CHAPTER VII

RESULTS

This chapter provides analyses of the findings relating to two main purposes of the present study: 1) to examine the impact of adjuvant chemotherapy on cognitive function, attention and working memory; and 2) to explore demographic and general health characteristics, physical and psychological symptoms, and cultural characteristics associated with deficits in attention and working memory. The data were obtained from 32 Korean women within four months following adjuvant chemotherapy and 32 Korean women as healthy controls within six months after negative screening mammography.

Sample Characteristics

Demographic Characteristics

The sample was composed of 64 Korean women including 32 chemotherapy-treated breast cancer survivors recruited from a cancer center in Korea (breast cancer group) and 32 women without breast cancer (healthy control group) as seen in Table 2. The overall mean age of the participants was 46 years (SD = 8), ranging from 31 to 61 years of age. The mean years of education were 12 years (SD = 2) and 33 women (52%) were high school graduates.

Participants lived with approximately three family members and 75% of all participants were married. Of 49 married women, 48 (98%) had at least one child and single women did not have any children. Seventy seven percent of participants had a son

and 66% of participants had a daughter. The average number of sons was one (SD = 1) and the mean number of daughters was also one (SD = 1).

Less than half of the total participants (41%) were employed outside of the home as full- or part-time workers. The annual household income was less than $22,000 (24,000,000 Korean won) for 19 participants (30%), between $22,000 and $ 33,000 (36,000,000 Korean won) for 20 participants (31%), and more than $33,000 in 25 participants (39%).

To determine whether there were differences in demographic characteristics between women treated with chemotherapy for breast cancer (breast cancer group) and women without breast cancer (healthy control group), the independent t-test and the Pearson Chi-square analyses were conducted. No significant differences were found in age ($t(62) = -0.37$, $p = 0.72$), years of education ($t(62) = -0.94$, $p = 0.35$), marital status (χ^2 (1, 64) = 0.78, $p = 0.38$), and child-related variables including having a son (χ^2 (1, 64) = 0.09, $p = 0.77$), having a daughter (χ^2 (1, 64) = 0.00, $p = 1.00$), the number of sons ($t(62) = -1.22$, $p = 0.23$), or the number of daughters ($t(62) = 0.67$, $p = 0.51$) between these two groups. Employment status was the only variable which was significantly different between the breast cancer and the healthy control groups (χ^2 (1, 64) = 12.70, $p < 0.001$). Specifically, the majority (81%) of women in the breast cancer group were not employed outside of the home, while more than 60% of women in the healthy control group were employed outside the home. No significant difference in the average annual income was found between the two groups, χ^2 (2, 64) = 2.63, $p = 0.27$, (see Table 2).

Table 2
Demographic Characteristics

	Total sample (N = 64)	Breast cancer group (n = 32)	Healthy control group (n = 32)
	M ± SD (Range)	M ± SD (Range)	M ± SD (Range)
Age (year)	46 ± 8 (31 – 61)	46 ± 8 (31 – 61)	46 ± 8 (31 – 59)
Education (year)	12 ± 3 (6 – 20)	12 ± 2 (6 – 16)	13 ± 3 (6 – 20)
Number of family members	3 ± 1 (0 – 6)	2 ± 1 (0 – 6)	3 ± 1 (0 – 6)
Number of sons	1 ± 1 (0 – 2)	1 ± 1 (0 – 2)	1 ± 1 (0 – 2)
Number of daughters	1 ± 1 (0 – 4)	1 ± 1 (0 – 4)	1 ± 1 (0 – 3)
	n (%)	n (%)	n (%)
Marital status			
Single[a]	15 (23)	6 (19)	9 (28)
Currently married	49 (77)	26 (81)	23 (72)
Having a son			
Yes	49 (77)	25 (78)	24 (75)
No	15 (23)	7 (22)	8 (25)
Having daughter			
Yes	42 (66)	21 (66)	21 (66)
No	22 (34)	11 (34)	11 (34)
Employment			
Employed outside home	26 (41)	6 (19)*	20 (62)
Unemployed	38 (59)	26 (81)	12 (38)
Annual household income			
Less than $22,000 (Less than 24,000,000 won)	19 (30)	8 (25)	11 (34)
$22,000 - $33,000 (24,000,000 won – 36,000,000 won)	20 (31)	13 (41)	7 (22)
More than $ 33,000 (More than 36,000,000 won)	25 (39)	11 (34)	14 (44)

[a] Including never married, divorced, widowed, and separated.
* $p < 0.001$.

General Health Characteristics

Table 3 presents general health characteristics of all participants. Thirty four (53%) of the participants were pre-menopausal and 21 (33%) were post-menopausal. Specifically, 53% of participants in both groups were pre-menopausal women while about 30% were in the post-menopausal state. The majority of participants (81%) did not have other medical problems. The same number of women (19%) in both the breast cancer and the healthy control groups had other medical problems. Those that had medical problems reported one or more diagnosed chronic diseases such as arthritis, diabetes, hepatitis, hypertension, or chronic pain due to intervertebral disc hernia.

To determine whether there were differences in general health characteristics between the breast cancer and the healthy control groups, the Pearson Chi-square analyses were conducted. Menopausal states and comorbidity were not significantly different between the two groups.

Table 3
General Health Characteristics

	Total sample (N = 64)	Breast cancer group (n = 32)	Healthy control group (n = 32)
	N (%)	n (%)	n (%)
Menopausal state			
Pre-menopause	34 (53)	17 (53)	17 (53)
Peri-menopause	9 (14)	4 (13)	5 (16)
Post-menopause	21 (33)	11 (34)	10 (31)
Comorbidity[a]			
Yes	12 (19)	6 (19)	6 (19)
No	52 (81)	26 (81)	26 (81)

[a] including arthritis, diabetes, hepatitis, hypertension, or chronic pain due to intervertebral disc hernia.

Breast Cancer-specific Characteristics

Descriptive information regarding breast cancer diagnosis and its treatment are presented in Table 4. All 32 participants in the breast cancer group were tested within approximately four months after completion of the last cycle of adjuvant chemotherapy (M ± SD: 70 ± 36 days). Most women were diagnosed with invasive ductural breast carcinoma within a year (M ± SD: 202 ± 49 days) and received approximately six cycles of chemotherapy within about four months ranging from 25 to 220 days. A majority (78%) of participants had mastectomy including simple or modified radical mastectomy. All breast cancer participants were newly diagnosed with localized breast cancer (Stage I to Stage IIIa) and treated with adjuvant chemotherapy involving intravenous administration of a combination of at least two cytotoxic agents such as cyclophosphamide (cytoxan, endoxan), doxorubicin (adriamycin) or epirubicin, 5-fluorouracil, and paclitaxel (genexol) or docetaxel (taxotere, monotaxel). Thirteen (41%) women were treated with the CEF regimen which consisted of the combination of cyclophosphamide, epirubicin, and 5- fluorouracil. Nineteen (59%) were treated with a non 5-fluorouracil based chemotherapeutic regimen. Specifically, 11 (34%) were treated with the ACT regimen, a combination of adriamycin, cyclophosphamide, and paclitaxel. Eight (25%) women were treated with AC (the combination of cyclophosphamide and adriamycin) or TC (the combination of cyclophosphamide and docetaxel). Five (16%) women were still receiving adjuvant radiation therapy and nine (28%) women were being treated with hormonal therapy. There was only one woman who was receiving both radiation and hormonal therapy after the completion of adjuvant chemotherapy.

Table 4
Breast Cancer-Specific Characteristics (N = 32)

	n (%)	M ± SD (Range)
Time since diagnosis (days)		205 ± 41 (96 – 269)
Time since the last cycle of adjuvant chemotherapy (days)		70 ± 36 (3 – 127)
Time interval of chemotherapy (days)		114 ± 39 (25 – 220)
Number of chemotherapy cycles received		6 ± 2 (3 – 9)
Type of cancer		
Invasive ductural carcinoma	30 (94)	
Invasive apocrine carcinoma	1 (3)	
Other type	1 (3)	
Stage of cancer		
I	10 (31)	
II	15 (47)	
IIIa	7 (22)	
Type of surgery		
Lumpectomy	7 (22)	
Mastectomy	25 (78)	
Chemotherapeutic regimen		
CEF	13 (41)	
ACT	11 (34)	
AC	3 (9)	
TC	5 (16)	
Radiation therapy		
Yes	5 (16)	
No	27 (84)	
Hormone therapy		
Yes	9 (28)	
No	23 (72)	

Note: CEF is a combination of cyclophosphamide, epirubicin, and 5- fluorouracil; ACT is a combination of adriamycin, cyclophosphamide, and paclitaxel; AC is a combination of cyclophosphamide and adriamycin; TC is a combination of cyclophosphamide and doxetaxel.

Summary

The sample includes 64 Korean women currently residing in South Korea. Specifically, 32 participants were diagnosed with early stage breast cancer and treated

with chemotherapy following lumpectomy or mastectomy for localized breast cancer. The other 32 participants consisted of non-cancer healthy women. Most participants were middle-aged, well-educated, and married. Participants in both groups lived with approximately 2 or 3 family members including their parents or children. The majority of women in the breast cancer group were unemployed, while more than half of women in the healthy group were employed outside of the home. The average annual income was similar between the breast cancer and the healthy control groups. More than 60% of all participants reported an annual income of more than $33,000. The majority of participants in two groups was pre-menopausal and did not have any chronic disease. No significant differences in demographic and general health characteristics were found between the two groups, except for the employment status.

Differences in Cognitive Function between Groups

Specific aim 1. To investigate the incidence and severity of deficits in attention and working memory in Korean women treated with adjuvant chemotherapy for early stage breast cancer

Cognitive function was defined as cognitive test performance and mean scores of a self-report measure. Specifically, cognitive test performance included 1) individual scores of digit span and COWA tests, 2) the total cognitive score, and 3) error rates and reaction time on the ANT. A self-report measure, the AFI, was also used to evaluate perceived effectiveness in attention and working memory.

Cognitive Performance between Groups

- *Research Question 1.1. Are there identifiable differences in the incidence and severity of deficits in cognitive performance between Korean women treated with chemotherapy for early stage breast cancer and women without breast cancer?*

Cognitive screening. The K-MMSE was used to screen for the presence of cognitive impairment. The total scores of the K-MMSE were not significantly different between the breast cancer and the healthy control groups. All participants had greater than 25, ranging from 26 to 30 indicating intact cognitive function.

