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Running Head: USING AN EDUCATIONAL MULTIMEDIA

Using an educational multimedia application to prepare children for outpatient surgeries

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Abstract:

Surgery is a highly stressful event for children and caregivers. Extensive effort has been made to improve preoperative care in order to alleviate worry about the surgical procedure itself. This study tested the impact of an educational multimedia intervention on the cognitive, emotional and physiological responses of children undergoing surgery, as well as on parental state anxiety. Children ($n = 90$) were assigned to three different groups: an educational multimedia intervention (experimental group), an entertainment video game intervention (comparison group) and a control group (no intervention). Children who received the educational multimedia intervention reported lower level of worries about hospitalization, medical procedures, illness and negative consequences, than those in the control and in the comparison groups. Parental state anxiety was also lower in the both the educational and the entertainment video game interventions compared to the control group. These findings suggest that providing information to

children regarding medical procedures, hospital rules and routines is important to reduce their preoperative worries, and also relevant for parental anxiety.

Keywords: outpatient paediatric surgery, preoperative preparation, multimedia application tool, video games.

Surgery may be a stressful and traumatic event for children (e.g. Wright, Stewart, Finley & Buffett-Jerrott, 2007). It usually involves uncertainty potentially leading to emotional overload, which may affect both children and their families (Moro & Módolo, 2004). Since the mid-twentieth century, studies have shown the relevance of preparing children for surgery and hospitalization, specifically in minimizing children's anxiety, distress regarding hospitalization and surgery; and providing positive consequences for the family and for the healthcare providers (Jaaniste, Hayes, & von Baeyer, 2007). Special attention should be given to strategies for improving preoperative care for outpatient surgery, since there might be fewer opportunities for interaction with the healthcare professionals, and consequently for providing relevant information (Margolis et al., 1998).

According to the Information Provision Model (IPM) (Jaaniste et al., 2007), several mechanisms are involved in preoperative programs. The IPM integrates self-regulation and schema-script theories, and considers the role of several individual factors (e.g. temperament, age, coping styles) on the efficacy of preoperative preparation programs for surgery. By providing information about surgery and medical procedures, children may be able to identify the most relevant and appropriate schemata to cope with these situations (Jaaniste et al., 2007). Children without accurate information may activate inappropriate schemas related to hospital settings, which in turn may increase their worries, fears and anxiety; resulting in less realistic expectations. Accurate information may contribute to the decrease in anxiety in anticipation of medical events and lead to positive outcomes, minimized threat perception and reduction of the uncertainties and inconsistencies between fantasy, beliefs and the reality of surgery (Jaaniste et al., 2007).

The use of entertaining and educational materials in paediatric settings has grown dramatically, including the use of video games specifically designed for health education (Kato, 2010). Gaming has been one of the most popular activities among people of different ages and countries; and over the last decade, this industry has increased its range of game content and genres (Brandtzæg & Heim, 2009). Several studies have highlighted the relevant role of using video games to help patients cope with illness and medical problems, such as cancer (e.g. Kato, Cole, Bradlyn, & Pollock, 2008), asthma (e.g. Lieberman, 2001), diabetes (e.g. Brown et al., 1997), and also pain management associated with intrusive clinical interventions (Patel et al, 2006). Gaming may have helped to manage stress, and deal with aversive aspects involving disease (Kato, 2010).

Several studies have highlighted the relevant role of using video games to help patients cope with surgery (Patel et al., 2006; Rassin et al., 2004). Patel and colleagues (2006) analysed the effect of video games on cognitive distraction in children undergoing surgery, and showed its efficacy in reducing anxiety in both the preoperative and the perioperative phases. The use of video games as an educational tool to prepare children to cope with surgical processes and medical procedures has also been analysed, but few studies have evaluated their effects. To our knowledge, only one published work (Rassin et al., 2004) has reported on the development of a video game for elementary school-aged children to help them cope with surgical processes and medical procedures but limited its scope to tonsillectomy and adenoidectomy surgeries. In Rassin and co-author's study, children reported their preference for learning about surgery/hospitalization through a video game (Rassin et al., 2004). However, the authors only described the process of video game development, discussed its use to prepare children for surgery based on a review of the literature and interviews

conducted with children, but the results of its efficacy were not tested. In addition, while many studies have used video games as a cognitive distraction, to our knowledge, no study has been conducted to test the effects of an interactive game application intended to educate children about surgery on their emotions and worries.

Cognitive interventions that provide preoperative information have been considered the most effective for school-age children (LeRoy et al., 2003). However, we should also consider that with limited time for preoperative intervention, distraction methods may also be effective solutions (e.g. Patel et al., 2006). Because distraction techniques such as books, toys, audio and video devices, involve the redirection of the children's attention from their own anxiety feelings to an entertaining activity, children's level of anxiety and distress tend to be reduced (Le Roy et al., 2003).

