (culturally and geographically different) participants to understand better and complete the test (major issues identified in the Omidvar (2018) and Omidvar et al. (2019) studies). Recruitment of the students used a non-probabilistic and purposive sampling technique, focusing on criterion sampling, allowing the researcher to find a group of individuals who meet a specific criterion; preschool children attending a Reggio-Emilia Inspired school (Payls and Atchison, 2014). Though demographic information was not collected, the participants attend a culturally diverse Reggio-Emilia Inspired school in Halifax, NS, Canada, founded on pillars, such as environmental stewardship and a commitment to culture and community. A recruitment email was sent out by the Director and Head Teacher of the school to the parent(s)/guardian(s) of children aged 3-5 enrolled in the preschool program. The newly modified tool was tested with the recruited students (n=9).

The testing tool included six different games that tested the children's emotional affinity with nature, the children's environmental awareness, and the children's attitudinal affinity with the biosphere. All six games had to be played in order for the testing to be considered complete. All answers were audio-recorded upon the parent(s)/guardian(s) consent and transcribed for further analysis. Due to it being beyond the scope of this paper to discuss the results of the pilot testing itself (i.e. the bioaffinity results of each participating child), the purpose of the pilot test focused on determining whether the modified tool was more effective when used with a younger and culturally and geographically different audience than that used in the Giusti et al. (2014) study. As such, the research team took

extensive observational notes to determine how well the test was received, such as, did the children understand the question, were there children who dropped out and did the children recognize the nature items presented.

RESULTS OF THE MODIFICATIONS

The following section presents the significant findings from the literature review, interviews with ECE experts, and then goes on to describe general observations regarding the efficacy of the modified tool during pilot testing.

Literature Review and Interview Results

When analyzing the results from the literature review and interviews with ECE experts, four significant themes emerged concerning the original test: (1) game design, (2) the use of cartoons versus real pictures, (3) the use of appropriate language, and (4) the length of time it takes for participants to complete the test. Each theme aided in modifying the tool to become more culturally (in regards to Canadian and Halifax, Nova Scotia cultural norms), geographically (concerning a Canadian setting), and developmentally appropriate for the 3-5-year-old participants in the study. These themes were then considered within the context of the six individual games that make up the tool as a whole. Tables created for each of the six games highlighted: (1) the areas that needed to be added or that required changes; (2) justifications for the change (i.e. a reference to the literature or ECE expert interviews); and (3) the modifications suggested for a modified tool. For example, Table 1 showcases the modifications made to Game 1A, which is concerned with emphatic (emotional affinity with the biosphere) behaviour (note: access to all of the tables can be provided by writing the authors directly).

Table 1
Condensed table portraying the literature review and interview data results (justification) that constitute the modifications for game 1A

Areas Added or Requiring Change	Justification	Modifications
Game Design (Identified during expert interviews, 2019)	• Tasks keep participants' attention; • Tactile games, the incorporation of various kinds of movement throughout the testing and hands-on tests are more appropriate during the preoperational developmental stage.	• Change to a 'sorting game'; • Use 'yes' and 'no' bins that are placed on opposite ends of the testing space in order to facilitate the sorting.
Cartoon vs. Real Pictures (Identified in Omidvar, 2018 and Omidvar et al., 2019; Identified in developmental psychology literature Kail and Barnfield, 2015; Hughes, 1975; Dasen, 1994; Identified during expert interviews, 2019)	• Due to preschool children's egocentrism, they are inclined to have difficulty viewing the world from another's point of view (Kail and Barnfield, 2015); • Cultural context is crucial to ensure the child has an increased chance of knowing and understanding the images they see and are expected to use (Dasen, 1994); • Some children may not be exposed to cartoons, whereas all children have likely been exposed	• A picture of a green check mark was added to the game to place on one of the sorting bins; • A picture of a red 'x' was added to the game to place on the other sorting bin; • All cartoons replaced with real images (i.e. the cartoon tree image replaced with a common local tree).