Digit span test. Mean scores in the DSF were significantly different between the breast cancer group (M = 5.94, SD = 1.46) and the healthy control group (M = 6.81, SD = 1.55) as presented in Figure 3. Similarly, mean scores in the DSB differed significantly between these two groups (M = 4.03, SD =1.38, breast cancer group; M = 4.81, SD = 1.57, healthy control group). In both DSF and DSB performance, the breast cancer group showed significantly lower scores than the healthy control group. The effect sizes for the group comparisons were computed using the conventions articulated by Cohen (Cohen, 1988). Cohen's d estimates ranged from 0.53 to 0.58, indicating that the effect size was medium.

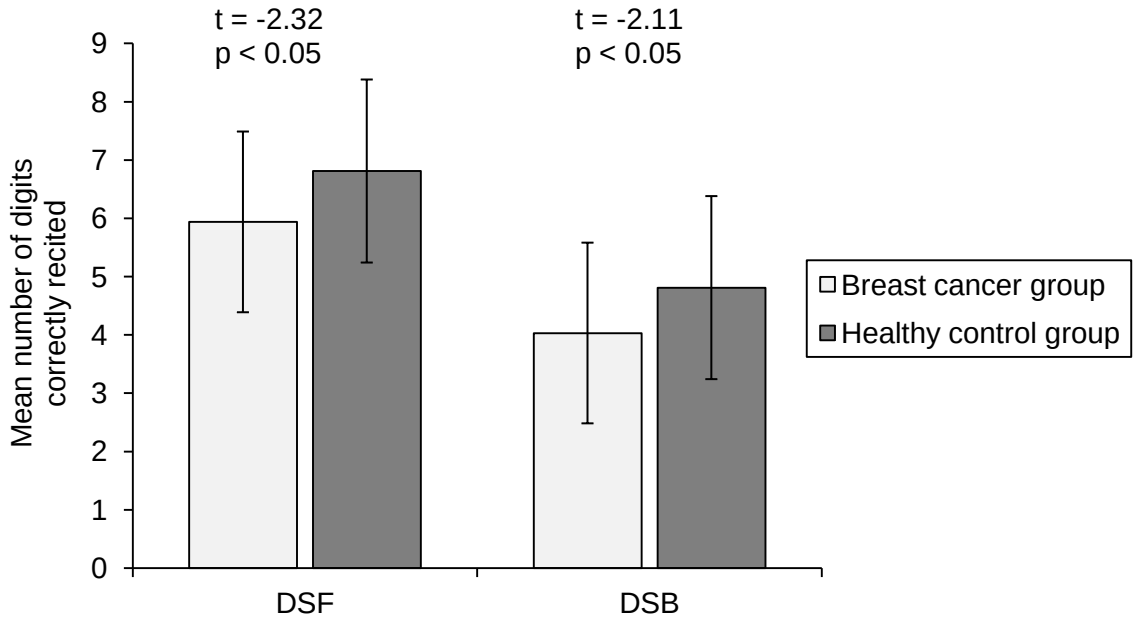


Figure 3. Mean and Standard Deviation on DSF and DSB Comparing Chemotherapy-treated Breast Cancer survivors (n = 32) and Women without Breast Cancer (n = 32)

Controlled Oral Word Association (COWA) test. The breast cancer group (M = 23.53, SD = 10.44) showed significantly lower scores on the COWA part A, letter fluency, as compared with the healthy control group (M = 33.81, SD = 13.13). Likewise, women in the breast cancer group performed significantly worse (M = 29.50, SD = 8.44) on the COWA part B, category fluency, relative to women in the healthy control group (M = 39.84, SD = 9.84), see Figure 4. Cohen's *d* estimates of effect sizes for these comparisons were 0.87 and 1.13, suggesting that the effect size was large (Cohen, 1988).

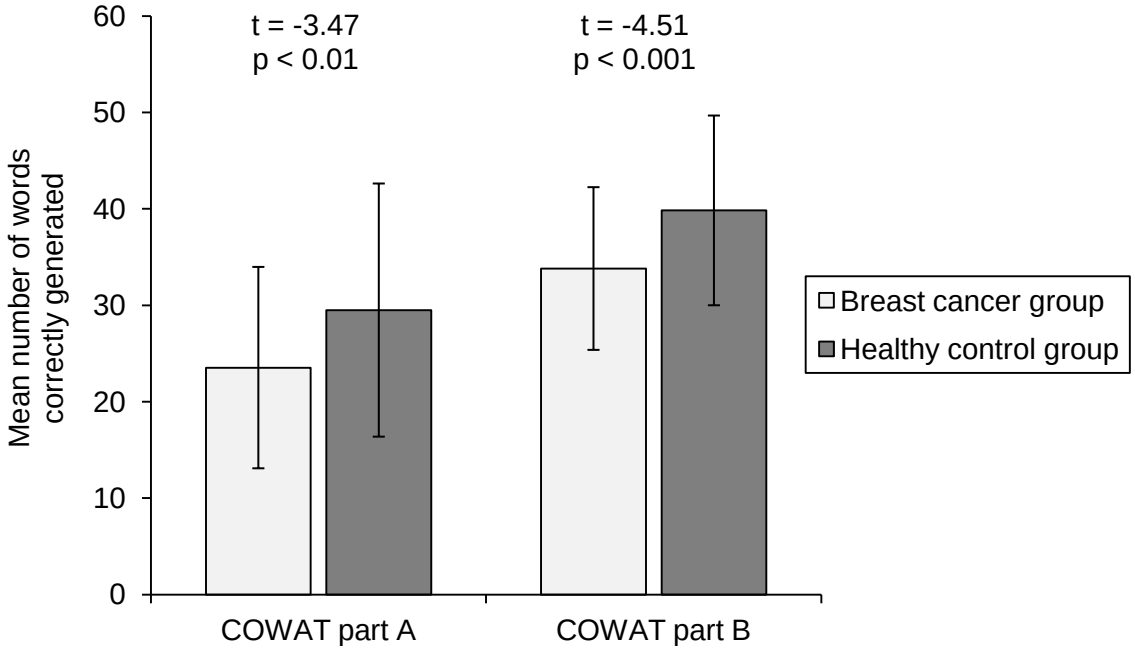


Figure 4. Mean and Standard Deviation on COWA Performance Comparing Chemotheapy-treated Breast Cancer Survivors (n = 32) and Women without Breast Cancer (n = 32)

Total cognitive score. A total cognitive score was computed as a sum score of standardized scores on the DSF, the DSB, the COWA part A, and the COWA part B. The total cognitive score was significantly different between chemotherapy-treated breast cancer participants (M = -2.50, SD = 4.32) and the healthy participants without breast cancer (M = 2.50, SD = 5.41) as presented in Figure 5. Cohen's d estimate was 1.02,

indicating that the effect size of the difference in the total cognitive score was large (Cohen, 1988).

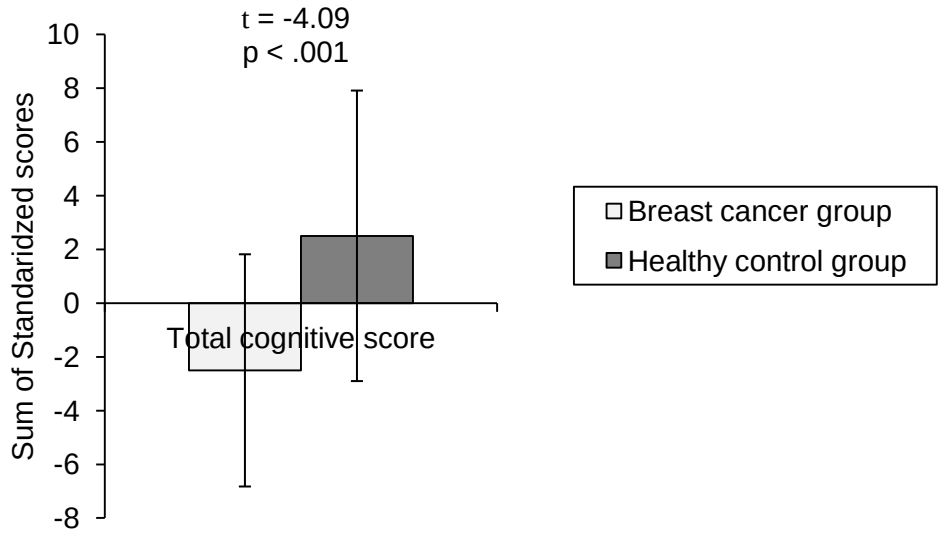


Figure 5. Mean and Standard Deviation for a Total Cognitive Score Comparing Chemotherapy-treated Breast Cancer Survivors (n = 32) and Women without Breast Cancer (n = 32)

Incidence of Deficits in Cognitive Test Performance

The incidence of cognitive deficits was compared between the two groups. In general there are two ways suggested for defining cognitive deficits: 1) using a standard deviation cut-off (e.g., 1.5 SD or 2.0 SD); and 2) a norm-referenced cut-off score (Lezak, 2004; Ruff et al., 1996; Tombaugh et al., 1999). Considering the distribution patterns of scores on the digit span and the COWA, the incidence of cognitive deficits was examined using norm-referenced cut-off scores for each single test.

Digit span performance. For DSF performance, a span of 5 was used to define "mild cognitive deficits" and a span of 4 was used as a cut-off score of "moderate deficits" (Lezak, 2004). As presented in Figure 6, mild deficits were found in 10 (31%) and moderate deficits were observed in four (13%) of women in the breast cancer group, as compared with four (13%) and two (6%) women in the healthy control group,

respectively. When combining mild and moderate levels of cognitive deficits, 14 (44%) of women in the breast cancer group and six (19%) women in the healthy control group were classified as having cognitive deficits. The incidence of cognitive deficits on DSF performance was significantly different between cancer and healthy groups (χ^2 (1, 64) = 4.66, $p < 0.05$).

For DSB performance, a span of 4 was used to define "mild deficits" and a span of 3 was used for "moderate deficits" as presented in Figure 7 (Lezak, 2004). Specifically, 11 (34%) and 13 (41%) women in the breast cancer group had mild to moderate cognitive deficits, respectively. In contrast, eight (25%) and seven (22%) in the healthy control group exhibited mild to moderate deficits. Again, when mild or moderate levels of cognitive deficits were combined, 24 (75%) of chemotherapy-treated breast cancer participants and 15 (47%) healthy participants without breast cancer had cognitive deficits. The incidence of cognitive deficits was significantly different between two groups (χ^2 (1, 64) = 5.32, $p < 0.05$). It is noteworthy that the groups differed significantly in respect to incidence and severity of deficits. More specifically, the breast cancer group exhibited more cognitive deficits than the healthy control group.

