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Development and Validation of a Virtual Human Vignette to Compare Nurses' Assessment and Intervention Choices for Pain in Critically Ill Children

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Abstract

Introduction—As virtual experiences are increasingly used in healthcare training and research, it is important that adequate processes are applied for developing valid scenarios. We describe the development and validation of virtual human (VH) vignettes, computer-generated scenarios with animated patients and clinical information, for a mixed-methods study regarding nurses' assessment and intervention choices for critically-ill children's pain.

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Methods—We followed the Case Development and Review Process for High-Fidelity Simulation Case Scenarios, including use of validated written vignettes and content experts. Forty nurses described their pain assessment and intervention choices for the newly derived VH vignettes and completed a pain questionnaire. Nurses' reports of VH vignette consistency with their professional experience and recognition of VH facial expressions were evaluated to establish face validity. Their pain ratings for the VH and written (questionnaire) vignettes were evaluated for convergent validity. Qualitative content analysis, descriptive statistics, correlations, and paired *t*-tests were employed.

Results—Most nurses (68.4%) supported vignette consistency with their professional experience. Facial expression recognition was 98.4%. Smiling children's pain was rated significantly lower than grimacing children in both VH and written vignettes. Pain was rated significantly lower for grimacing children in the VH vignettes than the written vignettes. VH vignette pain ratings were strongly correlated with their written counterparts.

Conclusions—This process was effective for developing VH vignettes that demonstrated good face validity with participants and convergent validity with written vignettes. VH vignettes may be useful in studying the influence of facial actions on nurses' choices for children's pain assessment and treatment.

Keywords

Vignettes; Pediatric Intensive Care; Pediatric Nurses; Children's Pain; Sickle Cell Disease

Introduction

Virtual human (VH) vignettes, computer-generated scenarios with animated patients and clinical information, may augment the study of healthcare professionals' judgments and beliefs; yet, scenarios must be validated to ensure meaningful results. Presented here is the development and validation of four pediatric VH vignettes for use in a mixed-methods study. Availability of valid VH vignettes was essential to accomplish the primary study purpose, to describe pediatric intensive care unit (PICU) nurses' beliefs regarding children's pain and their assessment and intervention choices for children with differing behaviors (smiling or grimacing) and pain types (sickle cell vaso-occlusive crisis or abdominal surgery).

Uncontrolled pain events, most of which are preventable, are the second most reported adverse event in the PICU.[1,2] Nurses may contribute to children's unalleviated pain when they fail to adequately assess pain intensity (using behavior over self-report) or hold inaccurate beliefs regarding pain management.[3–5] However, studies of child pain with PICU nurses are limited and outdated.

Written vignettes have frequently been used to assess pediatric nurses' pain assessment and intervention choices.[4,6–9] Vignettes allow manipulation of variables often not possible in actual practice settings and are an inexpensive and efficient research methodology.[10] Vignettes provide context for participant response and offer insight into how judgments and actions interrelate with beliefs and meanings.[11] Yet, potentially important detail is lost when

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experiences are replaced with text.[12] Ambiguity or misinterpretation of phrasing may compromise the equivalence of participants' interpretations.[13, 14] Moreover, wording of written instruments can cause bias or cue a socially desirable response.[11, 14] Consequently, vignettes incorporating visual experiences are proposed as a more sound methodology.[12]

Recently, VH vignettes were used to evaluate nurses' pain-related decision making for adults.[15,16] VH vignettes present animated patient scenarios in which patient attributes may be manipulated to allow comparison. To our knowledge, VH vignettes have not been applied in a pediatric pain study. As use of virtual experiences expands in healthcare training and research, it is important that adequate processes are used for developing valid scenarios for these simulations. This article is presented in two sections: first we describe our process for VH vignette development. Second, we present study data used to evaluate VH vignette validity for use with PICU nurses.

