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Case Report

Exploring the Effects of Doll Therapy on Cerebral Blood Flow in Young Adult Women: A Preliminary Study

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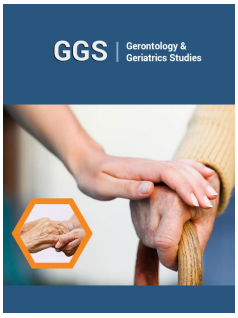

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Abstract

Doll therapy is a non-pharmacological approach aimed at enhancing emotional well-being in individuals with dementia. This study involved 20 young women without prior childcare experience who interacted with a baby doll. Using functional near-infrared spectroscopy, changes in cerebral blood flow in the prefrontal cortex were measured during different conditions. The results showed that hugging a baby doll with emotional expressions led to a significant decrease in oxyhemoglobin concentration in the left prefrontal cortex, indicating reduced emotional arousal. This suggests that doll therapy may have a relaxing or emotion-regulating effect, potentially beneficial for individuals with dementia. Notably, the emotional expression of the doll played a crucial role in eliciting this response. While the study had limitations, including a small sample size, these findings highlight the potential therapeutic implications of doll therapy, particularly when involving emotionally engaging stimuli.

Keywords: Doll therapy; Cerebral blood flow; Prefrontal cortex; Emotional well-being; Dementia

Abbreviations: DT: Doll Therapy; CBF: Cerebral Blood Flow; PFC: Prefrontal Cortex; oxy-Hb: oxyhemoglobin; NCGG: National Center for Geriatrics and Gerontology; EG1: Experimental Group 1, participants who hugged the baby doll for 3 minutes; EG2: Experimental Group 2, participants who hugged the baby doll exhibiting emotional expressions, such as crying or laughing, for 3 minutes; CG: Control Group, participants who sat for 3 minutes.

Introduction

Doll Therapy (DT) is a non-pharmacological approach aimed at fostering feelings of attachment, companionship, and purpose in people with dementia, enhancing their well-being, and reducing the appearance of challenging behaviors [1,2]. Several studies [3-6] demonstrated that DT significantly improved mood while decreasing depression and apathy among people with dementia. Martin-Garcia et al. [7] reported in their systematic review that DT not only ameliorates the emotional state of those with dementia but also diminishes disruptive behaviors and enhances communication. However, no certain view has been obtained on whether Cerebral Blood Flow (CBF) is improved or decreased during DT.

Previous studies have indicated that evaluating changes in CBF, particularly in the prefrontal cortex (PFC), can be an effective measure of emotional state alteration [8]. PFC plays a critical role in the generation and regulation of emotion [9]. Therefore, this study aims to examine changes in CBF during DT in young adult women who have not yet exhibited organic brain changes.

Methods

This study involved 20 healthy, right-handed young women (mean age±standard deviation, 25.4±4.3 years) with no prior childcare experience. Exclusion criteria included any organic brain disorders and a Self-rating Depression Scale (SDS) score of≥50/80. The study was approved by the Medical Ethics Committee of the National Center for Geriatrics and Gerontology (NCGG, No. 1081). A customized version of Smibi a baby robot was utilized and its dimensions are as follows: 440mm in height, 200mm in width 190mm in depth and 1.2kg in weight [10]. It has a soft, human-like face made of silicone resin and is clothed in acrylic bore fabric [10].

CBF changes in the PFC were measured using functional near-infrared spectroscopy (FOIRE-3000; Shimadzu Corp., Kyoto, Japan). Participants were subjected to three conditions: hugging the baby doll for 3 minutes (Experimental group 1; EG1), hugging the baby doll exhibiting emotional expression such as crying or laughing for 3 minutes (Experimental group 2; EG2), and sitting for 3 minutes (Control Group; CG). Emotional expression of the doll in EG2 included 45% positive (laughing, babbling and singing), 36% neutral (blinking, sneezing, and coughing) and 19% (crying) reactions, featuring sounds sampled from infants approximately one year old.

The primary outcome measured was the mean oxyhemoglobin (oxy-Hb) concentration in the left PFC during the three conditions. Mean oxy-Hb concentrations were compared among the conditions using Tukey-type multiple comparisons. Statistical analysis was performed using SPSS Statistics (version 24 for Mac; IBM, Chicago, IL, USA) with a significance level set at P<0.01.

Results

The mean oxy-Hb concentration in EG2 was significantly lower compared to both EG1 and CG (p<0.01) (Table 1 and Figure 1). No significant difference was observed in the mean oxy-Hb concentration between EG1 and CG (Table 1 and Figure 1).

Table 1: Multiple comparisons of mean values of oxyhemoglobin concentrations per group (N=20) Mean oxy-Hb concentrations were compared among the conditions using Tukey-type multiple comparisons.

EG1: Experimental Group 1, participants who hugged the baby doll for 3 minutes; EG2: Experimental Group 2, participants who hugged the baby doll exhibiting emotional expressions, such as crying or laughing, for 3 minutes; CG: Control Group, participants who sat for 3 minutes.