COWA performance. For COWA part A (letter fluency), a number of 28 words were used to define "mild deficits" and a number of 25 were used to indicate "moderate deficits" (Ruff et al., 1996). Two (6%) and 18 (56%) chemotherapy-treated breast cancer participants were classified with mild and moderate deficits respectively, as compared with four (12%) and nine (28%) of healthy participants without breast cancer (see Figure 8). The breast cancer group showed significantly higher incidence of moderate cognitive deficits than the healthy control group (χ^2 (1, 64) = 5.19, $p < 0.05$).

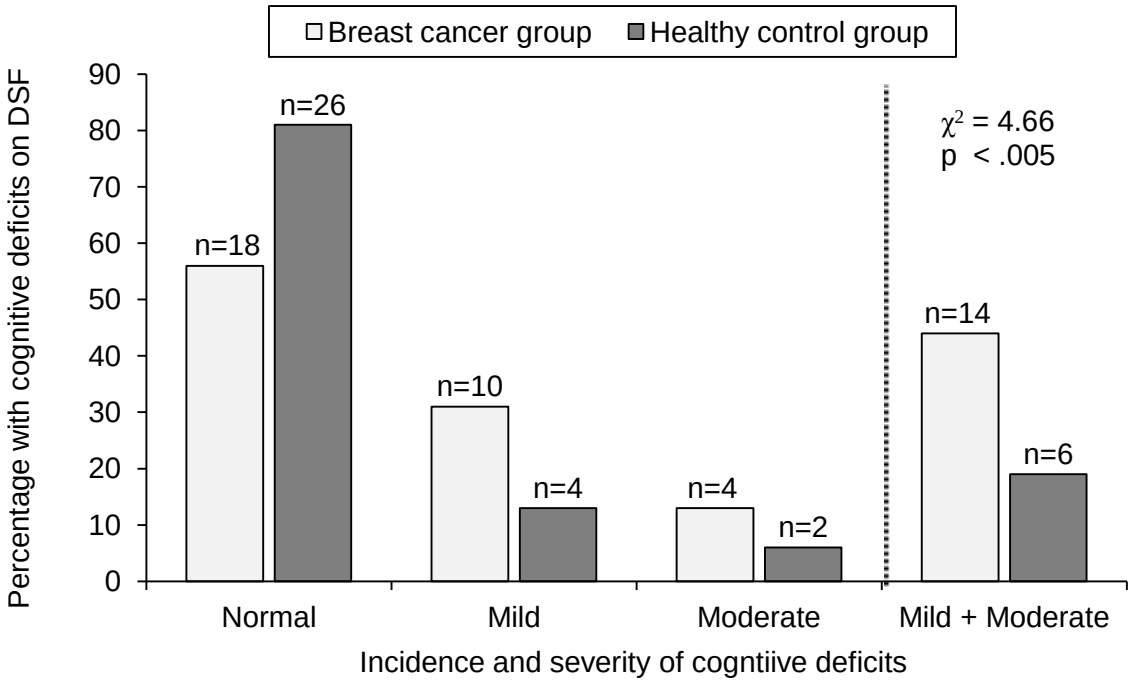


Figure 6. Incidence and Severity of Cognitive Deficits Related to DSF Performance. Mild deficits were defined by the cut-off score of 5 on the DSF; moderate deficits were defined by the cut-off score of 4.

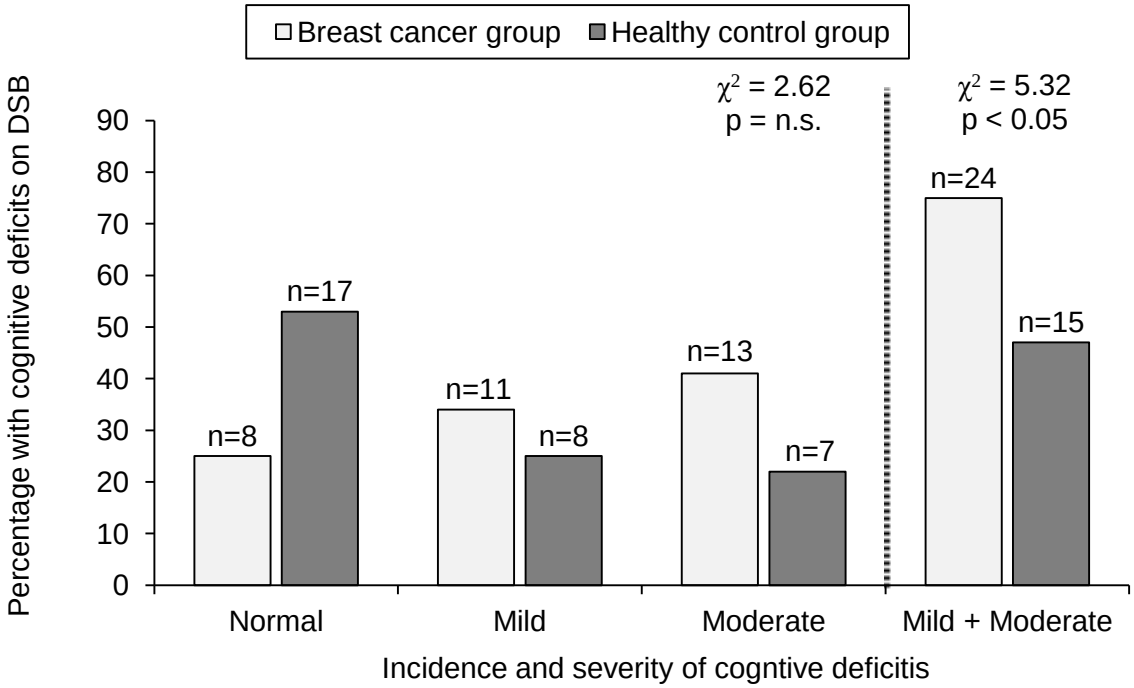


Figure 7. Incidence and Severity of Cognitive Deficits Related to DSB Performance. Mild deficits were defined by the cut-off score of 4 on the DSB; moderate deficits were defined by the cut-off score of 3.

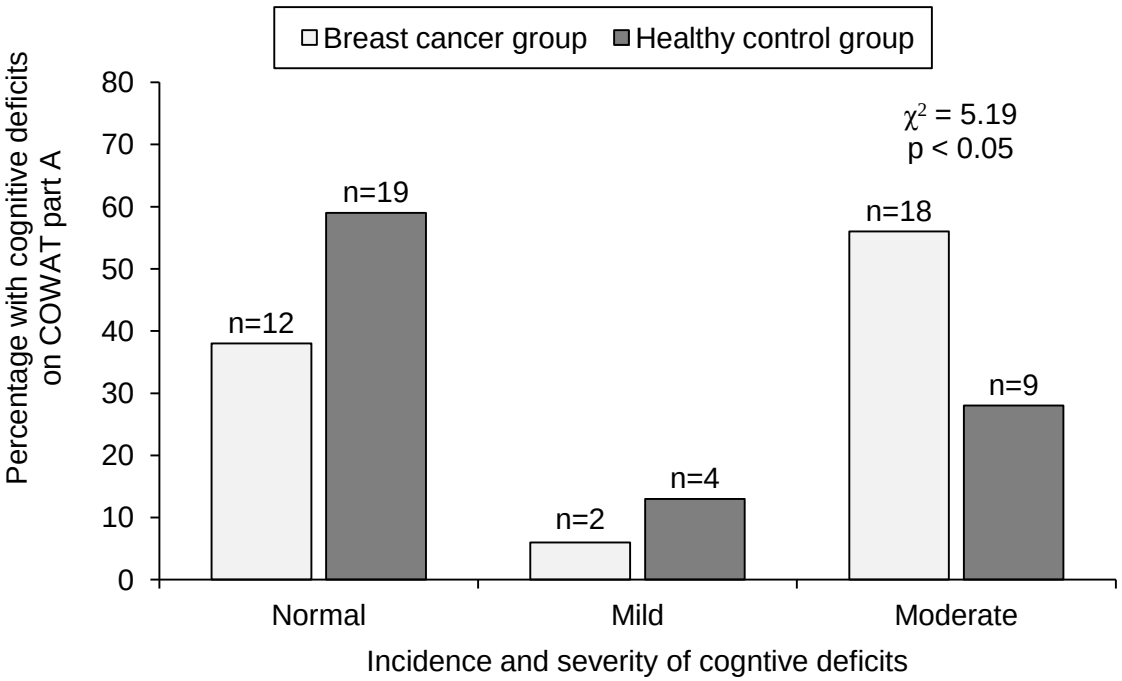


Figure 8. Incidence and Severity of Cognitive Deficits Related to COWA Part A Performance. Mild deficits were defined by the cut-off score of 28 on COWA part A performance; moderate deficits were defined by the cut-off score of 25.

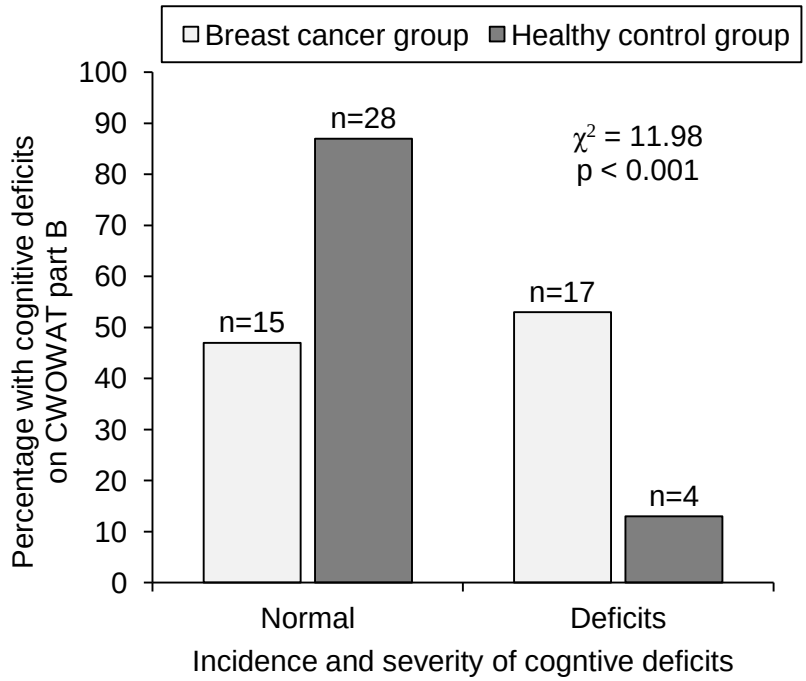


Figure 9. Incidence and Severity of Cognitive Deficits Related to COWA Part B Performance. Mild deficits were defined by the cut-off score of 30.

