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ORIGINAL ARTICLE

Effectiveness and feasibility of using the computerized interactive virtual space in reducing depressive symptoms of Hong Kong Chinese children hospitalized with cancer

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Abstract

Purpose. To examine the effectiveness and feasibility of using the computerized interactive virtual space in reducing depressive symptoms of children hospitalized with cancer.

Design and Methods. A nonequivalent control group design was employed. Children (8–16 years of age; n = 122) admitted to a pediatric oncology ward during a 14-month period were recruited.

Results. The results support the effectiveness and feasibility of using the computerized interactive virtual space in reducing depressive symptoms of children hospitalized with cancer.

Practice Implications. The results heighten the awareness in nurses of the importance of integrating play activities as an essential component of holistic and quality nursing care.

The diagnosis and treatment of childhood cancer have been described as an extremely stressful and threatening experience in the life of a child (Hicks & Lavender, 2001; Penkman, Scott-Lane, & Pelletier, 2006). Although survival rates are higher than ever as a result of new technology and breakthroughs in cancer treatment, the course of treatment for cancer continues to be a very stressful experience in the life of a child (Stam, Grootenhuis, Caron, & Last, 2006). Treatment of cancer incorporates chemotherapy, surgery, radiotherapy, and bone marrow transplantation, alone or in combination, all of which may severely affect children's physical and mental well-being (Dowling, Hockenberry, & Gregory, 2003; Enskar & von Essen, 2008).

As increasing numbers of children are being cured of the physiological aspects of cancer, there is a growing awareness of the importance of their emotional and psychosocial well-being. Nevertheless, most research in childhood cancer has traditionally concentrated on medical issues and has disregarded the importance of the emotional and psychosocial well-being of children with cancer (Penkman et al., 2006). Furthermore, most studies of childhood cancer conducted in Hong Kong have focused on examining the experience, psychological well-being, and quality of life of family members or caregivers (Wills, 2009; Wong & Chan, 2006; Yin & Twinn, 2004). Some studies, conducted in Western countries (Hedström, Haglund, Skolin, & Essen, 2003; Penkman et al., 2006) have attempted to investigate the experience of cancer from children's own perspectives.

LITERATURE REVIEW

A review of the literature reveals that so far very few studies have attempted to investigate the experience of cancer from children's own perspectives in the Hong Kong Chinese context (Li, Chung, & Chiu, 2010). In a recent study examining the impact of cancer on Hong Kong Chinese children's physical,

emotional, and psychosocial well-being (Li, Chung, & Chiu, 2010), results revealed that nearly all children hospitalized with cancer expressed different degrees of sadness and worry. The issues most frequently talked about by children in the interviews were confinement and feelings of estrangement. Moreover, the findings indicated that children reported relatively high state anxiety scores on admission for cancer treatment, and more than half of the participants were potentially at risk of depression, or at least presented some depressive symptoms during their stay in hospital. Although it cannot be assumed that there is a high risk of depression for children with cancer from this cross-sectional study, previous studies conducted in Western countries added further evidence that children hospitalized with cancer are at a high risk of depression (Cavusoglu, 2001; Dejong & Fombonne, 2006; Matziou, Perdikaris, Galanis, Dousis, & Tzoumakas, 2008). The psychological impacts of cancer on children could be accounted for by the painful medical procedures and hospitalizations since these are anxiety-provoking events to children (Li, Chung, & Chiu, 2010).

Over the past few decades, numerous research studies in children's health care have focused on different interventions in promoting psychological health for children hospitalized with cancer (Dowling et al., 2003; Hicks & Lavender, 2001; Penkman et al., 2006). Among all nursing interventions, the provision of information on physiological care in cancer treatment is the most common nursing practice in pediatric oncology units in Hong Kong. Yet, the psychological needs of children hospitalized with cancer have seldom been taken into consideration. Indeed, helping children ease the psychological burden of cancer treatment is recognized as one of the most vital responsibilities of a nurse (Chien et al., 2003). There is an imperative need for nurses to develop and evaluate appropriate psychological nursing interventions that can minimize children's emotional distress during the course of treatment in hospital. Specifically, it is crucial for nurses to find ways to help children resume normal development and make their cancer journeys less difficult.