Development

The validity of a vignette is directly tied to its design. Content must be real, relevant, and clear to participants for the instrument to be sensitive and accurate.[14, 17–18] In this section, we briefly describe our process for VH vignette development and expert review; a more complete description is located in the supplemental digital content (SDC). During VH vignette development, we followed the case development and review process for high-fidelity simulation case scenarios.[19] Though screen-based computer simulations such as our VH vignettes are generally not considered high-fidelity,[20] this process was chosen because it is consistent with recommended practices in developing written vignettes,[10,14] and addresses the translation of a scenario into a simulator (see SDC 1 for a figure that depicts the case development and review process) (see SDC 2 for a table with a step-by-step example of how the process was followed).

The VH vignettes derived from two written vignettes in the Pain Beliefs and Practices Questionnaire (PBPQ), a 41-item questionnaire regarding the management of acute pain in children.[21] Content validity (use of previously validated items, review by nursing experts in pain research) and internal consistency (Cronbach's alpha 0.83–0.85, consistency in repeated items 71–88.5%) of the PBPQ has been reported.[21] In the PBPQ vignettes, 10-year-old boys reporting severe pain after abdominal surgery are described; the boys only differ in behavior (one smiles and talks/jokes with a visitor [smiling] and one lies quietly in bed and grimaces [grimacing]). Nurses rate each child's pain (0 to 10) and choose either no analgesia or a dose from a prescribed range (multiple-choice item). [21]

In collaboration with the PBPQ developers, two more written vignettes of boys with sickle cell vaso-occlusive crisis were created. This diagnosis was chosen because children in vaso-occlusive crisis often report severe pain during hospitalization[22–26] and have additional risk factors for uncontrolled pain.[27–29] The final written vignettes included four ten-year old boys with the same vital signs (stable), pain intensity (8 out of 10 on a numeric rating scale), and prescribed intravenous morphine dose. Vignettes only varied in child behavior and pain type:

Vignette #1: child first postoperative day abdominal surgery, smiling

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Vignette #2: child first postoperative day abdominal surgery, grimacing

Vignette #3: child with sickle cell vaso-occlusive crisis, smiling

Vignette #4: child with sickle cell vaso-occlusive crisis, grimacing

Four advanced practice nurses, with an average of 10 years' experience working with critically ill children and familiarity with the PICU staff nurse role reviewed the written vignettes. They were asked to comment on the plausibility, comprehensiveness, and complexity of the vignettes for PICU nursing practice; the nursing experts deemed the content appropriate and sufficient to meet the study aims.

To translate the written vignettes to VH vignettes, scripts outlining the flow of content were developed and visual elements not included in the written vignettes were addressed. For example, VH children were chosen to be African American, as children of this race experience the highest incidence of sickle cell disease in the United States.[36] When possible, text was transformed to a visual format consistent with the PICU environment (e.g. vital signs viewed in a video of a patient monitor). The final content was compiled as a webpage (html) (see Figure 1).

The virtual humans were developed using the Lifelike Responsive Avatar Framework, a method of creating realistic avatars in a shortened period of time.[31] Upon Institutional Review Board approval for development, photos of four African American boys, aged 9 to 11, were used to form base head models for the four virtual humans (Figure 2). To achieve recognizable facial expressions, we collaborated with an expert certified in the Facial Action Coding System (FACS), a reliable method of detecting and measuring facial movements.[32] The FACS expert confirmed final VH facial actions were accurate for the intended expressions and consistent across patients with like expressions. The virtual humans were randomly assigned to a pain type (surgery or sickle cell vaso-occlusive crisis). A fifth virtual human with a neutral facial expression and diagnosis of asthma was developed for nurses' use as a practice vignette prior to viewing the study vignettes (See SDC 3, text, provides more detailed text regarding the written vignettes, translation of facial expressions into a simulator program, and the assignment of virtual humans to a vignette).