	to the real objects portrayed in the tool in some capacity (ECE Interviews).	
Use of Language (Identified in developmental psychology literature (Kail and Barnfield, 2015; Bloom, 1998; Smith, 2000)	• Original language used with 5-year-old children in Sweden may be too developmentally complex and/or not commonly used in a Canadian context (Giusti et al., 2014, ECE interviews); • Vast difference between the vocabulary of a two-year-old (roughly a few hundred words) to that of a six-year-old (over 10, 000 words) (Kail and Barnfield, 2015).	• Original question about pain replaced with developmentally appropriate terms (i.e. from "does a tree feel pain?" to "can a tree feel an owie? Can a tree get hurt?"; • The term "hens" modified to "chickens"; • The term "bicycle" modified to "bike"; • The term "plane" modified to "airplane"; • The term "birds" changed to the singular form.
Length of Time (Identified in previous studies Omidvar, 2018; Omidvar et al., 2019; Identified in developmental psychology literature Kail and Barnfield, 2015; Identified during expert interviews, 2019)	• Omidvar (2018) noted that the amount of time needed to complete the game's testing was roughly between 30-40 minutes and that many participants lost interest; • Kail and Barnfield (2015) state that three-year-olds will have a decreased attention span compared to that of a five-year-old and need strategies to stay focused (Kail and Barnfield, 2015; ECE Expert 2).	• Develop active game boards with game pieces; • Have students move during the games to enhance focus; • Ensure games are culturally appropriate, and linguistically specific (in relation to Halifax, NS, Canada norms) to maintain attention (see changes made above).

Modifications Made to the Delivery of the Game's Testing Tool

In addition to the recommendations for modification of each of the six individual games, the analyses of the literature review and interviews with ECE experts revealed a set of recommended changes for the games testing tool as a whole due to limited instruction provided in the original Giusti et al. (2014) testing tool. Table 2 demonstrates the five recommended modifications that were informed by the overall analyses.

The first idea, 'general recommendations for how to prepare and conduct the testing,' (Item 1), equips future researchers with an understanding of how to execute the testing similar to the testing conducted with this cohort and to add to the validity, reliability and trustworthiness of the tool.

The ECE experts encouraged the section 'overview of water pollution, ground pollution, and air pollution' (Item 2) before starting the game's testing and during a 'debrief' (Item 5) upon completion. These explanations were incorporated to include a learning experience for the children concerning the three pollutants they would encounter during the testing period and may not have heard of or seen before. The modifications suggested to describe the images shown in the testing rather than discuss the impacts, for example, air pollution causing health risks to humans and animals. The experts agreed that this would minimize bias due to not iterating the consequences the three pollutants have on people, animals, and objects asked about during the testing.

The 'overall game design' (Item 3) reiterates and solidifies the justification for the subsequent game design modifications. Both the scholarly literature and the experts advocated that children's responses and engagement would increase if they were mentally and physically stimulated during the testing because children enjoy being "hands-on," and their developmental strategies are driven by sight and touch (ECE expert 3; Kail and Barnfield, 2015).

Item 4, 'colour vs. greyscale,' addresses the need to minimize colour bias (discussed further in the section 'Tool Modification'). The literature shows that children between the ages of 3-5-years begin to develop categories for colours that rely mainly on primary colours, and more specifically, they tend to gravitate towards their "favourite" colours when partaking in daily tasks (Pitchford and Mullen, 2003; Bonnardel and Pitchford, 2006; Regier and Kay, 2009).

As mentioned above and in Table 2, the debrief (Item 5) section required the researcher to now elaborate on the explanations provided concerning the three pollutants and adds the corresponding consequences associated with each. Therefore, providing the participants with an opportunity to complete the testing with more knowledge of water pollution, ground pollution, and air pollution.

Table 2
Condensed table portraying the literature review and interview data results (justification) for the overarching modifications added to the overall tool

Areas Added or Requiring Change	Justification	Modifications
General Recommendations for How to Prepare and Conduct the Testing (Identified in previous study Omidvar, 2018; Identified during expert interviews, 2019)	• Omidvar (2018) recommended numerous revisions to both individual games and overall structures of the tool; • Audio recording instead of writing answers will save time and help with accurate collection of data.	• A list of initial recommendations was added at the beginning of the tool to guide future researchers on how to utilize it, as well as additional suggestions made for each individual game throughout the rest of the tool (please contact authors for full list).
Overview of Water Pollution, Ground Pollution, and Air Pollution Before Starting the game's testing (Identified during expert interviews, 2019)	• This section was recommended to facilitate a learning experience for the children about the three pollutants seen throughout the tool.	• Upon starting the game's testing, the researcher is now required to go over the concepts/ideas of water pollution (dirty water), air pollution (dirty/smoky air), and ground pollution (dirty ground), without discussing the consequences associated with the form of pollution.
Overall Game Design (Identified during expert interviews, 2019)	• Developmentally appropriate to make games more interactive; • Transformation of the games to "active" will reduce the time needed to complete the testing.	• All six of the games were turned into real 'board' games. The original four tables used throughout the testing tool (games 1B, 2A, 2B, 3A and B) were enlarged and printed to become the size of a board game, and pictures enlarged to complement the size of board.