Taking into account previous findings demonstrating the possible stressful impact of surgery on children, and the potential positive effect of preoperative preparation programs, we developed an interactive multimedia tool, entitled "An Adventure at the Hospital", to prepare children for common outpatient surgeries. The present study aimed to test the efficacy of this interactive multimedia application, by examining its effects on the children's emotional, cognitive and physiological preoperative responses. The multimedia application combined film modelling and interactive game activities. Most of the information about hospitalization and surgery in the multimedia application was presented in a video that included children of the same age as our target users (see the Methods section for details). We chose modelling for two reasons: it is one of the most effective methods for children at the specific operational stage of development (7-11 years); and the use of modelling is one of the most efficient strategies in preoperative care (LeRoy et al., 2003). According to the Social Learning Theory's theoretical framework (Bandura, 1998), certain behaviour can

be learned and reproduced, under similar conditions, by observing the actions performed by others. Research indicates that modelling can be very effective to provide information, to teach effective behaviours and reinforce self-efficacy (Bandura, 1998). Additionally, modelling can be even more effective if it portrays children or symbolic models (i.e. illustrations, cartoons) of the same age as the user to increase the identification with model (Bandura, 1998; Jaaniste et al., 2007).

We tested the multimedia application's efficacy using a randomized design. Children were randomly assigned to one of three groups: the educational multimedia intervention "An Adventure at the Hospital" (experimental group); an entertainment video game intervention (comparison group); and a control group (no intervention). We hypothesized that children who played the educational multimedia application, compared to children in both the comparison and the control groups, would report lower level of preoperative worries about surgery (H1); high positive emotions, i.e., high positive affect (H2) and less subjective arousal (H3); and display reduced physiological indicators of arousal, i.e. lower heart rate (H4) and lower blood pressure (H5).

According to the literature, parents also experience significant distress and anxiety from their children's illness, fears and distress, especially during the preoperative period (Kain et al., 2007). Some studies have indicated that parental anxiety can mediate children's preoperative fears and distress (Kain et al., 2000). An increase in parental anxiety has been shown to be positively related with their child's anxiety levels and fears during medical procedures (e.g. Kain et al., 2003; Wright et al., 2007), which may be a consequence of a contagious interaction (Jay, Ozolins, Elliott & Caldwell, 1983). Several studies have documented this relationship between child and parental anxiety (Fincher, Shaw & Ramelet, 2012). In addition, preoperative educational programs concerning the hospital and medical procedures may reduce parental anxiety

(Watson & Visram, 2003), not only when preoperative information is provided directly to parents, but also through their child's preparation (Watson & Visram, 2003), given that parents could be indirectly involved in the activities through their child (Fincher et al., 2012). Thus, we also expected that parents in the Educational Multimedia Group would report less anxiety than those in the Control and in the Entertainment Video Game Group (H6).

In addition, research has suggested other factors that may affect the children's preoperative responses, including previous surgical experiences and individual factors, such as the child's age and their temperament (Kain, Mayes, O'Connor & Cichetti, 1996b). Therefore, we considered potential predictors of children's responses, such as the child's age, temperamental characteristics, previous hospitalization, and parental anxiety.

Method

Participants

Ninety children (69 males and 21 females), from 8 to 12 years of age ($M = 10.20$; $SD = 1.54$), who underwent a minor outpatient surgery composed the sample. Most common surgical procedures were circumcisions (45.5%), excisions (20 %) and herniorrhaphies (17.8%). Some children reported previous hospitalization (46.7%), which in some cases involved surgical experiences (37.8%). The inclusion criteria were as follows: children aged 8-12 years; scheduled for a minor ambulatory surgery; accompanied by a parent; and having parental consent to participate. Children were excluded if they were non-Portuguese speakers or had non-Portuguese speaking parents; had other underlying complicating conditions or a developmental delay. These exclusion criteria were important to guarantee that all participants had the necessary

skills to understand the questions and to report their responses in the scales that were provided.

Ninety parents (78 mothers and 12 fathers) composed the parental sample, with a mean education of the 9th grade and a mean age of 38.43 years ($SD=5.56$). Most parents were Portuguese (86%) but only some reported having previous experience with hospitalization (34.8%), outside of childbirth.

The main characteristics of the sample, from both children and parents, did not differ between the group conditions (all χ^2 tests with $p > .05$). Given that we collected the data in three different hospitals, we tested for potential differences between the hospitals on the outcome responses of the children and parents. Due to non-significant differences between hospitals on all responses ($ps > .10$), and to safeguard the confidentiality of the hospitals, we did not include this variable in further analysis.

Measures and materials

The Educational Multimedia Application: "An Adventure at the Hospital". From a previous pilot study which gathered information on common child beliefs, misconceptions and fears about surgery, we developed a multimedia application with the goal of preparing children for common outpatient surgeries. The sample of this pilot study was composed of 490 children from different schools in the Lisbon metropolitan area, aged 7-12 years ($M = 9.22$; $SD = 1.52$). In addition, several meetings were conducted with healthcare professionals to improve the content of the educational application. The multimedia application begins with the identification of child's gender (i.e. male or female) and ethnicity (i.e. Caucasian or African). There is also a brief introductory explanation and exercise on how to report emotions (i.e. children have to match the facial expressions of a game character with a correspondent word to guarantee that the child understands the task. After this initial section, the multimedia

application is divided into seven levels that illustrate hospital procedures and stages: 1) Hospital admission; 2) Healthcare staff and hospital rules; 3) Medical instruments; 4) Medical procedures; 5) Surgery room; 6) Recovery room; and 7) Aftercare and Going home. Each level (from admission to aftercare) begins with a brief video with children of the same age explaining a specific topic of the intervention, involving sensorial (e.g. the appearance of the operating room) and procedural information (e.g. rules regarding food and clothing). All levels were developed to include information about medical staff, medical instruments, clinical procedures, parental separation, induction of anaesthesia; as well as explanation of specific rules for the child to follow. The educational multimedia also included interactive game activities. These activities were always related to the topic of the previous modelling video and were used to guarantee that the information was understood by the child. At the end of each level, and after the interactive activity, children were asked to report their feelings by choosing the facial expression of the game character (sadness, happiness, anger, and fear). The application ran on a Tablet PC device and lasted 15 minutes. Note that due to a biased response pattern (i.e. children most frequently selected happiness) these results were not analysed.

