

## Editorial

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# Real-Time Technology Video-Coding Tools for Programming Multisensory Interventions Incorporating Exotic Local Fruits and Vegetables in Early Childhood: Implications for Pediatric Obesity Prevention Research

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## SCIENTIFIC BACKGROUND

Promoting fruit and vegetable (henceforth referred to as F&V) intake in early childhood is significant to public health now and in the future.<sup>1</sup> One of the goals of Healthy People 2020 (i.e., Goal NSW-15) is to increase the variety and contribution of vegetables in the dietary habits of the population, including its youngest members (U.S. Department of Health and Human Services, 2014).<sup>2</sup> Education efforts fostering the consumption of fruits and vegetables in young children serve as a catalyst for efforts to combat childhood obesity by helping promote shifts in dietary patterns with decreased intake of energy-dense foods high in fat and sugars to foods high in vitamins, minerals, and phytonutrients. In our work with the U.S. federal food assistance program, Head Start, in the New England region of Western Massachusetts,<sup>3</sup> we found that children were not achieving the recommended F and V intake, and that overweight and obesity, as well as micronutrient deficiencies (vitamins A and C, and iron) may be prevalent.<sup>4</sup> Although the direct correlation between F and V consumption, and lowering of obesity is yet to be established in this early life-stage, F and V, especially exotic varieties are low-calorie, low-fat sources of vitamins (vitamin C, carotenoids), minerals, and fiber and provide an array of phytonutrients and antioxidants, and anti-inflammatory benefits.<sup>5-7</sup>

## SENSORY MESSAGING FOR EXOTIC FRUIT-VEGETABLE EDUCATION IN EARLY CHILDHOOD SETTINGS

Early childhood researchers and practitioners addressing obesity prevention should consider introducing exotic varieties of F&V with diverse sensory qualities.<sup>4</sup> In this novel intervention effort, educators must consider utilizing messaging that involves engagement of the five senses (sight, smell, touch, taste, texture and integrate the combination of all senses in children's food perceptions and sensory-based food education activities.<sup>8</sup> Introducing a variety of F and V in positive, engaging activities highlighting their sensory characteristics such as color, shape, texture, and taste, increases the likelihood that young children will taste and eat a wider variety of these health-promoting foods. Frequent experience with foods through sight, smell, and taste exposures are critical to achieving acceptance of these items in preschool age,<sup>9</sup> as this experience has been shown to influence the hedonic preferences for exotic vegetables (swede, rucola) and berries (bilberry, lingonberry, and sea buckthorn) among children.<sup>10</sup>

However, what is lacking is research assessing the correlation between preschool children's sensory exploration, and mediators of exotic F and V consumption, such as willingness

to taste and preferences. In the U.S, Cooperative Extension programs teach children about the diversity of F and V by engaging the children in multisensory activities in the classroom. A French ‘Glasses du Goût’ (Sapere taste education), developed for school-aged children, is a widely accepted sensory education method. In Finland, project funding has been available for training day care personnel and various sensory-based activities have been implemented in many kindergartens.<sup>11</sup>

#### **BRIDGING THE CLASSROOM FEEDING PARAMETERS ASSESSMENT GAP WITH VIDEO OBSERVATIONS OF SENSORY INTERACTIOS**

Several studies have successfully used video recordings of infant feeding sessions through the application of the Feeding Infants: Behaviour and Facial Expression Coding System (FIBFECS) to document a clear and valid means of measuring *liking* and *wanting* in infants at the time of complementary feeding.<sup>12,13</sup> This type of analysis represents an interesting avenue for future research.

#### **PROCESSING EARLY CHILDHOOD SENSORY NUTRITION EXPLORATIONS DATA WITH VIDEO-CODING OBSERVATIONS**

With the global rise in the use of sensory based approaches to address healthy eating, the availability of reliable and valid measures of observation in early childhood classroom settings is critical for program developers, child care providers, and parents, and researchers. Since preschool is a particularly important stage in the development of eating habits and a period in which assessment of *liking* and *wanting* is difficult or subjective, the development of systematic, and reliable methods to assess *liking* and *wanting* of foods is warranted. A particular area that needs improvement is the validation of tools assessing the developmentally relevant multi-sensory food education interactions, and early childhood activities such as sorting and categorizing based on perceptual properties. Measures appropriate for assessing the quality of sensory interactions in child care settings are scarce. Currently available measures often focus more on the environment and are valid only for certain types of settings, and for the simultaneous assessment of both feeding related behaviors and facial expressions observed during the maternal-child feeding process.<sup>12,13</sup>

Can we expand existing video based assessment methodology utilized with infants, to validate willingness-to-taste and taste measures in individual preschool and elementary school age children in circle-time/group naturalistic settings (e.g., Head Start, early Head Start, elementary school classrooms)? Central to this question is how we define and measure the quality of sensory explorations, and engagement in an early childhood environment context. Our current definition of sensory assessment and evaluation includes a variety of tools. We propose the implementation during classroom circle-time of video recordings to observe and code young children’s ‘real-time’ truthful reactions to foods combined with the more detailed examination of early childhood sensory behavior and facial expression coding, anchored in assessment and ratings of engagement in sensory activity, and willingness to taste. Reliably collecting video-recordings of food-based sensory exploratory observations, and coding and analyzing such behavioral data within children’s peer-circle time settings is an exciting venue for research.