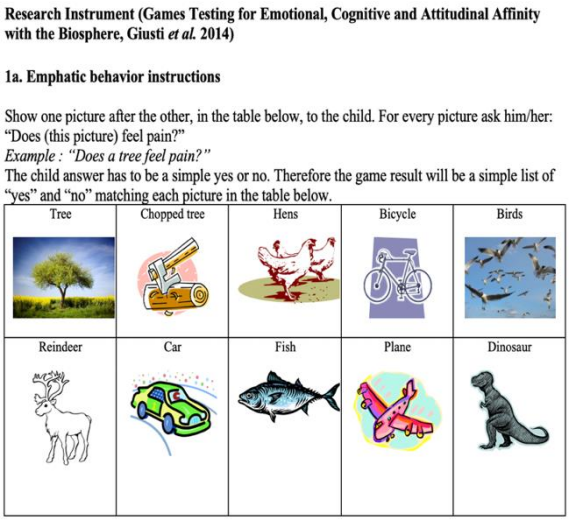
		When possible, tasking was embedded into games (e.g. sorting).
Colour vs. Greyscale (Identified during expert interviews, 2019; Identified in developmental psychology literature Pitchford and Mullen, 2003; Bonnardel and Pitchford, 2006, Regier and Kay, 2009)	• Between the ages of three-to-five-years, children begin to develop preferences for colours (Pitchford and Mullen, 2003); • Preschool children rely on primary colours more than complex colours (Bonnardel and Pitchford, 2006); • Children tend to gravitate toward their 'favourite' colour when partaking in daily tasks and activities (Regier and Kay, 2009).	• All pictures throughout the testing tool modified to greyscale.
Debrief (Identified during expert interviews, 2019)	• Participants need an opportunity to better understand the concepts discussed during the game's testing, and the opportunity to ask questions; • Debrief may stimulate children to ask more questions about pollution that they see in their daily routines.	• The researcher is now required to review the concepts/ideas presented at the beginning and throughout the testing, including the consequences associated with each form of pollution.

Principal Modifications

Informed by the results of the literature review and interviews offered above, the Giusti et al. (2014) tool was modified, using the themes and concerns identified above, in order to make it more culturally, geographically and developmentally appropriate for a younger audience. The revisions of the original tool and the presentation of the new tool are described below and organized according to the four major themes identified earlier (game design, the use of cartoons versus real pictures, the use of appropriate language, and the length of time it takes for participants to complete the test).

Game Design. The original Giusti et al. (2014) games testing tool was played on standard printer paper, with small images and varying types and colours of pictures (see Figure 1). As seen in Figure 2, the opening page of the newly modified tool now includes descriptive instructions and suggestions for how to use the game's testing tool.

Table 3 offers an abbreviated version of the different game design modifications made to the Giusti et al. (2014) tool. As demonstrated in both Table 3 and Figure 3, the original games testing tool was revised so that all games are now tangible (i.e. they now involve game boards with game pieces that the child can manipulate and/or game pieces paired with tasks). Figure 3 illustrates the outcome of the revised game design for Game 1B. This part of the test shows participants a game board (in poster form) and game pieces (happy and sad faces) and asks the participants to place them on the board according to the questions (i.e. "does this image make you sad or happy?").