Entertainment Video Games. An additional pilot study identified the three most popular video games in a sample of 17 children (10 boys; 7 girls), aged 8 and 10 years ($M = 8.82$; $SD = .64$). The most popular video games were Super Mario (Nintendo, 1988) (14.3%), Angry Birds (Rovio Entertainment, 2009) (12.2%) and FIFA/PES (EA Sports, 2011) (12.2%). According to the Pan European Game Information ratings (PEGI, 2003-2013), the content of all these video games are suitable for all persons, being recommended for children over the age of 3 years old. Thus, these games were

used in the Entertainment Video Game Group condition and each child could choose one of these video games to play.

Demographic and Clinical Data. The hospital nursing services and parents provided demographic (e.g. age, gender, educational level, ethnicity, nationality) and clinical (e.g. previous hospitalization, surgical and anaesthetic experiences) information about children and parents.

Preoperative Worries about Surgery. Children filled out the Child Surgery Worries Questionnaire self-reporting measure (CSWQ; Quiles et al., 1999), which was used to evaluate their level of preoperative worry. The CSWQ is composed of 23 items that measure the following three dimensions of preoperative worries: hospitalization, medical procedures, and illness and its negative consequences. Children were asked to indicate the level of worry regarding each statement, using a five-point Likert scale response with a thermometer scale format (ranging from 0 = *not at all worried* to 4 = *extremely worried*). Higher scores correspond to higher worries about the surgery. The original version showed good reliability (Cronbach's $\alpha = .88$) and construct validity (Quiles, et al., 1999). In the present study, all preoperative worry dimensions were highly correlated ($.73 < r < .76$, all $p < .001$) and the Cronbach's alpha was high, indicating a good internal consistency for overall worries ($\alpha = .95$), and for each dimensions (all $\alpha > .83$).

Emotional Responses. The Self-Assessment Manikin (SAM; Bradley & Lang, 1994) was used to evaluate children's feelings of arousal and valence (i.e. pleasant/unpleasant emotions). This scale is composed of five graphic figures (manikins) in each dimension: valence (from a totally unhappy to a very happy manikin) and arousal (from a totally calm to a highly aroused manikin). Children were asked to indicate how happy or sad (valence dimension) and how aroused or calm

(arousal dimension) they were feeling at the moment in each of the five-point scale figures. SAM has provided good convergent validity with other measures of emotions (e.g. Bradley & Lang, 1994).

Physiological Measures. We used the Omron R3 pulse monitor device to collect information about heart rate and blood pressure. Heart rate was expressed as beats per minute (bpm). Blood pressure was calculated using the Mean Arterial Pressure formula ($MAP = (2 \times \text{diastolic}) + \text{systolic} / 3$) (Rosdahl & Kowalski, 2008).

Parental Anxiety. We used the State-Trait Anxiety Inventory–Form Y (STAI-Y; Santos & Silva, 1997; Spielberger, 1984) to evaluate parental preoperative anxiety state. STAI-Y is composed of two subscales that measure trait and state anxiety, each containing 20 items; however in the present study, we only measured state anxiety. Parents were asked to indicate, on a 4-point scale (from 1 = *not at all* to 4 = *very much*), the way they were feeling while filling out the questionnaire. An average score was computed, with higher scores indicating higher state anxiety. Previous Portuguese studies have shown good reliability and validity of the STAI-Y (Santos & Silva, 1997). In this study, the coefficient alpha was .93, indicating a very high internal reliability.

Child's Temperament. We gave the child's parent the EAS Temperament Survey for Children: Parental Ratings (EAS-P; Buss & Plomin, 1984) to assess the child's temperament. The EAS-P consists of 20 questions divided into four temperamental dimensions: emotionality, activity, sociability and shyness (each dimension has five questions). Parental responses can be expressed using a five-point Likert scale format (from 1 = *not characteristic* to 5 = *very characteristic*). Several studies support the reliability and validity of the EAS-P questionnaire (e.g. Boer & Westenberg, 1994). In the present study, the Cronbach's alphas were acceptable (.82 for emotionality; .79 for

activity; and .70 for shyness) except for sociability ($\alpha = .49$). Therefore, sociability was not analysed in the present study.

Procedures.