The advantages of the proposed video recording approach are that the same assessor (s) can repeatedly observe the recordings which are not possible in real time observations. However, to code these video recorded sessions, it is important to know what behaviors to search for and systematically code and document based on the videotaped observations of the sensory measures of engagement/exploration/willingness/avoidance/circle-time behaviors. The circle time peer interactions and facial expressions included in the coding analysis should be evidence-based, and must include consultation with early childhood teachers, linguists, nutritionists, caregivers, and scientific experts. Clearly the assessment of other behaviors such as peer interactions, interactions with caregiver, verbal skills/literacy/vocalization, will offer value-added analytical benefits as facial expression alone may not capture all the information observed during circle time. Therefore, facial expressions in combination with other feeding related behaviors such as physical body and mouth movements indicating approach or avoidance engagement, exploration, willingness, and acceptance could provide a detailed and reliable method of assessing responses to novel foods in early childhood. Other unique aspects of the video-coding evaluation urgently needed are the assessment of the sensitivity of the coding scheme to feeding interventions, and triangulation with direct observations by trained raters, and with pre-post food waste measures. Finally, there is a need to develop STEM evidence-based and child-outcomes focused protocols for video-coding sensory observations and peer interactions in the context of a classroom sensory intervention aimed at children’s engagement with and consumption of locally available exotic F/V.

#### **SIGNIFICANCE OF INCORPORATING VIDEO-OBSERVATION CODING TECHNOLOGY IN SENSORY INTERVENTIONS**

The importance of incorporating technology in sensory intervention studies assessing early F and V acceptance is high. Preschool classrooms and circle time settings serve as unique early education settings for technology driven evaluation of developmentally appropriate responses to promotion of local F and V in young learners. The combination of coding both sensory interactive feeding behaviors and facial expressions can be useful to professionals and caregivers in recognizing sensory expressions linked to willingness-to-try and willingness-to-taste and consumption in early childhood. Recognizing the diverse sensory engagement cues

in conjunction may help caregivers to facilitate healthy eating and responsive feeding as young children appear to move naturally through developmental stages of food acceptance. While sensory-based food education activities may promote a willingness to eat vegetables and fruits<sup>4,8</sup> and child-centered test methods are important for evaluating the effects of dietary interventions among children, reliable and valid tools are essential for the long term success of such interventions. Another application of the video coding protocol involves the validation of constructs and domains from relevant theoretical frameworks. For a nutrition intervention to be effective, research shows that it should be based on sound theoretical principles. The social cognitive theory (SCT) postulates that children’s behavior is influenced by several factors. Personal (e.g., knowledge), behavioral (e.g., skills), and environmental (e.g., visual reinforcement) factors are believed to influence children’s health-related behaviors, such as dietary choices.<sup>14</sup> While systematically incorporating the framework domains and constructs through sensory activities implemented in the classroom, the video-codes could perhaps track changes in children’s self-efficacy in the context of exotic F and V consumption in response to sensory interventions.

**DEVELOPMENT OF THE VIDEO-CODING SYSTEM ASSESSING WILLINGNESS TO ENGAGE, EXPLORE AND TASTE**

In our ongoing work,<sup>3</sup> facial and behavioral (verbal/non-verbal) expression coding along with coding of developmental milestones aligned with STEM guidelines and State-specific early learning standards are being evaluated with Teaching Strategies GOLD® assessment system.<sup>17</sup> We are also comparing available software such as Dedoose,<sup>18</sup> Noldus<sup>19</sup> and others to identify reliable and robust online tools for observational coding. The children’s circle-time sensory behaviors will be extracted, and then applied and tested to assess structural validity and inter-observer reliability for assessing Willingness to Engage, Explore and Taste, along the continuum of the Willingness Rating Scale (Table 1 and Figure 1).

**QUANTIFYING REAL-TIME VIDEO RECORDINGS**

To standardize the extraction of quantitative data from the raw video recordings, a customized coding scheme must be developed using video annotation software such as ANVIL 5.0.<sup>19</sup> There is a need to define the assessment categories based upon the respective sensory observations chosen to be mutually exclusive.<sup>4</sup> To establish inter-rater reliability, coding of the videos must be divided