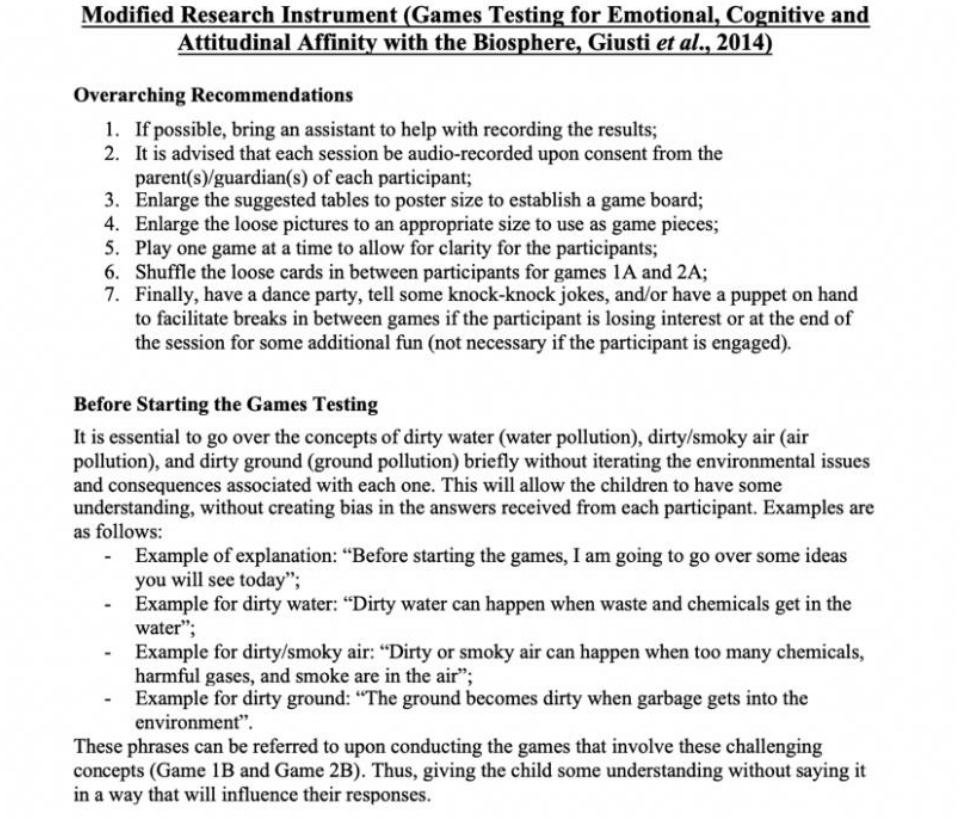
Research Instrument (Games Testing for Emotional, Cognitive and Attitudinal Affinity with the Biosphere, Giusti *et al.* 2014)

1a. Emphatic behavior instructions

Show one picture after the other, in the table below, to the child. For every picture ask him/her: "Does (this picture) feel pain?"
Example : "Does a tree feel pain?"
The child answer has to be a simple yes or no. Therefore the game result will be a simple list of "yes" and "no" matching each picture in the table below.

Tree	Chopped tree	Hens	Bicycle	Birds
Reindeer	Car	Fish	Plane	Dinosaur

Figure 1. Snapshot of the first page in the Giusti et al*. (2014) games testing tool*



Modified Research Instrument (Games Testing for Emotional, Cognitive and Attitudinal Affinity with the Biosphere, Giusti *et al.*, 2014)

Overarching Recommendations

1. If possible, bring an assistant to help with recording the results;
2. It is advised that each session be audio-recorded upon consent from the parent(s)/guardian(s) of each participant;
3. Enlarge the suggested tables to poster size to establish a game board;
4. Enlarge the loose pictures to an appropriate size to use as game pieces;
5. Play one game at a time to allow for clarity for the participants;
6. Shuffle the loose cards in between participants for games 1A and 2A;
7. Finally, have a dance party, tell some knock-knock jokes, and/or have a puppet on hand to facilitate breaks in between games if the participant is losing interest or at the end of the session for some additional fun (not necessary if the participant is engaged).

Before Starting the Games Testing

It is essential to go over the concepts of dirty water (water pollution), dirty/smoky air (air pollution), and dirty ground (ground pollution) briefly without iterating the environmental issues and consequences associated with each one. This will allow the children to have some understanding, without creating bias in the answers received from each participant. Examples are as follows:

- Example of explanation: "Before starting the games, I am going to go over some ideas you will see today";
- Example for dirty water: "Dirty water can happen when waste and chemicals get in the water";
- Example for dirty/smoky air: "Dirty or smoky air can happen when too many chemicals, harmful gases, and smoke are in the air";
- Example for dirty ground: "The ground becomes dirty when garbage gets into the environment".

These phrases can be referred to upon conducting the games that involve these challenging concepts (Game 1B and Game 2B). Thus, giving the child some understanding without saying it in a way that will influence their responses.