We collected data from January 2012 to February 2013 in different hospitals located in the Lisbon metropolitan area after receiving approval from each Hospital Ethics Board. The hospitals' healthcare professionals were also briefed beforehand about all the details of the present study. On the day of surgery, the parents were asked to give their informed consent. They were told that the research's main purpose was to investigate the children's preoperative responses related to surgery and hospitalization. All participants were guaranteed complete confidentiality and anonymity. Children also gave their consent, and all agreed to participate. Participants were randomly assigned to one of the three conditions: the educational multimedia group in which children played the multimedia application "An Adventure at the Hospital" (experimental condition; $n = 30$); the entertainment video game group in which children played popular retail video games (comparison condition; $n = 30$); and the control group (no intervention; $n = 30$). The Research Randomizer tool (<http://www.randomizer.org/form.htm>) performed the random assignment. All participants underwent the same research protocol at the hospital. The sequence of scales and questionnaires was identical for all groups. Parents were allowed to remain with their children in the ambulatory waiting room until their child went to the operating room. However, it was previously established that in the case of having children submitted to surgery on a same day, at the same hospital, and in the same preoperative ward room, their group condition would be the same. This procedure occurred with a maximum of 15 participants (16.67%). This decision was always taken before any contact between the researcher and the children and was based on ethical concerns, because children might feel deprecated if they would have found,

after the intervention, or during the postoperative period, that another child received a different treatment. This procedure occurred for all groups (Experimental, $n = 4$; Comparison, $n = 7$; Control, $n = 4$), thereby reducing a potential selection threat.

Before the experimental intervention, we obtained demographic and clinical information related to the child and parents. We used the SAM scales to evaluate the children's subjective emotional (arousal and valence) responses, while we used the Omron monitor to measure their physiological responses (blood pressure and heart rate). Subjective emotional and physiological responses were measured twice: before and after the experimental interventions: SAM was applied first, followed by the use of the Omron monitor to collect blood pressure and heart rate. Children's worries, using the CSWQ, were only evaluated after the experimental intervention. At the same time, parents were asked to report their own state anxiety and to evaluate their child's temperament by completing STAI-Y and EAS-P questionnaires, respectively (see Figure 1). After the experimental manipulation, the children underwent surgery, and their parents were debriefed regarding the specific aims of our project. All questionnaires and materials were applied in a quiet room (i.e. single room or ward) with children already in bed.

Results

Means and standard deviations of all dependent variables are listed in Table 1. Table 2 presents the Pearson linear correlations between all the main variables.

Children's preoperative worries about surgery as a function of group condition

To examine the effects of the intervention on children's worries about surgery, a multivariate analysis of variance (MANOVA) was performed, with worries about hospitalization; medical procedures; and illness and its negative consequences, as dependent variables. A MANOVA was chosen because it reduces Type I errors

compared with single analyses of variance (ANOVAs). The MANOVA results have shown a significant effect of group condition on the overall level of preoperative worries about surgery, $F(2, 87) = 39.082, p < .001, \eta_p^2 = .47$ (Wilks' $\lambda = .50, F(6, 170) = 11.732, p < .001, \eta_p^2 = .29$). Analyses of the univariate effects also indicated significant effects of group condition on each worry dimension ($ps < .001$):

$F_{\text{hospitalization}}(2, 87) = 19.305, \eta_p^2 = .31$; $F_{\text{medical procedures}}(2, 87) = 35.791, \eta_p^2 = .45$;
 $F_{\text{illness/consequences}}(2, 87) = 30.535, \eta_p^2 = .41$. In line with the first hypothesis (H1), the post hoc pairwise comparisons (LSD) revealed that children in the educational multimedia group reported significantly lower mean level of worries about hospitalization, medical procedures, illness and negative consequences, than those in the control and in the comparison groups ($ps < .001$). In addition, we also found that children in the comparison group (the entertainment video games condition) reported lower mean level of worries about illness and negative consequences compared to those in the control condition ($p = .024$). No significant differences were found between the comparison and the control groups on worries about hospitalization ($p = .297$) and medical procedures ($p = .083$). Because both parental anxiety and child temperamental activity were significantly correlated to the child level of worries about surgery, we performed an additional multivariate analysis of covariance (MANCOVA) using these two variables as covariates. The results also support H1: children in the educational multimedia group expressed significantly lower level of worries compared to children in both the comparison and control groups, $F(2, 85) = 37.177, p < .001, \eta_p^2 = .47$. The effect of group condition also remained significant in all three worry dimensions (all $p < .001$). However, the significant difference between the comparison and the control group on worries about illness and negative consequences did not hold after controlling for parental anxiety and child temperamental activity. In fact, no significant differences

were found between these two groups when these two covariates were included in the analysis.