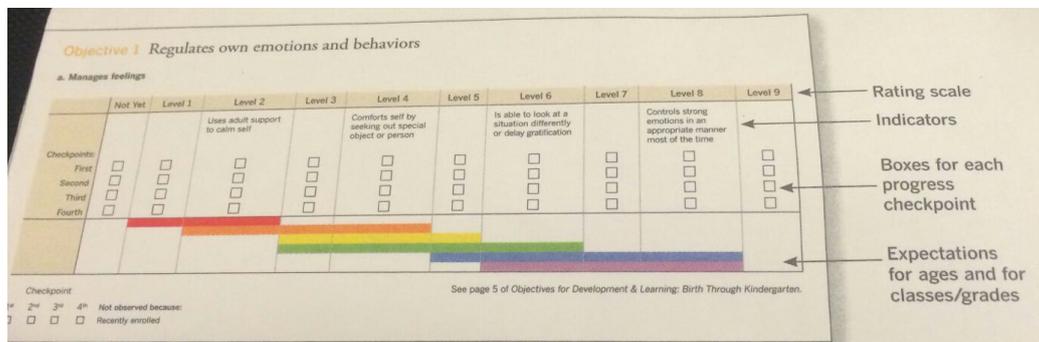


Figure 1: Sample rating scale for video-coding milestones from Teaching Strategies GOLD®.<sup>15</sup>

- 1. Not willing
- 2. Examined but would not taste or smell
- 3. Willing to smell
- 4. Willing to lick/taste → tongue
- 5. Willing to eat → put in mouth, chewed

- 5A. spit out
- 5B. consumed
- 5C. finished serving
- 5D. asked for more

Used to evaluate the enjoyment of the selected fruit  
Used to evaluate the enjoyment of the selected fruit

Table 1: Range of willingness rating scale for the assessment of children’s circle-time sensory engagement, explorations and interactions.

between at least three (trained) researchers, and coding variables must be established using robust criteria.<sup>18</sup> The video footage must be watched and coded by highly trained, independent raters (process described below) for outcomes based on the state-specific early learning metrics and early learning and development standards, using the Teaching Strategies GOLD Assessment System<sup>17</sup> and State-specific Learning and Development Standards, Child Assessment Portfolio Objectives must be matched (example: shows curiosity and motivation, and explores and investigates to make things happen).

For example, as shown in the Figure, children would be rated on a Level ranging from 0-9 to observe the results of their explorations, which is a basic science skill. Triangulated Data (trained research observers' notes) will be integrated with objective intake data representing pre-post consumption (grams) of exotic fruits and vegetables introduced during the sensory intervention.

#### **TRAINING SENSORY CODERS AND RATERS**

There is a need to standardize sensory coding, and training is extremely important. With sufficient training, the video-coding system can be used to explore sensory engagement and willingness-to-taste parameters in early childhood. A comprehensive training manual will be developed detailing the description of possible sensory behaviors and facial expressions including pictures/video extracts with information and assessment domains, including possible misinterpretations. Coding schemes and decision-trees must be developed and validated for the scientifically robust measurement of children's facial expressions as markers of willingness and acceptance. For each cue assessed, we will evaluate and establish test-retest reliability, and examine a range of validity measures. Sensory data will be coded using factor analysis, and quantified using rating scales.

#### **APPLYING EARLY LEARNING AND DEVELOPMENTAL MILESTONE STANDARDS TO CODE THE VIDEOS**

Based on current interest in designing Policy, System, and Environmental (PSE) interventions for food insecure such as Head Start populations,<sup>20</sup> we recommend that classroom videos documenting F-V sensory exploration by children be evaluated using state-specific early learning and developmental milestone standards, and validated with willingness and preferences for each F and V at baseline, during intervention and at follow-up. Utilizing currently available definitions for sensory measures, the video coding of acceptance data would potentially span a 7-point scale, ranging from 0 to 6 (Table 1). Specifically, coding of data will assess the children's responses to classroom educational activities along the domains of early learning such as: verbal skills, conceptual and language skills, memory, and sensory exploration.

#### **SELECTION OF SUITABLE SOFTWARE, MATCHING MEASURES WITH DEVELOPMENTAL MILESTONES AND ADAPTING A HYBRID FIBAC APPROACH WITH MANUAL CODING**

Suitable media player tools available for playing back the videos with ease (easily accessible, free to download, various visual effects such as zoom, color/contrast, frame by frame view and slow motion must) be utilized. There is an urgent need for accurate and affordable methods for evaluating sensory responses and we recommend a hybrid tool combining paper-based manual assessment with online ratings, as coders cannot rely only on software tools.

#### **CONCLUSION: METHODOLOGICAL STRENGTHS AND FUTURE RESEARCH**

We have made tremendous strides incorporating technology in the assessment of and understanding the impact of nutrition education interventions and generating observation-driven hypotheses related to patterns of sensory responses, of promising relevance to early childhood educational practices. Future work will focus on advancing sensory data collection, assessment, processing and interpretation tools, developing analytical methods, and creating an educational design framework that promotes practice of sensory skills for fun learning in early childhood.

There is a broad range of exciting interdisciplinary research and training opportunities spanning technological and database tools, theoretical models, early learning and developmental milestones, and population studies. Data analytical frameworks, tools and techniques are essential for unraveling the mysteries of children's multiple sensory modalities simultaneously, tuning effort and perception to gain what is useful in a given multisensory nutrition education context.

Scientific journals will continue to play a crucial role by providing the basic and translational research communities many opportunities to disseminate this innovative work. The potential opportunity to familiarize educators with viable technological tools, and sensory programming of interventions addressing pediatric health is an exciting and timely area for exploration.

**CONFLICTS OF INTEREST**

All authors declare that there is no conflicts of interest.

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