Figure 2 *Snapshot of the first page in the newly modified version of the game's testing tool*

Table 3
Abbreviated table of game design revisions pulled from the Modification Chart

Game 1A	Game 1B	Game 2A
This section is now a 'sorting game'. This involves 'yes' and 'no' bins that are placed on opposite ends of the testing space in order to facilitate the sorting.	Modified to be called "a game of happy and sad smiles". The table of images provided was enlarged and printed as a game board and eight of the happy and sad smiles (total = 16) were enlarged and printed in colour.	The game has been modified to facilitate a 'matching game'. Therefore, the table for list 2 was enlarged and printed to create a game board, and the pictures in list 1 were individually enlarged and printed to use as matching pieces.
Game 2B	Game 3A and 3B	
The game has been modified into two parts. Part 1 asks the child to explain the concepts of air pollution/dirty or smoky air, ground pollution/dirty ground, and water pollution/dirty water. Part 2 includes questions asking the child whether the type of pollution (found in list 1) can hurt the things found in list 2 (animal, car, and people). This part is now set up as a sorting game, with three of each item found in list 2 made into cut outs, so the participant can sort their answer into the 'yes' or 'no' bin utilized for game 1A.	The table of images provided was enlarged, and printed as a game board, with the question portion remaining similar to the original testing tool.	

ECE Input on Game Design. Both the ECE experts and the literature supported the revised game designs. Kail and Barnfield (2015) explained that during the preoperational stage (2-7-years-old), a child's memory strategies are developed and driven by sight and touch. Moreover, Smith (2000; 2009) strengthened their point by highlighting that the shape of things creates a connection to specific objects and words. Similarly, the ECE experts interviewed were unanimous in supporting the transformation to hands-on games, with responses such as:

> *"Cards games are good things to do with kids. You can get kids to sort cards into two bins"; "You have to vary, going from a card game, to a computer… they do much better" – ECE Expert 2*

> *"Kids are hands on… Kids because of that age still have an egocentric nature, so they will want to tell you or show you." – ECE Expert 3*

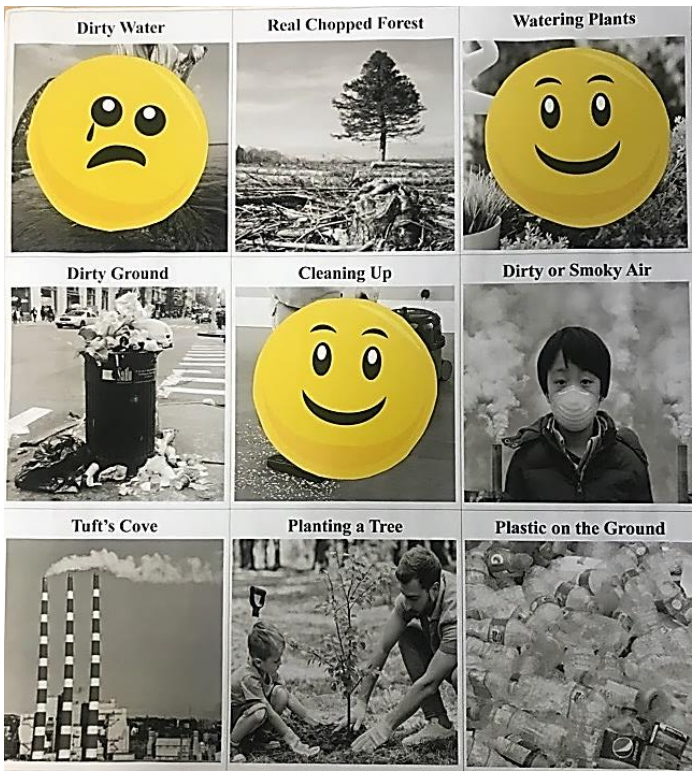


Figure 3. Picture of modified game 1B: concern and sensitivity instructions with the game board and game pieces

Cartoon vs. Real Pictures. Based on the analyses of the literature review and interviews, four main revisions were made to the pictures in the original Giusti et al. (2014) test: (1) grey scaling all of the pictures, (2) replacing all cartoon pictures with real images, (3) determining which images are culturally and geographically appropriate and replacing those that are not, and (4) ensuring that all images are developmentally appropriate pictures (understandable and straightforward).

Using colourful and complex pictures was considered a significant issue for the modified tool. As ECE Expert 2 stressed, "what you have to be careful of is to not make ugly looking images all be related to pollution," and that "some kids really like certain colours, everything red is perfect, doesn't matter what it represents." As seen in Table 2, preoperational (preschool) children are just beginning to develop the cognitive skills used to categorize colours, which means young children rely on primary colours or their favourite colours when partaking in daily tasks and activities (Pitchford and Mullen, 2003; Bonnardel and Pitchford, 2006; Regier and Kay, 2009). Thus, all of the pictures were greyscaled.