During the past few decades, there has been an increase in the use of play activities to help children cope with the stress of invasive medical procedures and hospitalization. In a randomized controlled trial to examine the effectiveness of a therapeutic play intervention on the outcomes of children undergoing day surgery (Li & Lopez, 2008), the results showed that children reported lower state anxiety scores and exhibited fewer instances of negative emotional behaviors in pre- and postoperative periods. Implementing play activities for children with cancer during their hospitalizations has particular advantages since serious illness and its accompanying stress and physical restriction interrupt natural play and socialization, which is essential for children's normal growth and development. However, owing to low body resistance and susceptibility to infection, most children have relatively few opportunities to engage in leisure activities. The lack of opportunity to play often leads to the development of dependent behavioral patterns, learned helplessness, and depression (Weiss, Bialik, & Kizony, 2003). Therefore, implementing play activities for children with cancer during their hospitalizations can provide more opportunity for children to engage in leisure activities. Greater involvement in leisure activities can improve children's coping skills, decrease their stress, and eventually link to better psychosocial adjustment to their illness and hospitalization. Regrettably, the majority of previous literature on play activities for hospitalized children is in the form of case studies based on theories and clinical observations. There is a lack of empirical evidence in the existing literature to determine accurately the clinical effectiveness of play interventions, in particular, using play activities to ease the psychological burden of children hospitalized with cancer. Moreover, it is unclear whether it is feasible and appropriate to implement play activities for children hospitalized with cancer in the Hong Kong Chinese context. Although a previous study has demonstrated the appropriateness of using play activities as preoperative preparation of Hong Kong children for minor day surgery (Li & Lopez, 2008), most Chinese parents view play as less important for hospitalized children with serious illness than physiological care or medical treatment (Li, Chung, & Chiu, 2010). A review of the literature revealed that the philosophy of Confucianism exerts a great impact on the Chinese society (Chan, Cheung, Mok, Cheung, & Tong, 2006), and the concept of fatalism is the central theme of this philosophical framework. People being influenced by this philosophy tend to have stronger belief in their fate. They are more likely to regard the event as unchangeable and more likely to believe that not much can be done in the situation, especially a life-threatening situation. Therefore, it is understandable that people who have a Chinese cultural background tend to believe that cancer is unpreventable (Li, 2009). Since there

are differences in cultural context between the Western and the Chinese societies, Chinese children may interpret illness with having a different meaning and nature. Subsequently, their responses to illness and psychosocial intervention may differ as well.

Given these issues, the purpose of this study was to examine the effectiveness of using play activities (the computerized interactive virtual space) in reducing depressive symptoms in Hong Kong Chinese children hospitalized with cancer. Specifically, the focus was on whether it would be appropriate and feasible to implement the computerized interactive virtual space in Hong Kong clinical settings.

THEORETICAL FRAMEWORK

The theoretical framework underpinning this study was derived from the theory of cognitive appraisal, stress, and coping (Lazarus & Folkman, 1984), which deals with how people cope with stress. According to this theory, ways of coping can be categorized into problem-focused and emotion-focused coping. Problem-focused coping is a coping style that focuses on controlling the current stressful situation. People who employ this type of coping style may try to control the situation by modifying, avoiding, or reducing the influences of a stressor. Conversely, emotion-focused coping is a coping style that aims to manage one's emotions relating to the stressor. Although people can adopt either coping style in response to a stressful event, they are more likely to adopt an emotion-focused coping strategy when the stressful situation cannot be easily resolved.

The rationale for using the computerized interactive virtual space

Previous study has shown that the computerized interactive virtual space can provide positive and enjoyable leisure experiences during physical interaction with different game-like virtual environments and can potentially lead to increased self-esteem and a sense of self-empowerment for children in clinical settings with physical and intellectual disabilities (Weiss et al., 2003). Greater flexibility is allowed in using computerized interactive virtual space when compared to traditional play. Children can select appropriate games in the virtual space according to their physical and mental abilities, type of disease, and therapeutic goals. Movement is unrestricted; children can sit or stand when playing in the virtual environment. It is also a real opportunity to provide children with a break from the rigors of hospitalization and treatment as well as providing them a sense of control over their illness and allowing them to have fun at the same time. Additionally, the computerized interactive virtual space provides a platform where children with illnesses that render them unable to perform leisure activities in "real-life" settings may be able to engage in them virtually.