Children's emotional states as a function of group conditions

Two independent factorial ANOVAs 3 (group condition) \times 2 (evaluation phase: pre-intervention vs. post-intervention) were conducted on the children's emotional states (valence and arousal). The choice for conducting two ANOVAs instead of a single MANOVA was based on the Circumplex Model of Emotions (Russell, 1980) and research indicating that these two emotional dimensions are independent. The main effect of phase was found for both valence, Wilks' $\lambda = .77$, $F(1, 87) = 25.669$, $p < .001$, $\eta_p^2 = .23$, and arousal, Wilks' $\lambda = .68$, $F(1, 87) = 40.776$, $p < .001$, $\eta_p^2 = .32$ for arousal. As can be seen in Table 1, there was an increase of positive affect and a decrease of arousal from pre-intervention ($M_{\text{valence}} = 4.07$; $SD_{\text{valence}} = .79$; $M_{\text{arousal}} = 2.37$; $SD_{\text{arousal}} = 1.00$) to post-intervention ($M_{\text{valence}} = 4.44$; $SD_{\text{valence}} = .69$; $M_{\text{arousal}} = 1.89$; $SD_{\text{arousal}} = .80$). In other words, children reported more positive emotional states (i.e. felt happier and calmer) on the second evaluative moment, regardless of the group condition. It is also important to note that in all groups, the majority of children reported positive emotional states in both phases. More specifically, the majority reported feelings of happiness (77.8% during pre-intervention; 88.9% post-intervention). In a similar way, the majority (86.7%) reported feeling low arousal (58.9%) or neutral states (27.8%) in the pre-intervention phase; a percentage that increase in the post-intervention phase (82.2% felt low arousal and 13.3% a neutral emotional state). However, our data did not support our second (H2) and third hypotheses (H3), given that the effect of group condition on both mean levels of valence and arousal were not statistically significant, $F_{\text{valence}}(2, 87) = .435$, $p = .649$, $\eta_p^2 = .01$ and $F_{\text{arousal}}(2, 87) = 2.186$, $p = .119$, $\eta_p^2 = .05$.

Children's physiological responses as a function of group condition

We used two independent one-way ANOVAs, with a 3 (group condition) x 2 (evaluation phase) design to measure the effects of the intervention on children's physiological responses (blood pressure and heart rate). Similar to the results for self-reported affective states, there was no effect of group condition on both physiological responses, $F_{\text{blood pressure}}(2, 87) = .301, p = .741, \eta_p^2 = .01$; $F_{\text{heart rate}}(2, 87) = 2.203, p = .117, \eta_p^2 = .05$. These results did not support the fourth (H4) and fifth hypotheses (H5) that predicted lower physiological indicators of arousal in children exposed to the multimedia application compared to children in the comparison and the control groups. There was, however, a significant effect of the evaluation phase on blood pressure, Wilks' $\lambda = .94, F(1, 87) = 5.146, p = .03, \eta_p^2 = .06$, indicating a decrease in blood pressure levels from the pre-intervention ($M = 78.54; SD = 11.54$) to the post-intervention ($M = 76.11; SD = 10.34$) across all three groups (see Table 1).

Parental state of anxiety as a function of group condition

An ANOVA test regarding parental anxiety as a function of group condition showed a significant effect of group condition, $F(2, 87) = 3.518, p = .034, \eta_p^2 = .08$ (see Table 1). These results were partially in line with our sixth hypothesis (H6) given that post hoc pairwise comparisons (LSD) revealed that parental anxiety was lower in the educational multimedia group ($M = 1.89; SD = .54$) compared to the control group ($M = 2.19; SD = .60$) ($p = .033$). However, the differences between the educational multimedia and the entertainment video game ($M = 1.85; SD = .50$) groups on parental anxiety was non-significant ($p = .805$).

Predictors of children's worries about surgery

Given that the children's reported levels of worry about surgery between the control and comparison groups were not statistically different, we decided to combine them into one single category. Therefore, the group condition was recoded into a

dichotomous variable (multimedia application group = 1; groups with no information about surgery = 0). The Pearson correlations between the potential predictors and the criterion variables have also shown that only children's preoperative worries were significantly correlated ($p < .05$) with the potential predictors evaluated in this study (see Table 2). Because all preoperative worry dimensions were highly correlated ($.73 < r < .76$, all $p < .001$) and the overall worry scale presented high internal reliability, we decided to conduct a multiple linear regression analysis (MLR) (stepwise approach) to identify which predictors were most effective in explaining the children's preoperative global worries. Results suggested that the most important predictor of global worries was the use of the Educational Multimedia Application, $\beta = -.670$, $t = -8.463$, $p < .001$; the second predictor was the children's activity levels (temperamental disposition), $\beta = -.231$, $t = -3.042$, $p = .003$. These two predictors explained 49 % of the variance in children's preoperative worries about surgery and hospitalization.

Discussion

Surgery and hospitalization are potentially traumatic experiences that can negatively affect a child's development and well-being (Schmitz, Piccoli, & Viera, 2003). To minimize some of these negative effects, we developed an interactive educational multimedia application, entitled "An Adventure at the Hospital". The present study aimed to test the efficacy of this interactive multimedia application on children's preoperative emotions and worries about hospitalization and surgery. In addition, we measured the effects on parental state anxiety. The findings support our predictions in relation to the efficacy of the educational multimedia application on cognitive responses; that is, children who used this educational tool reported less worries about the surgery in all preoperative worry dimensions, in contrast with children in the comparison and control groups. These results support our first hypothesis (H1)

and are in line with research that have shown the importance of providing information about hospital procedures to children in paediatric health care.