Vignette Validation

For a vignette to be valid content must be relevant, real, and clear to the participants; otherwise participant responses may not accurately reflect the phenomenon of interest.[14, 17–18] Vignettes can be evaluated directly by discussing content with participants immediately following the vignette[14, 18] and indirectly by appraising participants' responses during the study.[14] As noted, the VH vignettes were developed for a mixed-methods study of PICU nurses' beliefs about children's pain and their pain assessment and intervention practices. Though experts validated content during development, it was also important to evaluate the performance of the VH vignettes with the nurses, which we report here. Our goal was to determine face validity of the VH vignettes with PICU nurses and convergent validity of the VH vignettes with the written vignettes. Direct evaluation included examining the PICU nurses' perceptions regarding the VH vignettes' consistency with their professional experience (face validity). Indirect evaluation included examining their

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recognition of VH vignette facial expressions (face validity) and pain ratings for the VH and written vignettes (convergent validity). Our supposition was that if the nurses interpreted the VH vignette content as intended, their VH and written pain ratings would be concordant, establishing convergent validity of the two measures.

Methods

Sample—Forty PICU nurses were recruited from two urban hospitals in the Midwest. The sample size provided adequate power (0.87–0.99) for paired samples *t* test to detect the calculated effects (0.5–0.87) of behavior for nurses' pain ratings[21] and a medium effect (0.46) for diagnosis and vignette type (alpha 0.05, two-tailed). Most participants were female (92.5%) and identified their race as White (82.5%). Nurses' PICU experience ranged from 1 to 29 years, with a mean of 9.2 (*SD* 8.7). All nurses reported caring for children in pain weekly for the preceding three months.

Instruments—Study instruments included a demographic survey, VH vignette response form and semi-structured interview, and the PBPQ. The demographic survey included items regarding participants' age, sex, race, ethnicity, highest nursing degree, years of nursing experience, and frequency caring for children in pain. The VH vignette response form contained two items for each vignette in which the child's pain was rated from 0 to 10 and an intervention, if chosen, was recorded. Questions in the interview guide included "what were you thinking while rating pain/choosing an intervention for this child?" and "how consistent were these VH vignettes with your professional practice?" The PBPQ (described in the Development section and SDC 3 text) included the two original vignettes of children with abdominal surgery and the two new written vignettes of children with sickle cell vaso-occlusive crisis.

Procedures—Following Institutional Review Board approval, PICU nurses were recruited for the study. Once consent and demographic information were obtained, each nurse was guided through the practice VH vignette. Vignettes were displayed on a 24-inch monitor from a laptop computer. Nurses were asked to respond as if they were viewing actual patients and could view the vignette components as often as desired. The order in which the nurses viewed the four VH vignettes was randomly assigned.

After viewing each VH vignette, the PICU nurses completed a VH vignette response form. Immediately following, they participated in a semi-structured interview with the primary investigator. The nurses could refer to the VH vignettes during the interview. Interviews were digitally audio recorded and later transcribed and checked for accuracy. Lastly, the nurses completed the PBPQ.

Analysis—Interview transcripts were analyzed using qualitative content analysis. Frequencies were calculated for nurses' agreement that VH vignettes were consistent with their experience, reported differences between the VH vignettes and actual patient experiences, and accurate descriptions of the VH facial expressions. The nurses' responses to the VH vignettes (pain ratings and morphine doses) were evaluated for internal consistency (Cronbach's alpha). Bivariate relationships of nurses' pain ratings among the

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vignettes were evaluated using correlation analysis and paired *t* tests with Bonferroni adjusted alpha levels to correct for multiple comparisons.

Results

Our results are divided into three sections. The first section describes the nurses' reports of the VH vignette consistency with their professional experience; the second section describes the PICU nurses' recognition of the VH facial expressions; and the last section addresses the nurses' pain ratings for the VH and written vignettes, comparing ratings among vignettes and evaluating the convergence of the ratings for the two vignette types. During the study, no issues were identified with accessing or responding to the VH vignettes. Each nurse independently navigated the VH vignettes after going through a practice vignette and was able to assimilate the information to answer interview questions. Two audio recordings were interrupted during the interviews, resulting in missing data for some analyses.