For COWA part B performance (category fluency), a number of 30 words correctly answered was used to define "deficits" as presented in Figure 9 (Tombaugh et al., 1999). The level of deficit (mild, moderate) was not examined because such levels were not recommended based on normative data. Seventeen (53%) women in the breast cancer group were classified with "mild deficits" relative to four (13%) women in the healthy control group. The incidence of mild cognitive deficits was significantly different between two groups (χ^2 (1, 64) = 11.98, $p < 0.001$). Taken together, women treated with chemotherapy for breast cancer were more likely than women without breast cancer to have a higher incidence of cognitive deficits related to COWA performance.

Differences in Attention Network Test (ANT) Performance

The overall mean scores of error rates and reaction times in the ANT were different between the breast cancer and the healthy control groups ($t = 31.36$, $p < 0.05$, error rates; $t = 1.90$, $p = 0.06$, reaction times), see Table 5. For detailed examinations on performance of this test, each attention network (alerting, orienting, or executive control network) and the associated conditions were separately analyzed. First, behavioral performance (error rates and reaction times) of the three attention network tests were compared between groups. Second, behavioral performance on four cue conditions (no, double, center, spatial) or three flanker types (congruent, incongruent) associated with each network test were evaluated for group comparison. Last, the effects of three attention networks (alerting, orienting, and the executive control) were examined by using the repeated measures ANOVA for between-group analyses and by the paired t-test for within-group analyses. Error rates and reaction times on each attention network test and associated conditions were compared, respectively.

Table 5

Means and Standard Deviations of the Attention Network Test (N = 64)

	Breast cancer group (n = 32) Mean ± SD (Range)	Healthy control group (n = 32) Mean ± SD (Range)
Error rates (%)		
Alerting network	0.84 ± 2.23* (-5.00 – 6.00)	0.03 ± 1.26 (-3.00 – 4.00)
No cue	5.28 ± 10.46** (0.00 – 35.00)	0.63 ± 1.41 (0.00 – 7.00)
Double cue	4.44 ± 9.82** (0.00 – 33.00)	0.59 ± 1.10 (0.00 – 3.00)
Orienting network	0.09 ± 1.95 (-4.50 – 4.50)	-0.28 ± 1.40 (-4.50 – 1.50)
Center cue	4.56 ± 9.33** (0.00 – 35.00)	0.47 ± 0.92 (0.00 – 3.00)
Spatial cue	4.47 ± 9.68** (0.00 – 34.00)	0.75 ± 1.20 (0.00 – 5.00)
Executive control network	10.00 ± 26.37* (-1.00 – 100.00)	0.66 ± 1.36 (-2.00 – 5.00)
Congruent flanker	1.25 ± 3.67 (0.00 – 21.00)	0.31 ± 0.59 (0.00 – 2.00)
Incongruent flanker	11.25 ± 26.76** (0.00 – 100.00)	0.97 ± 1.43 (0.00 – 6.00)
Overall mean scores	4.70 ± 9.78** (0.00 – 34.00)	0.60 ± 0.75 (0.00 – 3.00)
Reaction times (msec)		
Alerting network	48.03 ± 28.26 (0.24 – 129.87)	42.25 ± 29.79 (-26.27 – 102.86)
No cue	719.47 ± 131.57* (496.64 – 1003.44)	668.14 ± 106.11 (494.14 – 940.67)
Double cue	671.43 ± 121.06 (470.60 – 934.32)	625.88 ± 116.08 (450.67 – 894.90)
Orienting network	43.65 ± 38.02 (-19.24 – 138.62)	42.26 ± 31.28 (-6.75 – 131.84)
Center cue	700.64 ± 132.11* (491.00 – 1023.67)	647.04 ± 118.36 (472.90 – 935.24)
Spatial cue	656.99 ± 129.82* (450.78 – 936.59)	604.77 ± 105.59 (431.16 – 873.65)
Executive control network	117.56 ± 72.55* (5.58 – 376.94)	84.68 ± 58.82 (-7.08 – 332.15)
Congruent flanker	656.35 ± 130.59 (439.86 – 929.36)	611.41 ± 109.18 (449.54 – 904.46)
Incongruent flanker	776.21 ± 140.26** (528.31 – 1095.35)	696.09 ± 130.11 (496.06 – 1091.38)
Overall mean scores	692.68 ± 125.65* (477.25 – 966.91)	636.64 ± 110.49 (464.31 – 891.98)

* $p < 0.1$. ** $p < 0.05$.

Alerting attention network. The alerting network function is defined as the extent to which double cues alert the participant to the upcoming appearance of the target stimulus as compared to when no cues are provided. Accordingly, the alerting network score was calculated by subtracting scores of the double cue conditions from those of the no cue conditions (Fan et al., 2002).

The breast cancer group had an error rate of 0.84% in the alerting attention network test, while the healthy control group had 0.03% (see Table 5). The findings showed that the breast cancer group had greater decrease in error rates than the healthy control group when alerting cues were presented. That is, chemotherapy-treated breast cancer participants seemed to utilize the beneficial effect of alerting information with double cues to accurately perform the task. However, approximately 95% of all responses in the no cue and the double cue conditions were correct in the breast cancer group, while more than 99% of answers were correct in the healthy control group (see Figure 10). This finding indicates that women in the breast cancer group still exhibited significantly higher error rates than the women in the healthy control group, regardless of the presence/absence of the alerting cues ($t(62) = 2.50$, $p < 0.05$, no cue; $t(62) = 2.20$, $p < 0.05$, double cue). Cohen's d effect size values for the group mean comparisons of the no cue condition, the double cue condition, and the alerting attention network score ranged from 0.45 to .0.62, indicating that effect size was medium.

Repeated measures ANOVA was performed to examine changes in error rates between the no cue and the double cue conditions. Greater changes in error rates were found in the breast cancer group than the healthy control group ($F(2,62) = 3.22$, $p = 0.08$). Specifically, the greater alerting effect (that is, a decrease in error rates when the alerting

cues are presented) was observed in the breast cancer group ($F(1, 31) = 4.58$, $p < 0.05$). In contrast, no significant alerting effect was found in the healthy control group ($F(1,31) = 0.02$, $p = 0.89$). The findings demonstrated that behavioral performance (error rates) of participants in the breast cancer group was influenced by whether or not the alerting cues were presented, while participants in the healthy control group responded correctly to both conditions of the alerting network test. Thus, it is possible that the breast cancer group may lack cognitive capacity to be vigilant in responding correctly, and thus additional support to attention function is required for better performance.

Mean reaction times of the alerting attention network test were 48 msec in the breast cancer group and 42 msec in the healthy control group (see Table 5). Both groups showed improvement in response speed under the effect of the alerting cue. Like the error rate scores, the breast cancer group showed slower reaction times on both the no cue and the double cue conditions than the healthy control group as seen in Figure 11. Statistically, the mean reaction times of the condition without any cue (no cue condition) was marginally different between the two groups ($t(62) = 1.72$, $p = 0.09$), while no significant difference in the condition with alerting cues (double cue condition) was found between groups ($t(62) = 1.54$, $p = 0.13$).

Changes in reaction times between the no cue and the double cue conditions were found within each group. When alerting cues were presented, mean reaction times were reduced in the breast cancer group ($F(1,31) = 92.42$, $p < 0.001$) as well as in the healthy control group ($F(1, 31) = 64.38$, $p < 0.001$). However, no significant difference in the alerting effect was exhibited between groups. The findings suggest: 1) the breast cancer group may require longer reaction times than the healthy control group, in correctly

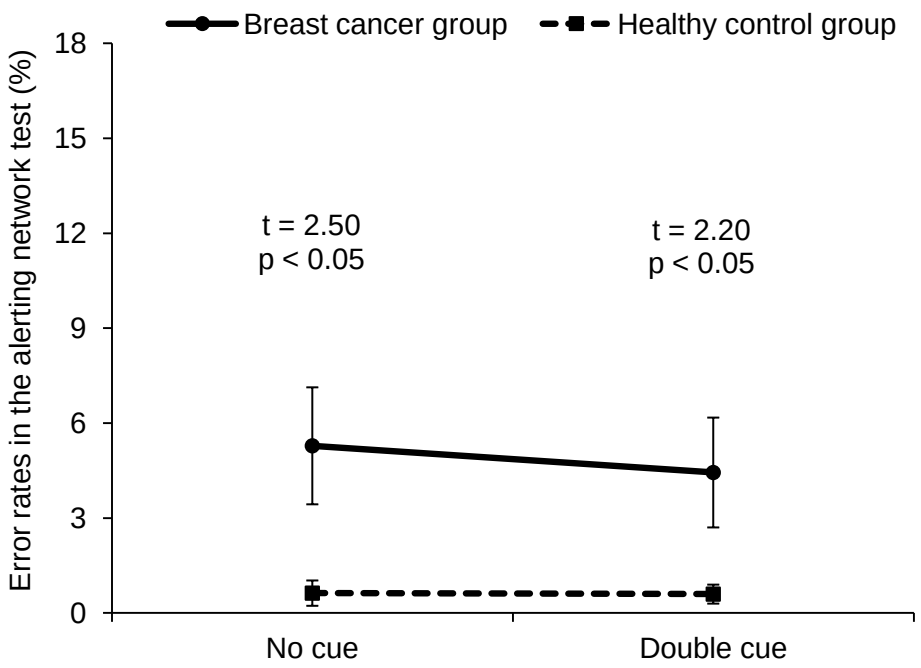


Figure 10. Error Rates of the No Cue and the Double Cue Conditions. Error bars represent standard errors. Points represent percent of error rates in each cue condition.