In terms of emotional (i.e. arousal and valence) and physiological (i.e. heart rate and blood pressure) responses, the results did not support our hypotheses, since we discovered no differences between group conditions for all responses. Thus, it seems that the educational multimedia application affects positively the cognitive level but does not affect the child emotionally. One possible explanation for the inconsistent results found between the cognitive (worries) and the emotional responses might be related to the fact that our multimedia application was developed to focus on a cognitive level, providing information on the surgical process in a straight forward manner to demystify inappropriate worries. Another possible explanation for this inconsistency could be due to the instrument that we used to measure self-reported emotions (i.e. the SAM), which may not have been enough discriminatory power. In addition, only one item was used to measure each emotional dimension (valence and arousal), which contrasts with the CSWQ that was used to assess the level of worries (23 items with a high reliability). To disentangle these inconsistent results we suggest, for future studies, the use of other instruments to assess self-reported emotions, with the inclusion of more items and affective dimensions. It is also important to note that children reported high positive affect and lower arousal after all group conditions. In addition, the decrease in self-reported arousal is consistent with the decrease on blood pressure. Overall, these results suggest that the majority of children felt better emotionally after the brief period in which the intervention took place. It would be interesting to understand if the presence of a healthcare professional (e.g. psychologist) with the child, during the preoperative period, might be important to produce positive effects on children undergoing surgery. It is also relevant to note that a previous study (Fernandes &

Arriaga, 2010) has demonstrated that hospital clown's intervention had a positive effect on both preoperative emotional and worry responses. This result is interesting given that hospital clown's intervention is more focused on increasing positive emotions and on distracting children, but does not involve the educational component our multimedia application does. Thus, both types of intervention seem to be important and complementary. However, empirical research comparing educational multimedia interventions with clown doctors or other less costly approaches, such as single brochures, board games or videos, is lacking. Nevertheless, our application was developed to be available full-time at the hospitals and an online resource for any child that might be interested in receiving information about common surgery procedures. This application was also cost-efficient. The inclusion of modelling videos and simple graphics in games or in multimedia applications developed for health purposes may save time, costs, and resources (Peng & Liu, 2008).

Another goal of the study was to analyse the extent to which parental anxiety would be reduced if the parent saw their child entertained by the multimedia application. We found, as expected, that parents in the experimental group reported a lower state of anxiety than parents in the control group. However, parents in both experimental and comparison groups reported similar levels of anxiety that were lower than in the control group. Several studies have shown that paediatric surgery can have negative impacts on parents, who may feel guilt and responsible for putting their child in a threatening situation (LeRoy et al., 2003). Our results thus suggest that parents might have felt calmer and less anxious when watching their own child distracted or entertained by an activity (e.g., playing with an educational activity or with a video game), and apparently feeling happy and not anxious. This is in line with previous studies conducted in paediatric settings and suggests that a potential

emotional contagion may occur between the child and the parental emotional states (Kain et al., 1996a).

It is also important to highlight that playing with the multimedia application was the strongest predictor of reduced worries about surgery. However, a child's high activity (temperament) was also a significant predictor of lower preoperative worries. The relationship between low temperamental activity and high anxiety has been previously reported (Laredo et al, 2007), but to our knowledge no previous studies have reported their role in preoperative worries. Because temperamental activity refers to the level of a child's energy and speed of action, including their preference for active games, it is possible that high activity could be related to being more engaged in activities such as those used in our study. However, because we did not measure engagement, this hypothesis could not be tested. Further studies should explore how activity relates to engagement and motivation with interactive activities, which in turn may contribute to reduce the levels of the child's worries and anxiety.

An important methodological strength of the present study was the assignment of participants to three distinct groups (experimental, comparison and control), attempting to address one of the limitations often mentioned in the literature, which is that most studies about video game interventions only use a control group with no intervention for comparison (Peng & Liu, 2008). The use of the entertainment video game group, allowed us to test whether the effect on children and parental responses occurred because of the specific information on hospitalization and surgery included in the educational application or whether the effects occurred because children were distracted and entertained with an interactive activity. The current study also tried to increase the internal validity of the research by taking into account several variables that may affect the children's responses, such as the age, the temperamental characteristics,

and the previous number of hospitalization of the child, as well as parental anxiety. We found that the multimedia application positively affected the levels of child's preoperative worries even after controlling for parental anxiety and child's activity.

Although this research was carefully prepared, we are still aware of some limitations and shortcomings. First, in both pilot and experimental studies, the samples were limited to children from the Lisbon and Vale do Tejo region, and were not randomly chosen from these regions. However, the pilot study ran in both public and private schools; and the experimental study ran in three hospitals (one private and two public hospitals). In both studies, our samples were also composed of children from different ethnicities and socioeconomic strata, which increased the generalizability of our findings. Second, some methodological issues related to the way we assign participants to groups must be clarified. Although we initially predefined a complete randomization of participants to conditions, in one particular circumstance - when children scheduled for surgery shared the same preoperative ward room - we chose in advance to assign participants to the same condition. This decision was based on ethical issues, to guarantee that these children would not feel excluded or deprecated if they talked about the study with their roommates after the study was completed. It is also important to emphasize that we also controlled for the diffusion threats to internal validity, by assuring that each child did not know any of the procedures that occurred to the other children. The experiment was always conducted individually and took place in different time periods. A third important limitation is that preoperative worries were only assessed after the experimental manipulation. We considered that it could be inappropriate to ask children to respond twice to the same long questionnaire in such a short time. However, it would be relevant, in future studies, to use a pre-post intervention design for all measurements, by assessing the child's worries some days

before the surgery. Fourth, we should consider that physiological responses were not evaluated with continuous devices of blood pressure and heart rate because we wanted to interfere as little as possible in this already stressful situation. However, a continuous assessment of the physiological responses reported in this study is warranted. Finally, the present study does not provide an understanding about which of the multimedia application's components may have contributed more to the final outcomes (i.e. modelling videos; mini game activities; "prizes" given at the end of each level). It would be important to identify the specific features that contributed most to the success of the application, in order to inform developers about the effective components that should be included in future multimedia applications designed for health purposes (Arriaga, Esteves, & Fernandes, 2013; Peng & Liu, 2008).