As seen in Figures 1 and 4, a variety of different pictures were utilized throughout the initial Giusti et al. (2014) games testing tool. Omidvar (2018) recommended that in any future use of the tool, the researcher should "choose more meaningful and easily understandable pictures and using the images of local locations may help children in better comprehending and relating to the question" (Omidvar, p. 108, 2018). This recommendation was supported by ECE Expert 3, who said: "if you are looking for answers to a realistic question about the environment, a realistic photo is good." Additionally, by choosing real pictures, it seeks to minimize a child's egocentrism (i.e. difficulty viewing the world from another's point of view) and minimize cultural variance by providing a local context (Kail and Barnfield, 2015). It is important to note that real pictures were chosen over that of material items due to the complications material items may have caused, such as distraction and the inability to have specific items brought to the testing (i.e. it would be problematic to have a tangible item for a 'river').

Finally, based on the feedback, it was essential to reduce the confusion caused by using a wide variety of different photos (Figure 4) by providing simple and straightforward images. As such, revisions made focused on using only one picture for each category throughout the test, including the image used of a bird in Game 1 would be the same image of a bird used in Game 4. Examples of specific picture modifications include: changing a cartoon picture of a "plane" to a real picture of an Air Canada airplane, revising the picture of the "birds" flying in the sky to a real picture of a single pigeon, and the three pictures of "animals" have been modified to a single picture of a domestic house dog, specifically a golden retriever, which are very common in Canada (Giusti et al. (2014) images seen in Figure 1 and Figure 4).

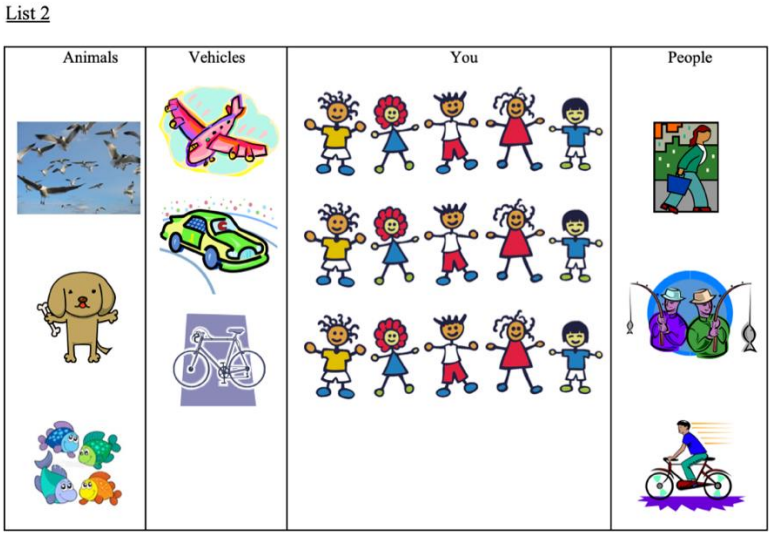


Figure 4. Snapshot of game 2B: pollution awareness instructions from the original Giusti et al. (2014) games testing tool

Use of Language. The use of culturally and developmentally appropriate language is critical during the preoperational stage, largely due to children's egocentrism and the impact of language exposure (Kail and Barnfield, 2015). Egocentrism causes children to find it difficult to see the world from another's point of view. Therefore, it is important that the literature used in the modified tool adheres to Canadian linguistic norms. Due to all languages using different phenomes (i.e. different sounds are used in different languages), syntax (i.e. specific rules that specify how to combine words in a sentence) and pragmatics (i.e. rules that lead to effective communication), the language used in the modified tool needed to reflect the Canadian background of the participants and the language they encounter in their daily lives (Kail and Barnfield, 2015).

Additionally, literature shows that the vocabulary of an English speaking 2-year-old includes only a few hundred words, while an average 6-year-old knows over 10,000 words (Kail and Barnfield, 2015; Smith, 2000). The language in the tool was therefore modified to cater to the younger Canadian participants (3-5-year-olds as opposed to the older Swedish students in the Giusti et al. (2014) study) to ensure the highest level of understanding (Kail and Barnfield, 2015; Bloom 1998 For example, the language was modified to words that are often used in Canada and simplified for clarity (i.e. the term "hens" changed to "chickens," and the use of the word "pain" switched to an "owie"). Other changes were concerning the three pollutants (original test language and pictures seen in Figure 5), which changed to dirty water (water pollution), dirty or smoky air (air pollution), and dirty ground (ground pollution), as seen in Figure 6. In each case, the modifications made concentrated on enhancing the language to be both culturally and developmentally appropriate.