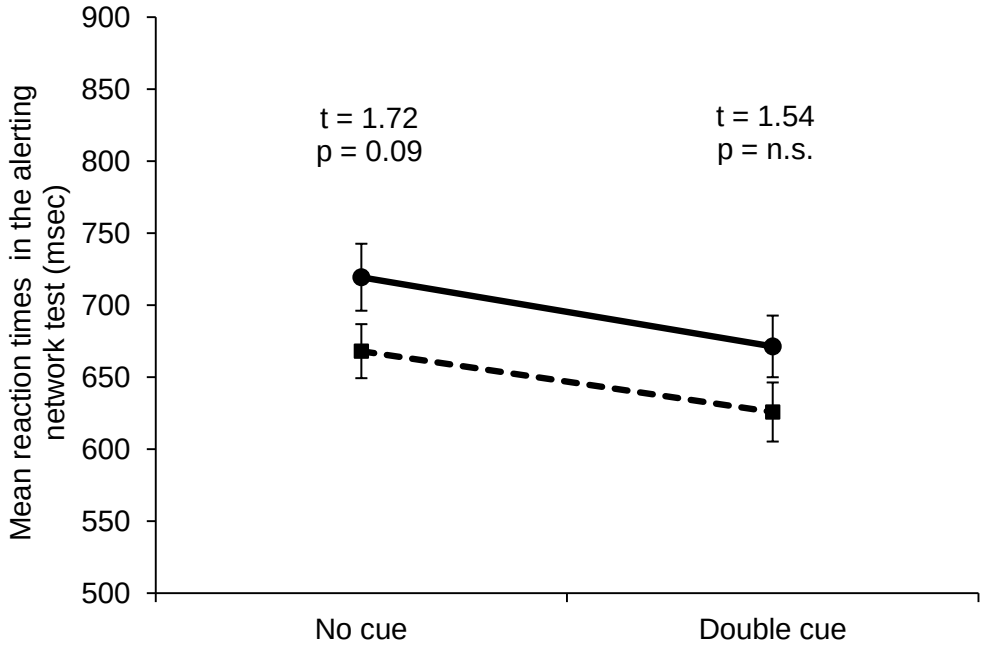


Figure 11. Mean Reaction Times of the No Cue and the Double Cue Conditions. Error bars represent standard errors. Points represent mean reaction times in each cue condition.

responding to the condition with relatively high demand (no cue condition) of the alerting network test; and 2) this group difference in reaction times may not persist when providing the cues with alerting information (double cue condition, which is a low demand condition).

Orienting attention network. The orienting network function is described as the extent to which spatially-determinate cues orient the participants toward an appropriate location before the upcoming target stimulus is presented, as compared to center cues without spatially predictive information. The orienting network test performance was computed by subtracting error rates and mean reaction times of the spatial cue conditions from those of the center cue conditions (Fan et al., 2002).

The orienting attention network test had an error rate of 0.09% in the breast cancer group and -0.28% in the healthy control group. The breast cancer group showed a slight decrease in error rates under the effect of the orienting cue, while the healthy control group showed a slight increase (see Table 5). However, the breast cancer group still had higher error rates on the center cue condition ($t(62) = 2.47$, $p < 0.05$) as well as the spatial cue condition ($t(62) = 2.16$, $p < 0.05$) than the healthy control group (see Figure 12). Regardless of presenting the center cue or the spatial cue, the breast cancer group showed lower performance than the healthy control group. Cohen's d for the group comparison of the orienting attention network test performance was 0.22, indicating a small effect size. Cohen's effect sizes on the center cue and spatial cue conditions were 0.54 and 0.62, which was medium.

The comparison of changes in error rates between the center cue and spatial cue conditions did not yield significant differences between groups and within each group.

Both groups did not exhibit significant changes in error rates despite the presence of spatial cues, indicating that presenting the spatial cues did not improve individuals' performances in responding correctly. However, the finding may be differently interpreted depending on group. The healthy control group correctly answered to more than 99% of all center and spatial cue conditions while the breast cancer group correctly responded to 96% of these two conditions. When considering actual performance of each condition between groups, the absence of the orienting effect on error rates is likely to make a more profound impact on the breast cancer group relative to the healthy control group.

Mean reaction times of the orienting attention network test were 43 msec in the breast cancer group and 42 msec in the healthy control group. Both groups showed similar improvements in response speed when presenting the spatial cue. Again, when examining reaction times for each cue condition, the breast cancer group had slower reaction times in the center cue condition ($t(62) = 1.71$, $p = 0.09$) and the spatial cue condition ($t(62) = 1.77$, $p = 0.08$) than the healthy control group (see Figure 13).

The changes in reaction times between the center cue and the spatial cue conditions did not significantly differ between groups. Within-group analyses showed a meaningful benefit of spatially predictive information in the breast cancer group ($F(1,31) = 42.17$, $p < 0.001$) and the healthy control group ($F(1,31) = 58.40$, $p < 0.001$). These findings indicated that the spatial orienting cues may lead to relatively faster speed in task performance compared to the center cue conditions in each group, but there was no significant difference in the spatial orienting cue effect between groups.

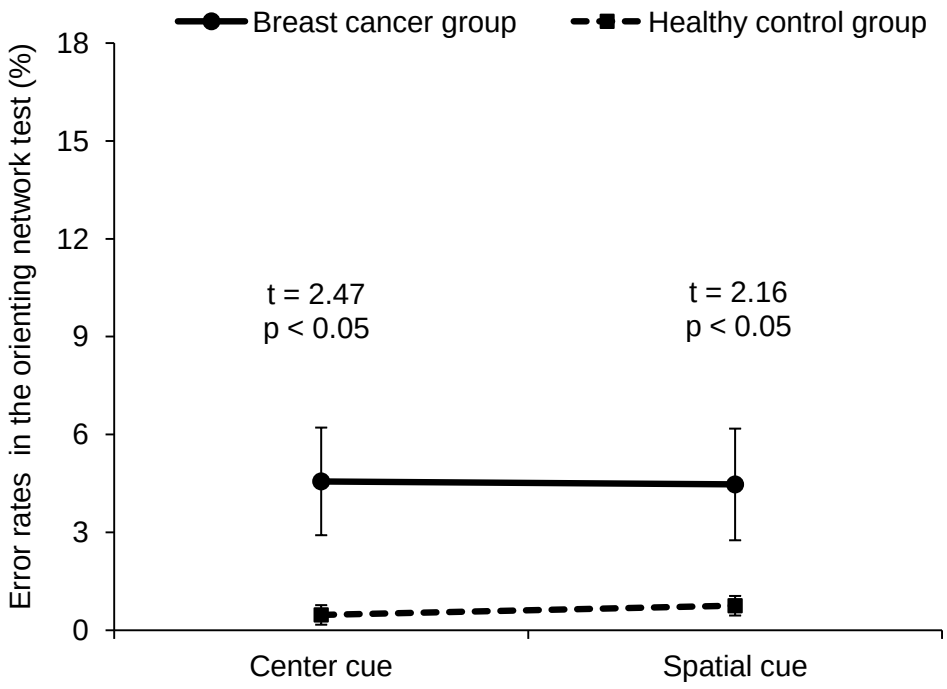


Figure 12. Error Rates of the Center Cue and the Spatial Cue Conditions. Error bars represent standard errors. Points represent percent of error rates in each cue condition.

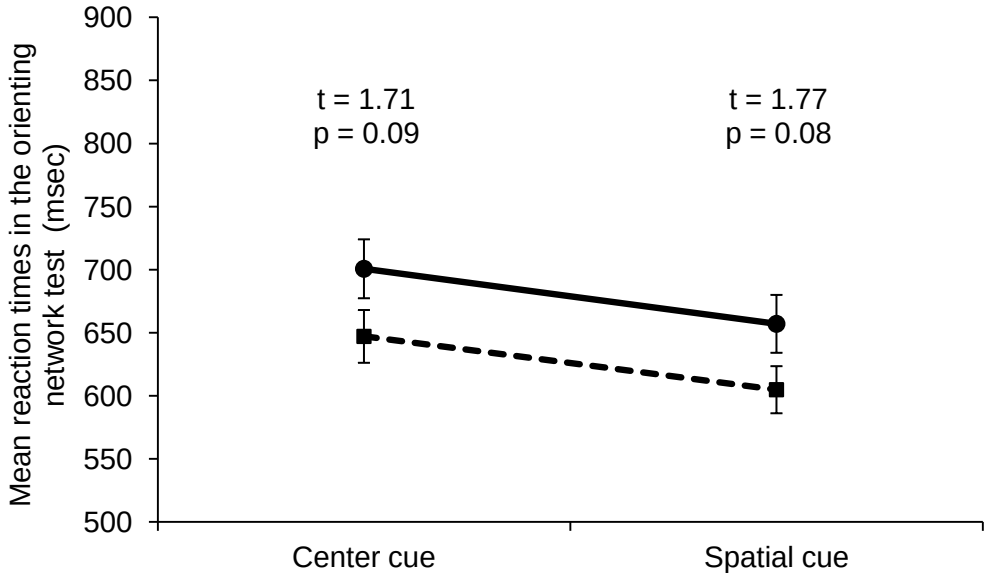


Figure 13. Mean Reaction Times of the Center Cue and the Spatial Cue Conditions. Error bars represent standard errors. Points represent mean reaction times in each cue condition.

Executive control attention network. The executive control attention network is defined as the extent to which incongruent flankers (opposite direction arrows) interfere with participant's response to the target stimulus, relative to congruent (same direction arrows) or neutral (lines only) flankers. Following the suggestion of the original developer of this test, performance on the executive control attention network test was calculated by subtracting error rates and mean reaction times of the congruent flanker conditions from those of the incongruent flanker conditions (Fan et al., 2002).

Overall error rates on the executive control attention network test were 10% in the the breast cancer group and 0.66% in the healthy control group, indicating that chemotherapy-treated breast cancer participants showed higher error rates than healthy participants without breast cancer when interference (distraction) was present (see Table 5). Specifically, error rates of the incongruent flanker condition significantly differed between two groups ($t(62) = 2.17$, $p < 0.05$), while no significant group differences were found in the congruent flanker condition ($t(62) = 1.43$, $p = 0.16$), see Figure 14. Effect size estimates for group comparisons were 0.50 (the executive control network test), 0.36 (the congruent flanker condition), and 0.54 (the incongruent flanker condition), indicating there were small to moderate effect sizes.

The executive control (interference) effect was found in each group, with higher error rates for the incongruent condition compared to the congruent condition ($F(1,31) = 4.60$, $p < 0.05$, breast cancer group; $F(1,31) = 7.47$, $p < 0.05$, healthy control group). Of interest, changes in error rates between the congruent flanker and incongruent flanker conditions were significant between groups ($F(1,62) = 4.01$ $p = 0.05$). The finding

indicated that breast cancer participants are more likely than healthy participants to be distracted by the interference effect of the executive control test.

Mean reaction times on the executive control attention network test were 118 msec in the breast cancer group and 85 msec in the healthy control group. Specifically, mean reaction times of the incongruent flanker condition significantly differed between the breast cancer and the healthy control groups ($t(61) = 2.35$, $p < 0.02$), showing that breast cancer participants had slower reaction times on the condition with distracting stimuli (incongruent flanker condition) than healthy participants. In contrast, no significant difference in reaction times on the condition without distracting information (congruent flanker condition) was found between groups (see Figure 15). Cohen's d effect size values ranged from 0.37 to 0.59, indicating that there were small to moderate effect sizes for group mean comparisons in the executive control network test and two flanker conditions.