The effectiveness of using the computerized interactive virtual space as an intervention tool in rehabilitation has been previously documented (Kizony, Katz, & Weiss, 2003; Schultheis & Rizzo, 2001). There is also some evidence that multisensory interactive experiences are an effective method of creating distraction and reducing children's anxiety (Steele et al., 2003).

METHODS

Design

The study was carried out in one of the largest acute-care hospitals in Hong Kong with a well-established pediatric oncology unit. To examine the effectiveness of the computerized interactive virtual space in reducing depressive symptoms of children hospitalized with cancer, a nonequivalent control group pretest–posttest, between-subject design was employed.

The study was divided into two phases. In phase one, all participants admitted to the oncology unit received usual care (the control group). After finishing data collection for the control group, we allowed a 1-month washout period before starting data collection in phase two. All participants in phase two received usual care plus play activities using the computerized interactive virtual space (the experimental group).

Participants

Children admitted for treatment with any type and stage of cancer were invited to participate in the study. The inclusion criteria were as follows: children should be between 8 and 16 years of age, able to speak Cantonese and read Chinese, and diagnosed with cancer at least 6 months previously. Children with cognitive or learning problems identified during health assessment by nurses and doctors on admission were excluded from the study. In addition, patients would be assessed by named nurses

and physicians for physical fitness before having play activities in the playroom.

The data collection lasted for 14 months (control group: from October 2008 to March 2009; experimental group: from April to November 2009). There was an outbreak of human swine influenza (H1N1) in Hong Kong at the time of data collection in phase two. According to the Hong Kong hospital authority's policy, all nonmedical-related activities, including play activities for children, were suspended during this period; therefore, a total of 122 children were recruited; 70 were recruited for the control group and only 52 were recruited for the experimental group before the suspension of nonmedical-related activities. The response and attrition rates in the control group were 96% and 2%, respectively, while those in the experimental group were 83% and 15%, respectively.

The Center for Epidemiologic Studies Depression Scale for Children (CES-DC)

Children's depressive symptoms were assessed by using the CES-DC. The tool was derived from the Center for Epidemiologic Studies Depression Scale for Adults (CES-D) developed by Radloff (1977). The CES-D was then modified to become more child-friendly by Weissman, Orvaschel, and Padian (1980). The CES-DC comprises 20 fully standardized items to evaluate depressive symptoms. The items consist of short and simple statements in the first person about the emotional-, cognitive-, and behavior-related components of depression. All items are evaluated on a 4-point Likert scale in relation to their incidence during the last week and are scored from 0 to 3 (0 = *not at all*, 1 = *a little*, 2 = *some*, 3 = *a lot*), with total possible scores ranging from 0 to 60, with higher scores indicating greater symptomatology. A score of 16 or greater indicates an individual demonstrating some depressive symptoms (Radloff, 1977). The psychometric properties of the CES-DC have been empirically tested (Barkmann, Erhart, Schulte-Markwort, & the BELLA Study Group, 2008) showing adequate internal consistency reliability, good concurrent validity, and excellent construct validity. The results of confirmatory factor analysis showed that there are four factors underlying the CES-DC, which is congruent with hypothesized configuration of the factor structure of the CES-D proposed by Radloff (1977). The four-factor version of the CES-DC is considered to have good factorial validity and stability across age (Barkmann et al., 2008).

The CES-DC was translated into Chinese following the technique described by Bracken and Barona (1991). First, the items were translated from English to Chinese by a translator. After that, another translator, without the knowledge of the original English version, translated the items from Chinese back to the English version. The researcher compared the retranslated English version and the original English version for conceptual meaning. Ambiguities and discrepancies existing between the two versions were resolved through discussions with the back-translator until agreements were reached.

The psychometric properties have been empirically tested (Li, Chung, & Ho, 2010) showing adequate internal consistency reliability, good concurrent validity, and excellent construct validity.

Interventions

In the control group, children and their parents received routine information from a nurse on physiological care in cancer treatment, such as attention to side effects and other complications of cancer treatment, oral hygiene, and nutritional dietary intake.