Figure 5. Snapshot of the three pollutants air pollution, ground pollution, and water pollution as found in the original Giusti et al. (2014) games testing tool

Figure 6. The three pollutants (air pollution, ground pollution, and water pollution) with their corresponding modified and greyscaled pictures found in game 2B: pollution awareness instructions

Length of Time. An issue with the amount of time it took the children to complete the game's testing was first identified during the Omidvar (2018) and Omidvar et al. (2019) studies, where they found that participants took approximately 30-40 minutes to complete the game's testing which was too long for the children and made them lose focus and interest in the tests. Additionally, the results of the interviews with ECE experts indicated that 30 minutes of testing with young children in a seated capacity (i.e. no activities) is inappropriate for their developmental stage:

> *"They will be bored out of their minds. After a couple minutes they will not be on board" – ECE Expert 3*
>
> *"It's a lot. You will need to break it up… you could get up and dance party or sing a song" – ECE Expert 4*
>
> *"You have to change activities frequently. You have to vary because they will get bored" – ECE Expert 2*

Therefore, various strategies were employed to reduce the time needed to complete the study, including bringing the games to life (incorporating movement and task), reducing some of the questions asked and pictures used, and greyscaling the images (e.g., greyscaling Table 1). One ECE expert explained that children could be distracted and gravitate towards vibrant colours, thus diverting the participants from making a non-colour-biased decision and making a timely answer.

RESULTS OF THE PILOT TEST

The pilot test explored the context of the original research question of whether a modified tool would be more effective with a younger, culturally and geographically different audience than the participants in the Giusti et al. (2014) study. The observations and analyses of the research team regarding the pilot test in this respect are discussed below. Ultimately, improvements throughout the pilot test results are in the form of the reduction in the amount of time necessary for testing, and more children being able to respond to the questions.

Length of Time

While the average time to complete the study for Omidvar (2018) was 30-40 minutes, children's average time to complete games testing with the modified tool was 15.25 minutes. The longest session during the pilot testing took 23 minutes, and the shortest session was 10 minutes. This reduction in average time suggests that the revisions worked to keep children more engaged and interested in the game's testing, which resulted in significantly reduced participation time.

Response Rate

In terms of the children's ability to understand questions, the research team observed an increase in comprehension. For example, in Game 1A, Omidvar (2018) reported that only 55% of the cohort were able to respond to the exercise, whereas 100% of the participants using the modified tool in our study were able to respond. Additionally, children completed the game quickly and seemed excited to run or dance the pictures to either the "yes" or "no" sorting bins on opposite sides of the room. Our observations suggest that the children showed increased engagement due to the sorting task given to them and that the increase in the children's understanding of the questions and eagerness to participate were beneficial results based on modifications to the original test.

Game 1B also showed signs of an enhanced outcome, with the game again being very quick in delivery and the children showing delight for the cut-out happy and sad faces. There was no hesitation in this game, and children were eager to place the happy or sad face on the game board. For example, one child exclaimed, "I like those happy faces" (C9) and started jumping up and down before beginning the game. Game 2A showed signs of enhancement primarily because children were better able to match the items with the associated nature source, and children were again engaged and eager to try and match the cut-out photos.

Game 2B, part one, was implemented in the new tool to showcase the children's understanding of the three pollutants and to gauge the understanding of the new pictures used for the pollutants (Figure 6). Results showed that all nine children were able to provide some description in response to the question "what is dirty or smoky air…what is dirty ground…and what is dirty water." Some examples of responses included:

> *"if there is something going on in a factory or a smokestack then it might make smoky air" (C1);*
>
> *"makes people sneeze" (C6);*
>
> *"it's polluting, people just throw stuff on the ground or a garbage can overflows" (C1);*
>
> *"if people pollute the water then you have to take animals out" (C1).*

These responses suggest either there was an increase in the children's understanding of the pollution concepts, or they could better understand and describe what they saw in the pictures. This indicates that the modified pictures and language used for water pollution, ground pollution, and air pollution are more culturally and developmentally appropriate for Canadian 3-5-year-olds.