Significant changes in reaction times between the congruent and the incongruent flanker conditions were found in within-group and between-group analyses. Again, the interference effect was found in each group, with longer reaction time for the incongruent condition compared to the congruent flanker condition ($F(1,31) = 7.47$, $p < 0.05$, error rates; $F(1,31) = 66.31$, $p < 0.001$, reaction times). Further, the breast cancer group was more affected by the interference effect, relative to the healthy control group ($F(1, 61) = 3.92$, $p = 0.05$). Taken together, the findings suggest: 1) the interference effect of the incongruent flankers may commonly reduce behavioral performance (higher error rates and longer reaction time) in both two groups; and 2) the breast cancer group was more likely than the healthy control group to lack the capacity to suppress the interference

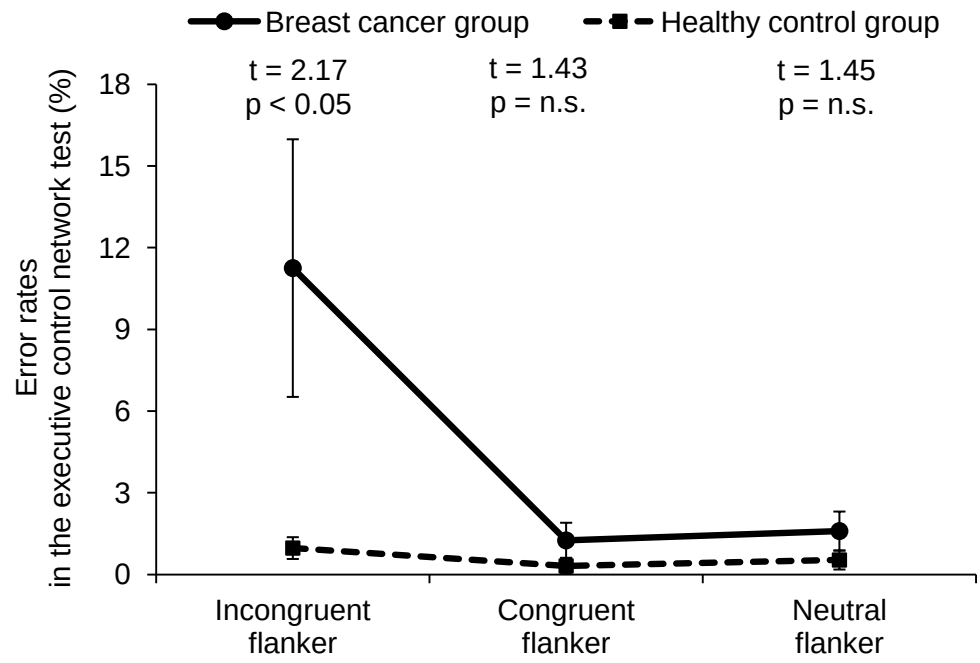


Figure 14. Error Rates of the Incongruent Flanker, the Congruent Flanker, and the Neutral Flanker Conditions. Error bars represent standard errors. Points represent percent of error rates in each flanker condition.

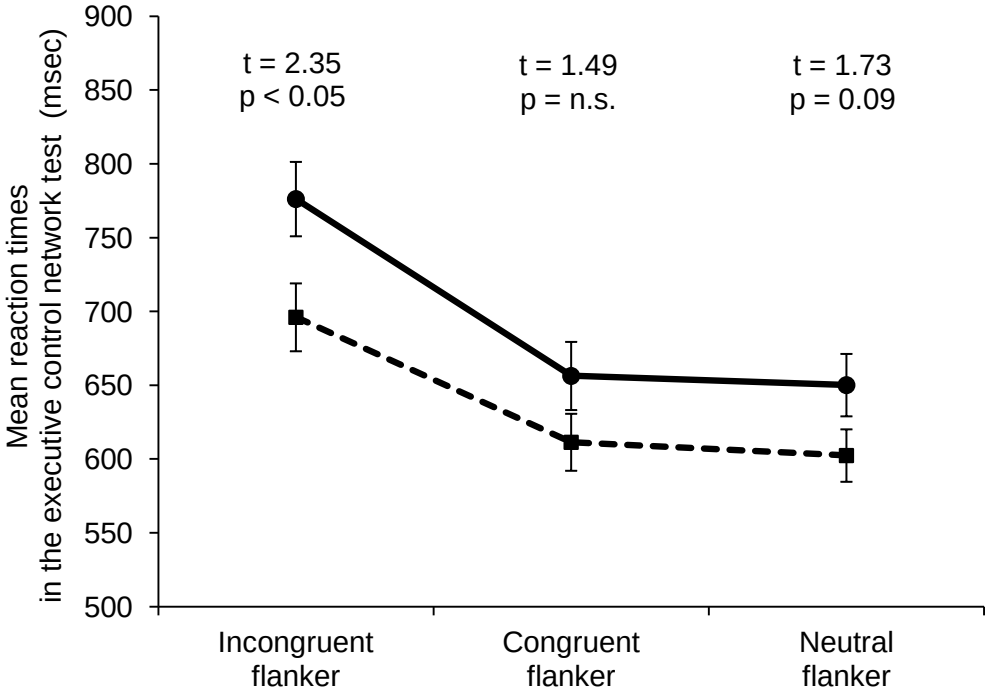


Figure 15. Mean Reaction Times of the Incongruent Flanker, the Congruent Flanker, and the Neutral Flanker Conditions. Error bars represent standard errors. Points represent mean reaction times in each flanker condition.

effect in correctly responding to increasing demands of the executive control network test.

Additional analyses. A woman in the breast cancer group had a 100% error rate in the incongruent flanker condition, indicating that all responses to the incongruent flanker conditions were incorrect. In order to determine whether there was an effect induced by the outlier on behavioral performance analyses, the same statistical analyses were performed including 32 healthy participants without breast cancer and 31 chemotherapy-treated breast cancer participants without the outlier aforementioned. As presented in Appendix B3, error rates for the double cue and incongruent flanker conditions were slightly decreased, indicating that the average rates of accurate responses for the two conditions increased when 31 women in the breast cancer group were analyzed. However, marginal differences in error rates for the double cue and the incongruent flanker conditions were still found between the breast cancer and the healthy control groups. The only effect of outlier was found in error rates for the alerting attention network due to increased accuracy scores of the double cue condition. There was hardly any outlier effect on response speed for all cue and flanker conditions. Data of 31 chemotherapy-treated breast cancer participants showed similar mean reaction times as compared to scores of 32 women in the breast cancer group. A difference in reaction times for the executive attention network test was still found between groups. Thus, when considering these results of the insignificant outlier effect, all women in the breast cancer group were used for other statistical analyses.

A Group Comparison of Attentional Function Index Scores

- *Research Question 1.2. Is there a difference in perceived effectiveness of attention and working memory function between Korean women treated with chemotherapy for breast cancer and women without breast cancer?*

Figure 16 presents differences in incidence of perceived effectiveness in cognitive functioning between women treated with chemotherapy for breast cancer and healthy women without breast cancer. Most of the women (97%) in the breast cancer group reported low or moderate levels of effectiveness in cognitive functioning, while 93% of women in the healthy control group reported moderate or high levels. Significantly more women in the breast cancer group perceived lower level of effectiveness in cognitive functioning than women in the healthy control group ($p < 0.001$).

Likewise, significant differences in severity of perceived cognitive deficits were found between women treated with chemotherapy for breast cancer and healthy women without breast cancer with regard to overall mean of total items in the AFI and subscales of effective action, attentional lapses, and effective interpersonal relations (see Figure 14). The breast cancer group ($M = 5.28$, $SD = 1.63$) showed a significantly lower total mean score of the AFI items than the healthy control group ($M = 7.55$, $SD = 1.16$). The breast cancer group also reported significantly lower mean scores of effective action, attentional lapses, and effective interpersonal relations than the healthy control group. Overall, the findings indicated that women treated with chemotherapy for breast cancer reported worse effectiveness in cognitive functioning than healthy women without breast cancer.

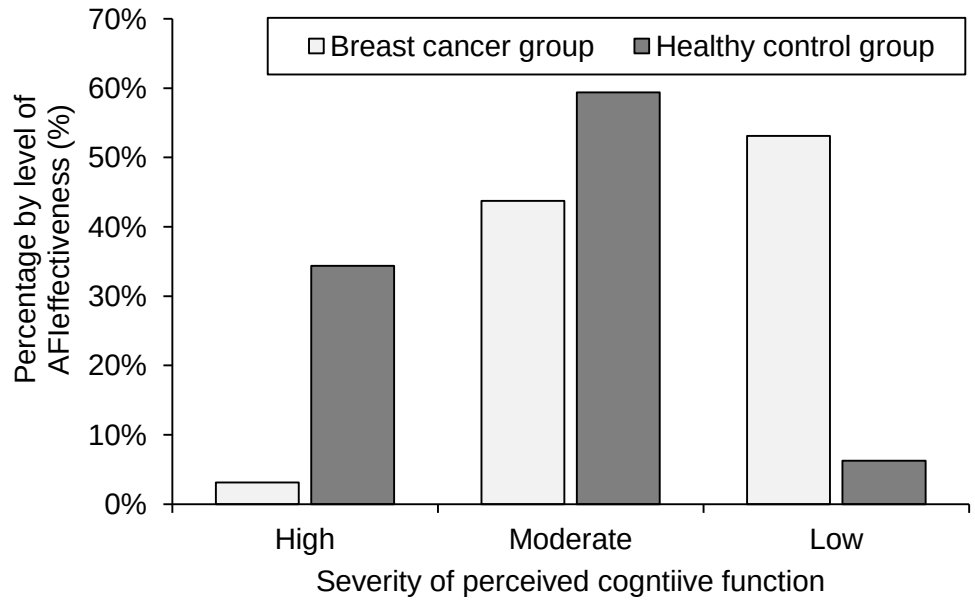


Figure 16. Reported Incidence of High (> 7.5), Moderate (5.0 – 7.5), or Low (< 5.0) Scores on the Attentional Function Index (AFI).