In the experimental group, besides receiving usual care, children received 30 min of play activities using virtual reality computer games daily (5 days a week). The content of play activities included using the computerized interactive virtual space created by computer hardware and software, which presented children with opportunities to engage in environments that appeared and felt similar to real-life objects and events. Only the shadows of moving arms were needed to enter projections of exciting, interactive play spaces—from flying over a city and creating trance-like waves, ripples, and colors to playing football, volleyball, or billiards. Examples of virtual reality computer games are given in Figure 1.

To produce an interactive virtual space for children to play, a PlayMotion!® (Leovation Ltd., North Point, Hong Kong; http://www.playmotion.com/) system was installed in a playroom of the pediatric oncology ward. This system is a device that transforms ordinary walls, floors, and ceilings into wildly interactive virtual playgrounds. It combines the flexibility of video projectors, computer vision algorithms, and the real-time special effects systems of videogames. PlayMotion!® requires no goggles, gloves, helmets, or markers, making it an immediate, totally intuitive, and completely natural experience. Moreover, the play area simply consists of light and shadows on a white wall, which is easy to clean and maintain and is safe for

Figure 1 Examples of Virtual Reality Computer Games. (A) Enter a Mysterious Underwater World Where Children Can Interact With and Manipulate Living Jellyfish With Just the Touch of a Hand. (B). Play, as Rainbows of Ever-Changing Color Radiate From Children's Moving Bodies.

play. There are hundreds of options, and some activities were more energy-consuming than others. Primarily, the intervener could, in accordance with the children's sex, age, ability, type of disease, and general condition, select suitable games for them to play. Additionally, the intervener would encourage the patients to choose games within the selected game pool according to their own preference.

The play activity was conducted by a research nurse. Unlike in Western countries, nurses in Hong Kong are the professionals responsible for providing psychosocial interventions to hospitalized children, such as play activities. The play activity was implemented in small groups with a maximum of four children in one group in a play room of the oncology unit. Previous studies (Cooper & Blitz, 1985; LeVieux-Anglin & Sawyer, 1993) pointed out that school-age children are more peer-oriented, and they can benefit from group teaching and learning. Moreover, playing in a group offers children an opportunity to interact with their peers and creates a nonthreatening atmosphere for children to express their concern and fear. To ensure children with cancer would be able to engage in the computerized interactive virtual space, the time of implementation was flexible and repeated sessions were carried out during daytime. Participants were invited to join the play activities when they were not occupied by any medical treatments or physiological care. The intervention was designed to be terminated if participants complained about tiredness. Before commencing the study, the research nurse received training provided by the PlayMotion!® company on how to implement the intervention. The training consisted of two sessions, and each session lasted for 1 hr.

Data collection

Study approval was obtained from the institutional review board of The University of Hong Kong/Hospital Authority Hong Kong West Cluster. Before commencing the study, permission from the pediatric oncology unit was obtained.

The unit heads of the pediatric oncology unit were fully informed about the study's purpose, nature, design, and duration. Written consent was obtained from the parents after they were told about the purposes of the study. Children were also invited to put their names on a special individual assent form. Both children and their parents were told that they were under no obligation to participate and could withdraw from the study with impunity at anytime and were assured of the confidentiality.

Children and their parents were recruited for the study at the time of admission to the oncology unit. The demographic data (Table 1) and baseline depressive symptoms of children were assessed after the consent was obtained from their parents. The depressive symptoms of children were reassessed 7 days after admission.

To ensure that the data collection was objective and impartial, a single-blind method was employed in this study. The intervention and data collection were carried out by two different nurses.

Table 1. Demographic Data and the Baseline Depressive Symptoms of Children in the Experimental and Control Groups

	Experimental ($n = 52$) Mean (*SD*)	Control ($n = 70$) Mean (*SD*)	*p*-value[a]
Age of children (years)	11.61 (2.12)	12.10 (2.30)	.74 ns
Children's depressive symptoms scores	22.31, 6.18	22.11, 5.62	.92 ns
	Frequency (%)	**Frequency (%)**	**χ^{2a}**
Gender of children			
Male	28 (53.85)	37 (52.86)	.98 ns
Female	24 (46.15)	33 (47.14)	
Education attainment (parents)			
Primary	5 (9.62)	6 (8.57)	.98 ns
Lower secondary	16 (30.76)	22 (31.43)	
Upper secondary	25 (48.08)	34 (48.57)	
Tertiary	6 (11.54)	8 (11.43)	
Medical diagnosis			
Leukemia	21 (40.38)	29 (41.43)	.74 ns
Lymphoma	13 (25.00)	17 (24.28)	
Brain tumor	3 (5.77)	2 (2.86)	
Germ-cell tumor	9 (17.31)	14 (20.00)	
Osteosarcomas	6 (11.54)	8 (11.43)	

Note: [a]Group comparisons *t*-test for continuous variables and χ^2 for nominal and categorical variables. ns, not significant at $p > .05$.