Consistency with Professional Experience—During the interviews, most nurses 26/38 (68.4%), endorsed vignette consistency with their past experiences working with children in pain. The remaining nurses (31.6%) neither confirmed nor denied consistency with practice; they instead elaborated upon their experiences managing pain. One participant supporting vignette consistency stated: "It's a good picture of what we see. I didn't see anything up here that I haven't seen a million times." Another commented, "In the sense that we're looking at the patient itself, how they are sitting, smiling, wincing, that kind of stuff, their vital signs, those are consistent with pain assessment in real life." Additionally, nurses shared patient experiences similar to the vignettes. One nurse stated:

> I took care of probably three sickle cellers in like a two-week span, and two of them were exactly like these two…. One was visibly in pain. One of them was like cracking jokes and in this horrible vaso-occlusive crisis and with like chest pain and everything and playing video games

Some nurses described differences between the vignettes and practice. Ten nurses (26.3%) requested more information (e.g., ask the patient questions/more detailed pain assessments, medical history). Eleven (28.9%) noted differences in the analgesic (e.g., use different medications, dose, or route in practice). The most frequent discrepancy reported (16/38, 42.1%) was the patients' stable vital signs. Vital sign changes were anticipated with a patient report of pain.

Facial Expression Recognition—Though the nurses were not asked to comment on the virtual humans' facial expressions, many mentioned the expressions during the interview. Each nurse viewed 4 VH vignettes, resulting in 160 viewings. Due to a recording interruption, data was available for 159 viewings. Nurses commented on the children's facial expressions during 129 of 159 viewings (grimace $n = 60$, smile $n = 69$). Of those 129 comments, 98.4% (127/129) described the intended expression. All smiles were recognized; nurses used the word *smile* or *smiling* in 87% of the views (60/69) or terms consistent with smiling, such as *happy*. For the grimacing patients, 83.3% (50/60) of nurses used the word *grimace* or *wince*, and 13% (8/60) described the expression as "showing pain" or "distressed." On two occasions, nurses used the word *smile* to describe a grimacing patient

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(3.3%). Neither nurse chose to review the VH vignette during the interview. Of note, 20% of nurses discounted the intensity of the grimaces of the virtual patients during the interviews, pointing out the brevity and infrequency of the grimacing. Comments included: “he looked pretty comfortable for the most part besides an occasional grimace” and “He looks okay… but the one wince, I can see he’s in pain, but he’s not distressed.”

Pain Ratings Among Vignettes—The PICU nurses’ pain ratings for the VH and written vignettes were compared to identify any significant differences in responses. Based on the Bonferroni adjustment, an alpha of 0.004 was used as the criterion for significance. Nurses’ pain ratings for the VH vignettes (Table 1) were not significantly different between the smiling child with sickle cell vaso-occlusive crisis and the smiling child who had surgery: $t(39) = 1.50$, $p = 0.14$. The same was true between the grimacing child with sickle cell vaso-occlusive crisis and the grimacing child who had surgery: $t(39) = 1.07$, $p = 0.29$. A significant difference was identified between the smiling and grimacing children of the same pain type; the smiling child with sickle cell vaso-occlusive crisis was rated lower than the grimacing child with sickle cell vaso-occlusive crisis: $t(39) = 4.61$, $p < 0.001$, and the smiling child with abdominal surgery was rated lower than the grimacing child with abdominal surgery: $t(39) = 5.86$, $p < 0.001$. Internal consistency for the VH vignette items resulted in a Cronbach’s alpha of 0.89.