In summary, preoperative preparation, when properly developed and implemented, can have positive effects in children and their parents (Jaaniste et al., 2007), which may allow healthcare staff to interact with more prepared and well-informed patients. Preparation tools can be more effective, less costly and readily available, without requiring excessive time or resources (Horne et al, 1994) to implement or develop, since it has been considered one of the most effective interventions for children at the operational development stage (LeRoy et al., 2003). Ideally, the preoperative preparation should be implemented in all hospitals and available to patients of all ages. This study provided further support about the relevance of preoperative programs on both children's worry responses and parental state anxiety.

The educational multimedia "An adventure at the Hospital" represents a step beyond previously available preoperative educational programs in hospital settings. The use of explicit modelling videos allows teaching of specific procedures, rules and proper behavioural skills to children about to undergo surgery. Playing video games demands

extensive and interactive involvement of players, and is an effective channel for providing learning experiences and improving health-related behaviours, in an entertaining and engaging format (Baranowski, Buday, Thompson, & Baranowski, 2008; Peng & Liu, 2008). We believe the present study's findings provide evidence about the importance and effectiveness of preparing children for surgery using educational and interactive multimedia applications. Intervention programs which deliver adequate and realistic information on hospital rules and medical procedures may be especially relevant for children who are highly worried about the hospitalization and surgery. Our findings also suggest that preoperative programs may also be very important in reducing parental anxiety, because parents may perceive their child to be less worried and entertained.

Extensive research is needed on interactive technology, in particular to understand the power of these interventions in health promotion and behavioural changes; they have clear and promising potential in the healthcare field. Thus, new interactive multimedia interventions should be developed to prepare children for other surgical and medical procedures.

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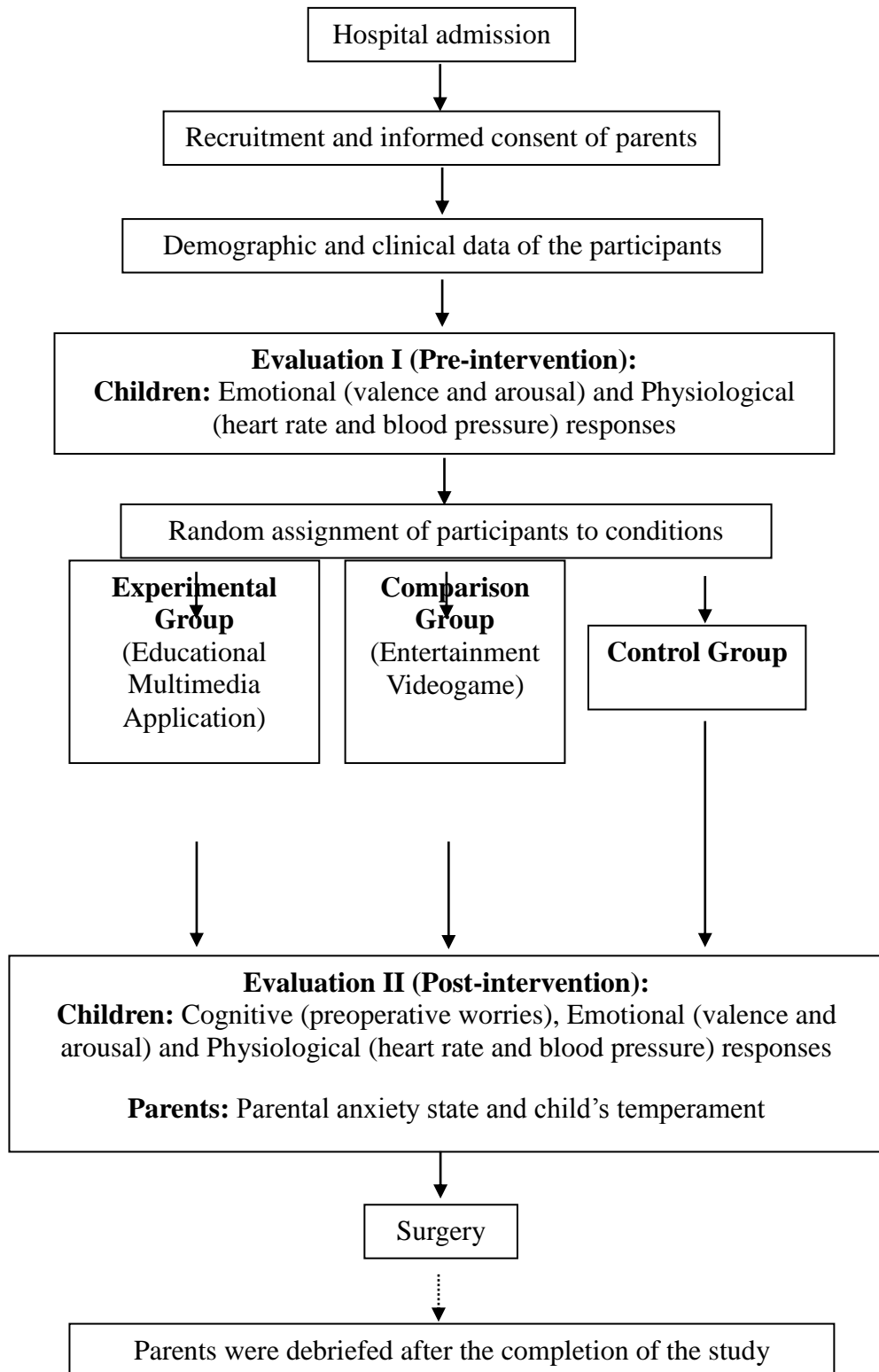