Data analysis

The Statistical Package for Social Sciences (SPSS) software, version 16.5 for Windows (SPSS Inc., Chicago, IL, USA), was used for data analysis. The homogeneity of the experimental and control groups were assessed by using inferential statistics (independent *t*-test and χ^2). The mixed between-within subjects ANOVA (split-plot analysis of variance [SPANOVA]) was used to determine whether using computerized interactive virtual space was more effective in reducing depressive symptoms of children hospitalized with cancer than that of solely providing routine nursing care.

RESULTS

The results of inferential statistics showed that the experimental and control groups were similar with respect to the age and gender of children, educational attainment of parents, medical diagnosis of children, and baseline depressive symptom scores for children, suggesting a homogeneity of variance between these two groups. The mean and standard deviation of the depressive symptom scores in children across the two time periods is shown in Table 2. Approximately 61% and 68% of the participants scored above the cut-off score of 16 on admission and on day 7, respectively, indicating that they presented some depressive symptoms. The results of SPANOVA are shown in Table 3. Results indicated that there was a statistically significant main effect for time, suggesting a change in the reporting of depressive symptoms by children in both groups across the two time periods. There was also a statistically significant interaction effect, indicating the changes in reporting of depressive symptoms by children over time depended on the types of intervention used. Additionally, there was a statically significant main effect for intervention, $F(1, 120) = 6.04$, $p = .02$, partial eta squared = .06, suggesting that children in the experimental group reported fewer depressive symptoms than children in the control group on day 7. Using the commonly used guidelines proposed by Cohen (1992), the partial eta squared (.06) indicates that the effect size for the intervention (the computerized interactive virtual space) was moderate.

Table 2. The Mean Depressive Symptom Scores in Children Across Two Time Periods ($n = 122$)

	Experimental Mean (*SD*)	Control Mean (*SD*)	Total Mean (*SD*)
Depression symptom scores on admission	22.31 (6.18)	22.11 (5.62)	22.20 (5.82)
Depression symptom scores on day 7	20.60 (5.87)	25.97 (6.32)	23.68 (6.15)

Table 3. The Results of SPANOVA on Depressive Symptom Scores in Children Across Two Time Periods ($n = 122$)

	Depressive symptom scores			
	F-value	*p*-value	Eta squared	Observed power
Main effect for time	17.18	.00	.13	.94
Main effect for intervention	97.2	.00	.49	.98
Main interaction effect	6.04	.02	.06	.81

DISCUSSION

Effect of the computerized interactive virtual space on depressive symptom scores of children

The results showed that most children presented some depressive symptoms during their stay in the hospital. The findings concurred with the results of a previous local study (Li, Chung, & Ho, 2010) showing that the course of cancer treatment has a tremendous impact on children. The results were also consistent with studies conducted in Western countries (Dejong & Fombonne, 2006; Matziou et al., 2008) adding further evidence that children with cancer are at high risk of depression.

The findings suggest that there was a change in the reporting of depressive symptoms by children in both groups across the different time periods. However, changes over the different times were dissimilar between the experimental and control groups. Following the admission to a pediatric oncology unit, the mean depressive symptom scores among children in the control group increased, as measured on day 7. Because hospitalization and painful medical procedures are anxiety-provoking events and can be emotionally devastating for children (Li, Chung, & Ho, 2010), common emotional responses like worry, fear, and uncertainty are likely to be meticulously reported after admission to hospital. This probably explains why children in the control group reported more depressive symptoms on day 7 than on admission. Nevertheless, in contrast to the control group, children receiving play activities, using the computerized interactive virtual space, reported significantly fewer depressive symptoms than children in the control group. This concurred with the results of a previous study where implementation of play activities was found to be effective in helping children cope with the stress of hospitalization (Li & Lopez, 2008). Apart from the rationale for using the computerized interactive virtual space that we discussed above, there is another possible factor that sheds light on the findings of this study. Under the influence of the philosophical concepts of Confucianism, most Chinese children believe that life-threatening diseases such as cancer cannot be prevented. Lazarus and Folkman (1984) postulated that emotion-focused coping is the more common form used when nothing can be done to change the situation. Because the computerized interactive virtual space includes components of emotion-focused interventions that attempt to regulate emotional distress by relaxation and distraction, this may possibly explain why children in the experimental group reported fewer depressive symptoms than those children in the control group who received only an information intervention (problem-focused).