Comparison Conditions	q-Value	P-Value	95% Confidence Interval			
			Mean Difference	Interval Width	Upper Limit	Lower Limit
EG1 vs CG	0.899	0.805	0.003	0.01	-0.007	0.0123
EG2 vs CG	4.454	0.008	-0.013	0.01	-0.023	-0.003
EG1 vs EG2	5.343	0.001	-0.015	0.01	-0.025	-0.005

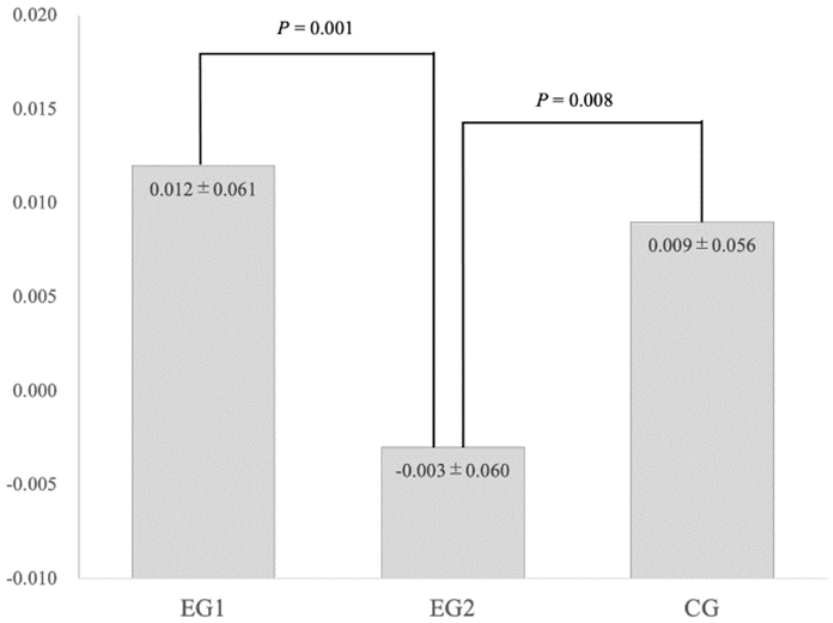

Figure 1: Multiple comparisons of mean values of oxyhemoglobin concentrations per group (N=20)
EG1: Experimental Group 1, participants who hugged the baby doll for 3 minutes; **EG2:** Experimental Group 2, participants who hugged the baby doll exhibiting emotional expressions, such as crying or laughing, for 3 minutes; **CG:** Control Group, participants who sat for 3 minutes.

Discussion

We observed a significant decrease in the mean oxy-Hb concentration in the left PFC during the DT session in which participants hugged the baby doll exhibiting emotional expression (EG2). This reduction in oxy-Hb concentration implies a potential decrease in emotional arousal during the DT session. This finding is in accordance with previous studies that have shown improvements in mood, as well as reductions in depressive symptoms and apathy among people with dementia undergoing DT [3-6].

The pivotal role of PFC in emotion generation and regulation [9] underscores the significance of our findings. The decrease in oxy-Hb concentration in the PFC during DT suggests a potential relaxation response or emotional regulation mechanism elicited by the interaction with the baby doll. This could be particularly relevant in the context of people with dementia, as it might offer a means to alleviate distress and anxiety, ultimately leading to an enhancement in their overall emotional state.

Furthermore, our results highlight the differential impact of two distinct DT conditions, EG1 and EG2. While both groups involved hugging a baby doll, it was notable that only EG2, where participants interacted with a baby doll exhibiting emotional expression such as crying or laughing, showed a significant reduction in oxy-Hb concentration. This contrast in outcomes between EG1 and EG2 suggests that the emotional expression of the doll played a critical role in eliciting a more pronounced emotional response.

Matsukawa et al. [11] found that pleasant stimuli significantly reduced oxy-Hb in the PFC, while negative and neutral stimuli elicited lesser or no significant effects. In our study, the emotional expressions of the baby doll in EG2, including laughter and crying, could be considered pleasant and emotionally engaging stimuli. Therefore, it is reasonable to infer that the observed decrease in oxy-Hb concentration in EG2 may be attributed to the pleasant and emotionally stimulating nature of the interaction with the doll. It is likely that the emotional expression of the doll, featuring sounds sampled from infants, played a crucial role in eliciting a more pronounced emotional response in this context.

However, this study had several limitations, including a small sample size and the recruitment of healthy young women without prior childcare experience as participants. Future research should investigate the broader physiological and biochemical effects of DT on participants. Specifically, the impact of DT on blood biochemistry may need to be assessed with relevance to changes in various analytes such as glucose, lipids, hormones and other measurements that are relevant to emotional well-being and dementia. Understanding how DT may influence not only emotional responses but also biochemical markers can offer a more comprehensive perspective on its potential therapeutic advantages. This approach has the potential to illuminate the mechanisms through which DT affects emotional well-being and symptoms related to dementia, paving the way for more targeted interventions and personalized treatment strategies. Furthermore, future studies should consider expanding the participant pool to include individuals with dementia, as their responses to DT might differ significantly from those of healthy young women. Additionally, it explores the long-term effects of DT and its sustainability in enhancing emotional well-being in people with dementia would be a valuable avenue for further investigation.

Conclusion

In conclusion, our study offers preliminary evidence that DT, particularly when involving a baby doll with emotional expression, might lead to a reduction in oxy-Hb concentration in the left PFC, indicating a potentially positive impact on emotional well-being. Further research is warranted to delve into the underlying mechanisms and potential applications of DT across various populations, including those with dementia.

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