Similarly, for the written vignettes, no statistically significant differences were found between the nurses’ pain ratings for the smiling child with sickle cell vaso-occlusive crisis and the smiling child who had surgery: $t(38) = 1.22$, $p = 0.23$. The same was true for the grimacing child with sickle cell vaso-occlusive crisis and the grimacing child who had surgery, $t(37) = 0.000$, $p = 0.99$. A significant difference was identified between the smiling and grimacing children of the same pain type; the smiling child with sickle cell vaso-occlusive crisis was rated lower than the grimacing child with sickle cell vaso-occlusive crisis: $t(37) = 6.10$, $p < 0.001$, and the smiling child with abdominal surgery was rated lower than the grimacing child with abdominal surgery: $t(37) = 6.30$, $p < 0.001$. When nurses’ pain ratings for the VH vignettes were compared to the written vignettes (Table 1), no differences were identified between smiling children. However, grimacing children’s pain in the written vignettes was rated significantly higher than grimacing children’s pain in the VH vignettes, regardless of pain type.

To further evaluate concordance of the nurses’ pain ratings among the vignette types, Pearson r coefficients between the VH vignettes and their written counterparts were examined (see Table 2). Though all the vignettes were significantly correlated ($r = .55$ to .94, $p < .001$), three of the VH vignettes were most strongly correlated with their written counterpart ($r = .8$ to .88, $p < .001$). The fourth VH vignette, depicting the grimacing child in sickle cell vaso-occlusive crisis, was most strongly associated with two VH vignettes (abdominal surgery/grimace and sickle-cell/smile), $r(38) = .79$, $p < .001$, as compared to its written counterpart, $r(36) = .65$, $p < .001$.

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Discussion

In this paper, we described the development and validation of VH vignettes to elicit PICU nurses' responses regarding their pain assessment and intervention choices. Face validity was endorsed by nurses' confirmation that content was consistent with their professional experience and ability to share examples of similar patient encounters. Additionally, a high percentage of nurses accurately recognized VH facial expressions. Convergent validity of the VH and written vignettes was endorsed by the concordance in pain ratings among vignette types. Nurses consistently rated smiling children lower than grimacing children regardless of vignette type. Also, pain ratings between the VH vignettes and their written counterparts were strongly correlated, and for 3 of the 4 VH vignettes, pain ratings were most strongly correlated with the written counterpart. Our findings are consistent with past studies using written vignettes, in which pediatric floor nurses rated smiling children's pain lower than grimacing children.[3,4,8,21]

The greatest inconsistency PICU nurses identified between the VH vignettes and practice was the patients' unchanged vital signs. However, vital signs are repeatedly noted in adults and children to be neither specific to pain nor to have a relationship with patients' self-reports of pain intensity.[33–39] Rather than reflecting on vignette realism, this inconsistency likely suggests that PICU nurses inappropriately use vital signs to verify children's self-reports of pain intensity. Yet, all of the identified inconsistencies (vital signs, patient information, and medication orders) are easily adjusted within the VH vignette application; variations in these components should be considered for future studies.

Similarities in pain ratings between VH vignettes with like expressions support the equivalence of facial expression intensity among vignettes. Several nurses expressed that the VH vignette grimaces lacked intensity; this may explain why grimacing children in the VH vignettes were rated lower for pain than grimacing children in the written vignettes, an imagined grimace. This finding suggests that the VH vignettes successfully acted as a visual anchor for responses and may be useful in studying the influence of facial action intensity on nurses' choices for children's pain. Because the VH vignette depicting the grimacing child with sickle-cell vaso-occlusive crisis was more strongly correlated with other VH vignettes, further evaluation is necessary; it is possible that this vignette was not interpreted in the same way as its written counterpart.

Limitations of our VH vignette validation include a convenience sample from two PICUs, adaptation of the written vignettes from the PBPQ, and a possible order effect. The sample hinders generalizability of our vignette validation, as nurses' practice across PICUs may vary. Additionally, the sickle cell vaso-occlusive crisis vignettes were developed for this study and had not been previously evaluated for validity and reliability with pediatric nurses. Finally, the nurses' responses to the VH vignettes may have influenced their subsequent responses to the written vignettes. However, there was a greater concern that the written vignettes, if completed first, would influence nurses' interpretation of the VH vignette visual content. To allow for a better comparison, future research should include random assignment of nurses to vignette types.