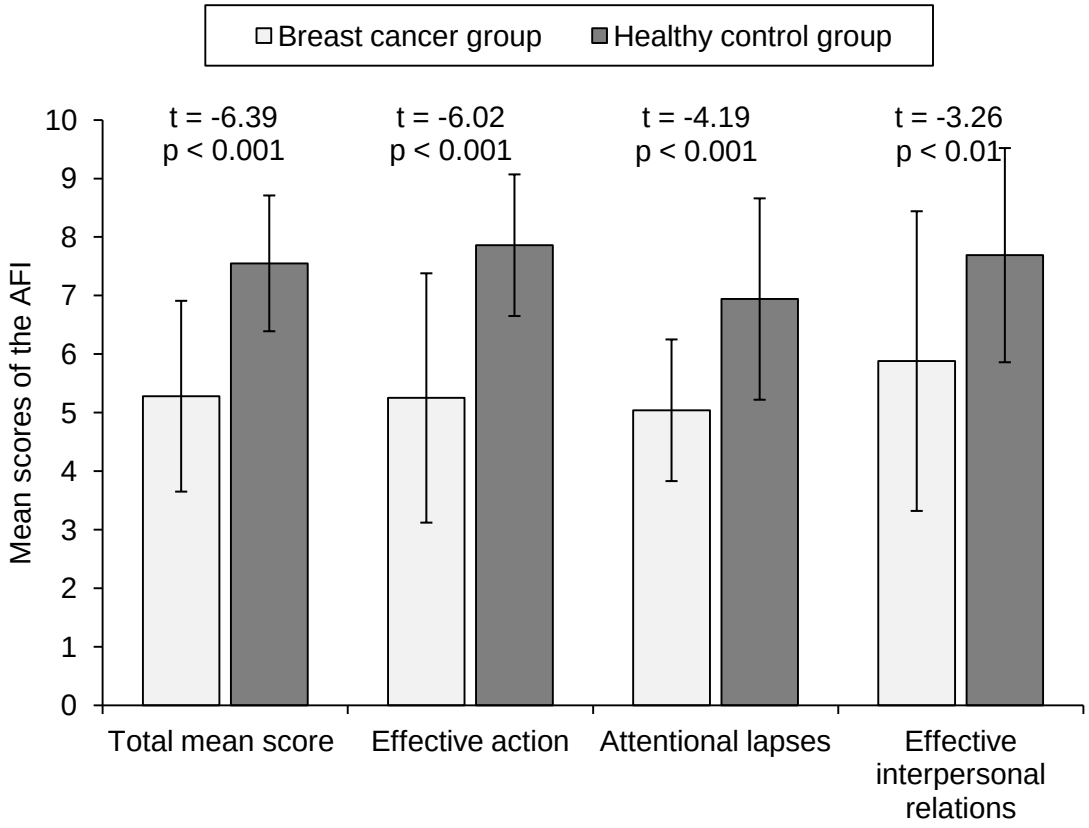


Figure 17. Severity of Perceived Cognitive Function in Women Treated for Breast Cancer (n = 32) and Women without Breast Cancer (n = 32) for Effective Action, Attentional Lapses, Effective Interpersonal Relations, and Total Mean Score of the AFI.

Summary

Women treated with chemotherapy for breast cancer showed greater deficits in attention and working memory function than healthy women without breast cancer. Specifically, the breast cancer group had 1) lower scores on the DSF, the DSB, the COWA part A (letter fluency), the COWA part B (category fluency), and a total standardized cognitive score, 2) higher error rates and longer reaction times for all conditions in the ANT, 3) greater inefficiency in the executive control attention network function, and 4) lower self-rated AFI scores than the healthy control group. Similarly, a higher incidence of attention and working memory deficits was also observed in the breast cancer group than in the healthy control group. Taken together, women treated with chemotherapy for breast cancer were more likely than healthy women without breast cancer to show greater severity and higher incidence of deficits in attention and working memory following adjuvant chemotherapy.

Effects of Potential Covariates

Specific aim 2. To explore the factors (demographic and general health characteristics, physical and psychological symptoms, and cultural characteristics) associated with deficits in attention and working memory in Korean women

- *Research Question 2.1. What are the relationships between demographic and general health characteristics, physical and psychological symptoms and cultural characteristics and cognitive performance and perceived effectiveness in attention and working memory function?*

- *Research Question 2.2. What are the significant predictors of cognitive performance and perceived effectiveness in attention and working memory function?*

The second specific aim of this study was to explore the effects of potential covariates on cognitive function measured by standardized cognitive tests and a self-

report measure. In order to test the Specific Aim 2 and associated research questions, the Pearson Product Moment Correlation and Multiple Linear Regression analyses were conducted. Specifically, the Pearson's correlation coefficients were calculated to examine the associations of demographic and general health characteristics, physical and psychological symptoms, and cultural characteristics with cognitive test performance (total cognitive score, overall error rate on the ANT, overall reaction time on the ANT) and perceived effectiveness in cognitive functioning (total mean score of the AFI). The multiple linear regression analyses were performed to determine potential predictors of cognitive function assessed by aforementioned cognitive measures. Potential predictors were selected according to the following conditions: 1) a continuous variable which shows significant correlations with cognitive test performance and perceived effectiveness in cognitive functioning; or 2) a categorical variable which has a significant main effect on cognitive function. Subsequently, selected variables were tested by examining the variance inflation factor (VIF) for detecting whether there is a variable having multicollinearity with other variables in multiple regression models. If the VIF score of a variable was more than 4, the variable was excluded from further regression analyses.

Effects of Demographic and General Health Characteristics

As presented in Table 6, age and education were found to be important covariates with cognitive performance on attention and working memory tasks. Interestingly, an unexpected factor, having a daughter, was found as a significant covariate of perceived effectiveness in cognitive functioning ($F = 9.95$, $p < 0.01$) as presented in Table 7. Other demographics and general health variables were not significantly associated with

cognitive test performance and perceived effectiveness in attention and working memory function (see Table 6 and 7). Accordingly, these three variables, age, education, and having a daughter would be used as independent variables in further multiple regression analyses.

Table 6
Correlations between Cognitive Function and Demographic and General Health Characteristics (N = 64)

	Cognitive test performance			Perceived cognitive function
	Total cognitive score	Overall error rate	Overall reaction time	AFI
Age	-0.48*	0.20	0.60*	0.10
Education	0.57*	-0.13	-0.46*	-0.01
Number of family members	0.19	-0.15	-0.16	0.06
Number of sons	-0.15	0.01	-0.02	0.04
Number of daughters	-0.12	0.14	0.23	0.19

Note. AFI = Attentional Function Index.
* $p < 0.001$.

Effects of Physical and Psychological Symptoms

Physical and psychological symptoms included fatigue, anxiety, depressed mood, sleep, the overall symptom severity, and the mean number of symptoms. The breast cancer group reported greater fatigue, anxiety, depressed mood, sleep problems, and greater overall symptom severity and had a higher number of symptoms than the healthy control group (see Table 8).

Correlations between physical and psychological symptoms and cognitive function. In general, physical and psychological symptoms were significantly correlated with cognitive test performance (total cognitive score, overall error rate on the ANT, overall reaction time on the ANT) and perceived effectiveness in cognitive functioning (total mean score of the AFI), as presented in Table 9. Specifically, the scores of the

Table 7

Mean and Standard Deviations of Objective Performance and Subjective Perception by Demographic and General Health Variables (N = 64)

	Cognitive test performance						Perceived cognitive function	
	Total cognitive score		Overall error rate		Overall reaction time		AFI	
	BC	HC	BC	HC	BC	HC	BC	HC
Marital status								
Single	-2.60 (6.24)	1.40 (6.49)	5.94 (11.54)	0.59 (0.70)	732.77 (160.11)	666.22 (131.52)	5.65 (1.92)	7.31 (1.24)
Currently married	-2.48 (3.92)	2.94 (5.02)	4.41 (9.57)	0.61 (0.78)	683.43 (118.22)	625.06 (102.05)	5.20 (1.59)	7.64 (1.15)
Having a son								
Yes	-2.84 (4.08)	1.62 (5.12)	4.77 (10.26)	0.68 (0.80)	692.80 (123.02)	646.95 (115.18)	5.46 (1.47)	7.44 (1.14)
No	-1.31 (5.26)	5.16 (5.72)	4.43 (8.52)	0.38 (0.55)	692.26 (145.06)	605.71 (94.97)	4.64 (2.12)	7.88 (1.25)
Having a daughter								
Yes	-2.24 (4.21)	2.39 (5.92)	5.29 (10.18)	0.51 (0.57)	713.81 (140.20)	639.93 (98.31)	5.88 (1.34)*	7.70 (1.27)
No	-3.00 (4.69)	2.73 (4.53)	3.58 (9.34)	0.79 (1.00)	652.36 (83.13)	630.35 (135.83)	4.15 (1.59)	7.27 (0.91)
Employment								
Employed outside home	0.51 (4.50)	2.26 (5.33)	0.67 (0.63)	0.60 (0.83)	613.00 (87.48)	632.13 (97.20)	5.26 (1.73)	7.25 (1.16)
Unemployed	-3.20 (4.05)	2.91 (5.75)	5.63 (10.66)	0.61 (0.60)	711.07 (127.17)	644.15 (134.12)	5.29 (1.65)	8.04 (1.03)
Annual household income								
Less than $22,000	-2.68 (5.54)	0.25 (5.24)	4.50 (10.06)	0.79 (0.54)	726.94 (148.72)	666.96 (134.18)	4.93 (1.41)	7.41 (1.19)
$22,000 - $33,000	-1.50 (4.49)	3.34 (6.20)	3.51 (8.54)	0.24 (0.63)	669.72 (131.57)	635.12 (131.57)	5.25 (1.97)	6.73 (1.27)
More than $ 33,000	-3.57 (3.10)	3.86 (4.92)	6.24 (11.55)	0.64 (0.90)	694.91 (105.17)	613.57 (76.94)	5.58 (1.43)	8.07 (0.85)
Menopausal state								
Pre-menopause	-1.82 (3.98)	5.12 (4.69)	2.92 (8.17)	0.45 (0.82)	655.10 (121.68)	568.36 (53.50)	5.46 (1.22)	7.56 (1.14)
Peri-menopause	0.59 (5.23)	1.37 (5.91)	0.75 (0.74)	0.53 (0.69)	658.44 (92.69)	669.43 (86.14)	4.15 (2.61)	7.00 (1.60)
Post-menopause	-4.69 (3.81)	-1.38 (3.95)	8.88 (12.60)	0.90 (0.61)	736.31 (119.74)	763.21 (114.99)	5.42 (1.81)	7.81 (0.99)
Comorbidity								
Yes	-2.19 (6.46)	0.19 (7.13)	6.44 (12.43)	0.33 (0.30)	694.31 (137.96)	643.29 (141.80)	5.04 (1.03)	7.94 (0.97)
No	-2.58 (3.85)	3.04 (4.95)	4.29 (9.32)	0.67 (0.81)	692.31 (125.58)	635.10 (105.37)	5.34 (1.76)	7.46 (1.20)

Note. AFI = Attentional Function Index; BC = breast cancer group; HC = healthy control group.