Figure 1. Study procedures

Table 1.

Means and standard deviations of children cognitive (worries), emotional (affective valence and arousal) and physiological (blood pressure and heart rate) responses, as a function of group condition

	Total Sample (n=90)		Group						<i>F</i> _{Group}	<i>F</i> _{Phase}
			Experimental Group (n=30)		Comparison Group (n=30)		Control Group (n=30)			
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Preoperative Worries (0-4)										
Global	1.31	.90	.46	.18	1.56	.73	1.91	.86	39.08****	–
Hospitalization	1.01	.84	.37	.29	1.24	.81	1.43	.86	19.31***	–
M. Procedures	1.49	1.13	.44	.33	1.82	.92	2.21	1.09	35.80****	–
Illness	1.43	.99	.58	.36	1.63	.83	2.08	.97	30.54****	–
Valence (1-5)										
Pre	4.07	.79	4.17	.75	4.00	.91	4.03	.72	.44	25.67***
Post	4.44	.69	4.47	.63	4.57	.68	4.30	.75		
Δ (Valence)	.38	.71	.30	.65	.57	.94	.27	.45	1.62	–
Arousal (1-5)										
Pre	2.37	1.00	2.17	.99	2.57	1.01	2.37	1.00	2.19	40.78***
Post	1.89	.80	1.60	.62	2.07	.83	2.00	.87		
Δ (Arousal)	-.48	.71	-.57	.63	-.50	.86	-.37	.62	.62	–
MAP										
Pre	78.54	11.54	78.46	11.25	79.98	11.64	77.19	11.95	.30	5.15*
Post	76.11	10.34	75.01	10.88	76.94	10.33	76.39	10.04		
Δ (MAP)	-2.43	10.10	-3.44	10.72	-3.03	9.79	-.80	9.91	.59	–
Heart rate (bpm)										
Pre	80.58	15.67	76.63	10.68	81.73	16.71	83.37	18.29	2.20	.211
Post	80.26	14.48	75.17	9.90	82.80	13.90	82.80	17.66		
Δ (Heart rate)	-.32	6.67	-1.47	6.33	1.07	7.47	-.57	6.11	1.12	–
Parental anxiety (0-4)										
	1.98	.56	1.89	.54	1.85	.50	2.19	.60	3.52*	–

Note. *****p* < .001; **p* < .05; Δ= post-intervention *minus* pre-intervention; MAP (Mean Arterial Pressure) = (2 x diastolic) + systolic / 3.

Table 2.

Zero-order correlations between the predictors and the dependent variables.

	Cognitive responses (Worries)			Affective responses			Physiological responses		
	Global	Hospitalization	Medical Procedures	Illness	Δ Valence	Δ Arousal	Δ MAP	Δ Heart rate (bpm)	Parental anxiety
Group condition	-.67***	-.55***	-.66***	-.61***	-.08	-.09	-.07	-.12	.11
Child's age	-.12	-.05	-.16	-.11	.11	-.01	-.09	.05	-.02
Child's gender	.10	.11	.09	.07	.08	-.04	.14	.122	.26*
Child's scholarity	-.07	-.07	-.07	-.06	.07	.03	-.05	-.02	-.08
Parental education	.02	-.04	.10	-.03	-.17	.11	-.13	.06	-.14
Prev. hospitalization	.17	.17	.13	.18	-.03	-.16	.01	.20	-.04
Prev. surgeries	.11	.09	.10	.13	.07	-.22*	.00	.14	-.07
Parental anxiety	.26*	.26*	.27**	.17	-.15	-.05	.11	.04	-
Shyness	-.06	.24*	.18	.14	.04	-.16	.14	-	-.01
Emotionality	.20	.25*	.23*	.27*	-.02	.03	.18	-.03	.28**
Activity	-.28**	-.44***	-.15	-.21*	.05	-.04	-.11	-.04	.24*

Note. * $p < .05$; ** $p < .01$; *** $p < .001$; Group condition (experimental = 1; comparison and control = 0); Δ= post-intervention minus pre-intervention; MAP (Mean Arterial Pressure) = (2 x diastolic) + systolic / 3; Higher values indicate high worries, shyness, emotionality, activity, sociability, parental state anxiety, more hospitalizations and surgeries, older age and more scholarity/education level.