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Strengths of this vignette development include use of a systematic process that incorporated a previously validated case concept, content experts in PICU nursing and FACS coding, and correction of vignette components during translation into a virtual experience. The mixed-methods design with open-ended interviews, allowed nurses to provide rationale for their choices and elaborate on differences between the VH vignettes and their professional experiences. To minimize the potential weaknesses of adapting the PBPQ vignettes, we collaborated with the PBPQ developers, used research findings to support the diagnosis was associated with severe pain, and incorporated content expert review. In using direct and indirect methods of evaluating the vignettes, we were able to triangulate measures of validity.

In conclusion, our VH vignettes, developed from current literature and an iterative and informative process guided by content experts, was successful. The nurses recognized the VH facial expressions, easily interpreted the content, and compared the VH vignettes favorably with their professional experience. In utilizing VH vignettes, we controlled for differences among patients and provided a consistent visual experience for participants. The nurses' desire for additional patient information for pain assessment speaks to the potential of interactive VH vignettes and may address another criticism of vignettes: the inability to provide interaction and feedback.[14] Future implications for this methodology in research are expansive; VH vignettes may be developed to compare healthcare professionals' responses to countless variations in patient characteristics and may be used as a training intervention. As technology improves the ease of developing realistic virtual experiences, future studies examining the value of this methodology as compared to written and other forms of visual vignettes (photographs, video) are warranted.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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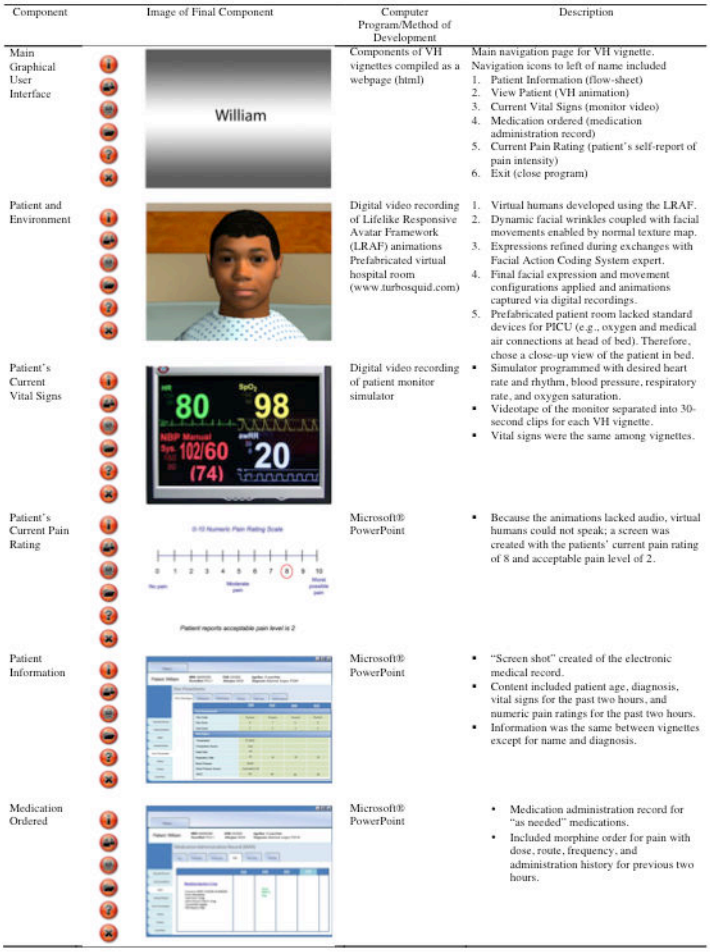

Figure 1.

Development of the virtual human vignette application components. © 2013 LaFond, reprinted with permission.