The feasibility of using the computerized interactive virtual space in reducing depressive symptoms in children hospitalized with cancer

As the PlayMotion!® system is user-friendly and easy to operate, it is expected that the virtual reality computer games implemented in this study could be quickly learned by nurses and would take little effort if used regularly. It thus seems feasible and appropriate to implement such games in clinical settings where children are hospitalized with cancer.

The overall results provide some evidence that the computerized interactive virtual space is effective and feasible in reducing depressive symptoms in children hospitalized with cancer. However, it is crucial to establish whether this innovation is acceptable to children and parents. The results of the study showed that the response rate was comparatively low but with a higher attrition rate in the experimental group. There are some factors that shed light on these issues. First, some children refused to participate in the play activities after receiving chemotherapy. Indeed, fatigue after chemotherapy has been one of the most common physical concerns reported by child cancer patients that prevented them from joining any energy-consuming activities (Whitsett, Gudmundsdottir, Davies, McCarthy, & Friedman, 2008). A child in the present study postulated that, "I felt powerlessness after chemotherapy. I even found difficulty in getting out of my bed." Second, there are some misconceptions about play interventions among parents. Some parents showed reluctance to let their children join the intervention as they thought that resting rather than playing was the most appropriate method for their recovery particularly during the acute phase of cancer treatment.

Moreover, for fear of their contracting infectious diseases, some parents did not encourage their children to engage in close social contact with other hospitalized children. In view of these concerns, it is advisable to allow those children who have received chemotherapy to have adequate rest for a day prior to introducing them to the computerized interactive virtual space. Moreover, parents should be informed about the prevention of cross-infection. Most importantly, parents should be made aware of the importance of play in promoting children's normal growth and development.

Study limitations

This study was limited in that all data were collected in one setting, which might limit the ability to generalize the result.

How Do I Apply This Evidence to Nursing Practice

The most important implications for nursing practice from this study relate to the determination of the clinical effectiveness of using the computerized interactive virtual space in reducing depressive symptoms in Hong Kong Chinese children hospitalized with cancer. In addition, this study demonstrated the feasibility of using the computerized interactive virtual space as psychological nursing interventions for children hospitalized with cancer. Most importantly, the findings of this study will heighten the awareness of the importance of integrating play activities as an essential component of holistic and quality nursing care to ease the psychological burden of cancer treatment.

The information from this study will promote awareness in nurses and parents that play is very important for the normal growth and development of children, and they need play even when they are ill.

It is possible that other children hospitalized with cancer may benefit from this intervention in ways similar to the results reported here. There are Chinese children living in many parts of the world other than China, Taiwan, Singapore, and Hong Kong. It may be beneficial for nurses in other parts of the world to implement the computerized interactive virtual space notwithstanding the differences in nursing practice. However, this study mainly focused on the Hong Kong Chinese population. It is recommended that further study be carried out in children hospitalized with cancer in different cultural settings.

Another limitation is that this study was not a randomized controlled trial. Although a randomized controlled trial is the most powerful approach to test a cause-and-effect relationship between independent and dependent variables, we could not randomize individual participants in this study. Randomization was not possible because there was a possibility of contamination between different treatment groups within the setting, and some children and their parents might have been concerned or disturbed by experiencing a different form of intervention. Therefore, a nonequivalent control group design was employed.

Notwithstanding some potential limitations, there was a considerable amount of positive feedback from children receiving virtual reality computer games in the study hospital. One of their comments was as follows:

> It was really boring to stay in bed all day long without anything to do. I never thought there would be some interactive computer games introduced to the ward. It occupied my time or at least let me forget any unhappy event ahead. I was so relaxed while I was playing.

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