The final two games (Game 3A and 3B) showed signs of enhanced understanding primarily because the cohort was quick to pick a picture on the game board as their answer. This seems to indicate that the pictures and language

used for the modified tool increased clarity for participants. Additionally, in Game 3B, the uncompleted responses were reduced from 15% in the Omidvar 2018 study to 11% in our study for Question 1, and from 35% in the Omidvar 2018 study to 11% in our study for Question 3.

CONCLUSIONS

This study is a direct response to the recommendations made by Omidvar (2018) and Omidvar et al. (2019), examining whether the psychological games testing tool developed by Giusti (2012) and used in the Omidvar studies can be more culturally, geographically and developmentally appropriate for a younger audience. Further, this study sought to examine whether the newly modified bioaffinity tool would be more effective in allowing younger participants to understand and complete the test. Our results show that the Giusti et al. (2014) test could be altered to address the issues experienced by Omidvar (2018) to better align with current research and practice in developmental psychology and early childhood education scholarship. Further, the pilot test outcomes and observations suggest that the modifications successfully enhanced the children's understanding of the games, primarily because there was a significant reduction of time needed to complete the testing and an increase in engagement.

In addition, this study has contributed to the field by documenting the modification and testing of a tool to measure preschoolers' bioaffinity. While psychological evaluation concerning environmental education is commonly conducted by scholars (Dunlap et al., 2000; Pell and Jarvis, 2001; Mayer and Frantz, 2004; Nisbet et al., 2009; Coster et al., 2011), there is a lack of transparent literature instructing researchers of ways to transform psychological testing tools to be more appropriate for different cultural, geographical and developmental situations. This study adds to the literature by offering guidance, first outlining how the original Giusti et al. (2014) tool was revised and then justifying the revisions by referring to the scholarly literature and interview results with experts. We suggest that any future studies that wish to use the Giusti et al. (2014) tool should use the modified version that we have presented in this paper (please note that a full copy of the test is available by contacting the authors) as it is more developmentally appropriate than the original test, and modified according to the current literature on childhood development and psychological testing techniques.

However, there are two caveats to any use of our newly modified tool. First, it needs to be adapted by future researchers to be appropriate with the cultural norms (i.e. make sure the language used is appropriately in relation to the linguistic norms of the study location) and geographical location (i.e. modifying images to items commonly seen in the participant's location) of the new study. Second, its use should be informed by the evolving body of knowledge regarding children's (age of the participants) biological and developmental growth, and the tool should continue to be modified as needed. As such, we do not offer our modified tool as a stand-alone tool that can be used in perpetuity, but rather as a starting point for bioaffinity researchers who wish to use an established tool, but one that can be modified so that it is both culturally and geographically appropriate. Further, we offer our process of modification as a template or guide to any future modifications.

Limitations

The first limitation of this study is the sample size of n=9 participants used for the pilot test; therefore, the results are not generalizable to all Reggio-Emilia Inspired schools in Halifax, Nova Scotia, Canada. However, the small sample size is justifiable due to the non-probabilistic and exploratory nature of this study. A second limitation is the participant's different socio-cultural backgrounds, which may influence their outlook and relationship with nature (Omidvar, 2018; Omidvar et al., 2019). The final limitation is the timing of the pilot testing. Similar to Omidvar (2018) and Omidvar et al. (2019), due to the testing taking place during winter in Canada, seasonal depression or negative notions about nature may influence the child's point of view and emotions during the time of testing.

Future Research

Finally, this study represents the beginning of what we anticipate to be a longer journey with our newly modified test. While this study was valuable in demonstrating how to modify the Giusti et al. (2014) bioaffinity tool in order

to be more culturally, geographically and developmentally appropriate for our purposes, this particular study was not able to address a number of issues that we are excited to pursue in the future. First, we intend to formally test the reliability and validity of the new test in several locations to add to the trustworthiness of the results presented here. Further, we intend to conduct more studies in our geographic area to measure the bioaffinity of preschoolers who attend environmental education-oriented schools as well as students who attend more traditional (i.e. not-environmentally-oriented) schools. Finally, we intend to use the process suggested in the methods section for this study to modify the test for various geographical locations globally and invite other researchers to do so in collaboration with us. We believe that reliability and validity testing should occur in these various cultural and geographical locations to ensure the continual revision of the tool for different settings and appropriate bioaffinity testing of preschool children in the future.

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