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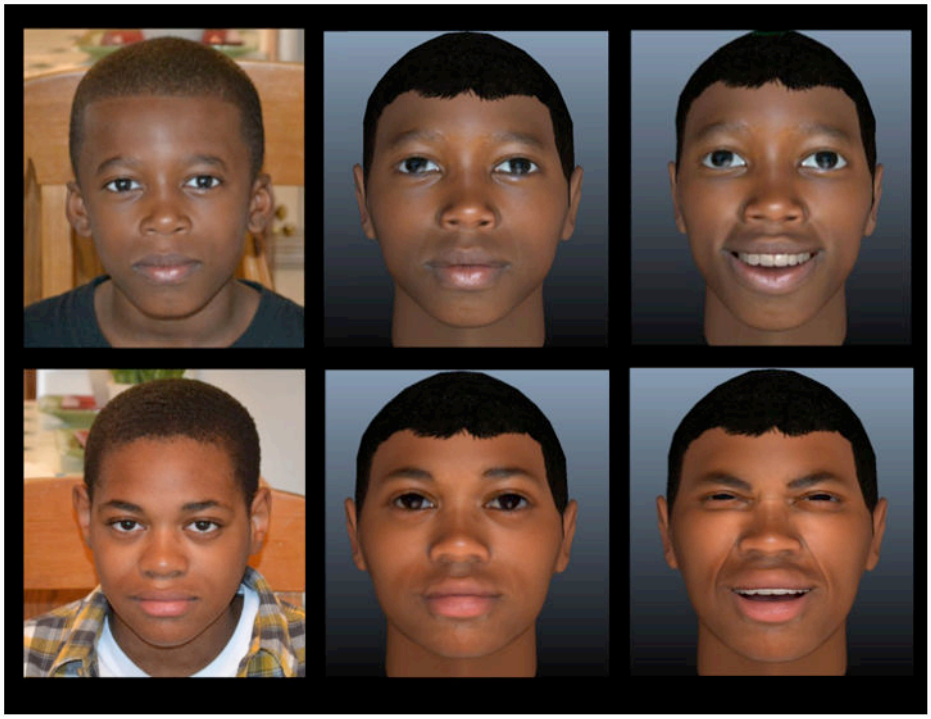

Figure 2.

Formation of base head models. Examples of photographs of two of the four children (left, top and bottom) used to develop the base head models for the virtual human vignettes. Top facial expressions include a neutral expression (center) and smile (right). Bottom facial expressions include a neutral expression (center) and grimace (right). © 2013 LaFond, reprinted with permission.

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Table 1

Nurses' Pain Ratings on a 0–10 Scale for VH Vignettes and PBPQ Written Vignettes

Vignette	Vignette Type		*t (df)*
	Virtual Human *M (SD)*	**Written** *M (SD)*	
Sickle Cell, Smile	4.94 (2.89)	5.05 (2.81)	0.06 (38)
Sickle Cell, Grimace	6.24 (2.01)	7.16 (1.39)	3.33 (37)*
Surgery, Smile	4.49 (2.94)	4.82 (2.80)	0.98 (38)
Surgery, Grimace	6.45 (1.88)	7.16 (1.46)	3.38 (37)*

* $p = <.004$

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Table 2

Correlation Matrix of PICU Nurses' Pain Ratings for VH and PBPQ Written Vignettes

Vignette	1	2	3	4	5	6	7	8
1. VH Surgery, Smile	—							
2. VH Surgery, Grimace	.70	—						
3. VH Sickle Cell, Smile	.79	.71	—					
4. VH Sickle Cell, Grimace	.73	.79	.79	—				
5. PBPQ Surgery, Smile	.88	.64	.81	.69	—			
6. PBPQ Surgery, Grimace	.55	.80	.72	.65	.61	—		
7. PBPQ Sickle Cell, Smile	.81	.64	.88	.73	.91	.69	—	
8. PBPQ Sickle Cell, Grimace	.56	.77	.75	.65	.58	.94	.70	—

Note: All correlations are significant at $p < .001$