* $p < 0.01$.

the FACT-F, a measure of fatigue, ranged from a low of 1 to a high of 47 with a mean of 18.70 (SD = 12.59), as presented in Table 8. While there were no women in the healthy control group scoring over 34 on the fatigue measure, 34% (n = 11) of women in the breast cancer group scored higher than 34, which has been suggested as a cut-off value to detect fatigue (Van Belle et al., 2005). This finding indicated that the breast cancer group experienced a higher incidence of fatigue than the healthy control group (Van Belle et al., 2005). Fatigue was significantly and inversely associated with the total cognitive score ($r = -0.32$, $p < 0.05$) and the total mean score of the AFI ($r = -0.73$, $p < 0.001$), indicating that fatigue had moderate to strong correlations with both actual performance and perceived effectiveness in attention and working memory function (see Table 9).

The anxiety scores measured with the HADS ranged from a low of 1 to a high of 20 and the mean was 6.66 (SD = 4.13) as presented in Table 8. Sixteen percent of women in the healthy control group and 50% of women in the breast cancer group had a mean score of more than 8 on the anxiety subscale of the HADS, which has been a recommended as a cut-off point to detect anxiety in the Korean population (Oh et al., 1999). Anxiety was strongly and inversely associated with the total score of the AFI ($r = -0.72$, $p < 0.001$) but not with cognitive test performance (see in Table 9).

The scores on the depression subscale of the HADS ranged from a low of 0 to a high of 19 with a mean of 6.55 (SD = 4.05) (see Table 8). Like the anxiety subscale, the same score of 8 on the depressed mood was used as a cut-off point to detect serious depressed mood (Oh et al., 1999). Sixty six percent of women in the breast cancer group scored more than 8 on the HADS depression subscale, as compared with 16% of women in the healthy control group. Depressed mood had a small but significant correlation with

the total cognitive score ($r = -0.29$, $p < 0.05$), indicating that women reporting greater depressed mood tend to have poorer performance on attention and working memory tasks (see Table 9). Similarly, there was a strongly inverse correlation between depressed mood and the total mean score of the AFI ($r = -0.72$, $p < 0.001$) as presented in Table 9. The finding indicated that as depressed mood increased, perceived effectiveness in attention and working memory function decreased.

The sleep scores, defined as overall sleep problem measured with the PSQI, ranged from a low of 0 to a high of 16 in all participants of this study. The mean was 5.80 (SD = 3.54), which was lower than a cut-off point of 6 to detect poor quality of sleep (Buysse et al., 1989). Specifically, 44% of women in the breast cancer group and 38% of women in the healthy control group scored more than 6 on the PSQI. The overall mean scores of the PSQI showed a strongly moderate, significant, and inverse relationship with the total mean score of the AFI ($r = -0.60$, $p < 0.001$), while there were no significant associations between PSQI scores and cognitive test performance (see Table 9).

The overall symptom severity and the mean number of symptoms were computed with the BCPT symptom checklist excluding three items of cognitive symptoms (forgetfulness, difficulty concentrating, and easily distracted) in order to avoid a conceptual overlap with cognitive measures. The overall symptom severity score was the sum of severity scores for the remaining 15 items in the BCPT and the mean number of symptoms was the total number of symptoms reported by participants in the previous four weeks regardless of severity. As presented in Table 8, the scores on overall symptom severity ranged from 0 to 46 with a mean of 13.02 (SD = 10.58) and the scores on the mean number of symptoms ranged from 0 to 15 with a mean of 6.63 (SD = 3.73).

Women in the breast cancer group reported greater severity of symptoms and higher number of symptoms than the women in the healthy control group. Both overall symptom severity and mean number of symptoms had significant, moderate, and inverse relationships with the total cognitive score ($r = -0.39$, $p < 0.01$; $r = -0.41$, $p < 0.01$, respectively) and the total mean score of the AFI ($r = -0.66$, $p < 0.001$; $r = -0.64$, $p < 0.001$, respectively). The finding indicates that as both severity and mean number of symptoms increased, actual test performance and perceived effectiveness in cognitive function decreased. Notably, the mean number of symptoms was significantly correlated with the overall error rate on the ANT ($r = 0.31$, $p < 0.05$), that is, women who reported higher number of symptoms had higher error rates on the ANT. Based on correlational analyses, the mean number of symptoms was more highly correlated with cognitive test performance than the overall symptom severity.

In summary, the total cognitive score was mildly to moderately related to fatigue, depressed mood, the overall symptom severity, and the mean number of symptoms. The overall error rate on the ANT was significantly correlated with the mean number of symptoms while there were no significant associations between the overall mean reaction time on the ANT and any physical and psychological symptoms. Likewise, the total mean score of the AFI showed significant, moderate, inverse associations with fatigue, anxiety, depressed mood, sleep, the overall symptom severity, and the mean number of symptoms. Of four variables, namely fatigue, depressed mood, overall symptom severity, and mean number of symptoms, commonly associated with actual performance and perceived effectiveness in attention and working memory function, fatigue and the overall symptom severity were identified as showing multicollinearity and conceptual redundancy and

Table 8
Means and Standard Deviations of Physical and Psychological Symptoms

	The total sample (N = 64)		Breast cancer group (n = 32)		Healthy control group (n = 32)	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Fatigue	18.70 ± 12.59	1 – 47	25.84 ± 12.80*	2 – 47	11.56 ± 7.29	1 – 27
Anxiety	6.66 ± 4.13	1 – 20	8.44 ± 4.60*	1 – 20	4.88 ± 2.65	1 – 10
Depressed mood	6.55 ± 4.05	0 – 19	8.31 ± 4.54*	0 – 19	4.78 ± 2.50	1 – 10
Sleep	5.80 ± 3.54	0 – 16	6.81 ± 4.36*	1 – 16	4.78 ± 2.09	0 – 9
Overall symptom severity	13.02 ± 10.58	0 – 46	19.16 ± 11.43*	0 – 46	6.88 ± 4.34	1 – 16
Mean number of symptoms	6.63 ± 3.73	0 – 15	8.53 ± 3.75*	0 – 15	4.72 ± 2.58	1 – 10

* $p < 0.001$.

Table 9
Correlations between Performance on Cognitive Function and Physical and Psychological Symptoms (N = 64)

	1	2	3	4	5	6	7	8	9
1. Fatigue	-	-	-	-	-	-	-	-	-
2. Anxiety	0.77***	-	-	-	-	-	-	-	-
3. Depressed mood	0.68***	0.74***	-	-	-	-	-	-	-
4. Sleep	0.68***	0.56***	0.63***	-	-	-	-	-	-
5. Overall symptom severity	0.76***	0.60***	0.60***	0.56***	-	-	-	-	-
6. Mean number of symptoms	0.71***	0.52***	0.55***	0.54***	0.90***	-	-	-	-
7. Total cognitive score	-0.32*	-0.20	-0.29*	-0.19	-0.39**	-0.41***	-	-	-
8. Overall error rate[a]	0.14	0.07	0.20	0.11	0.22	0.31*	-0.33**	-	-
9. Overall reaction time[a]	0.17	0.10	0.10	0.06	0.12	0.10	-0.64***	0.18	-
10. AFI	-0.73***	-0.72***	-0.72***	-0.60***	-0.66***	-0.64***	0.25*	-0.16	-0.07

Note. AFI = Attentional Function Index.
[a] scores of the Attention Network Test.
* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

were not retained in the regression analyses. Accordingly, depressed mood and the mean number of symptoms were included as possible predictors of cognitive function in the regression model.

Physical and psychological symptoms as predictors of cognitive function. A series of multiple regression models were estimated to determine possible predictors of 1) total cognitive score, 2) the overall error rates on the ANT, 3) the overall mean reaction times on the ANT, and 4) the total mean score of the AFI. Six variables including group (chemotherapy-treated breast cancer survivors versus healthy controls), age, years of education (education), having a daughter, depressed mood, and the mean number of symptoms were selected based on the findings addressed in the previous section. To justify each regression model, four statistical assumptions for multiple regression analyses were tested. First, linearity of relationship between dependent and independent variables was evaluated by the inspection of scatter plots and ANOVA test for linearity. Second, normality of the error distribution was evaluated by a histogram of standardized residuals and the Kolmogorov-Smirnov normality test. If normality is met in the regression model, a histogram shows a roughly normal curve and the Kolmogorov-Smirnov normality test is not significant. Third, homoscedasticity refers to the relationship under investigation being the same for the entire range of the dependent variable. In order to detect homoscedasticity, scatter plots of the standardized predicted dependent variables against the standardized residuals were used. If a regression model does not violate homoscedasticity, the scatter plot shows a random pattern across the entire range of the standardized predicted dependent variable. Last, to determine whether the assumption of independence of residuals (residual autocorrelation), the Durbin-

Watson statistic was computed. Except for the regression model for the overall error rates on the ANT, multiple regression models used in this study satisfied these four assumptions in terms of absence of violation of the linearity, normality, homoscedasticity, and independence.

Total cognitive score. Six selected variables accounted for 58% of the variance in the total cognitive score, multiple R = 0.76, $F(6, 57) = 13.08$, $p < 0.001$ (see Table 10). Four variables, group (t = -3.25, p = 0.002), age (-2.95, p = 0.01), education (t = 2.58, p = 0.01), and the mean number of symptoms (t = -2.30, p = 0.03), were found to be significant predictors of the total cognitive score while having a daughter and depressed mood were not significant predictors. The finding suggests that being in the breast cancer group, older age, less educational level, and a higher number of symptoms were significant predictors of lower cognitive score in this regression model.

Table 10
Symptom-Related Predictors of Total Cognitive Score (N = 64)

Variable	B	SE B	β	p
Group	-3.75	1.15	-0.35	0.002
Age	-0.25	0.08	-0.35	0.01
Education	0.58	0.22	0.30	0.01
Having a daughter	0.70	1.04	0.06	0.50
Depressed mood	0.11	0.15	0.08	0.49
Mean number of symptoms	-0.38	0.17	-0.26	0.03

$R = 0.76$, $R^2 = 0.58$, $F = 13.08$, $p < 0.001$.

Overall error rate on the Attention Network Test (ANT). The overall error rate is one of the response accuracy measures on the ANT. The six selected variables accounted for 17% of the variance in the overall error rate on the ANT but the regression model could not be considered significantly better than would be expected by chance, indicating

that the null hypothesis of no linear relationship of the dependent variable to the independent variables was not rejected (see Table 11).

Table 11
Symptom-Related Predictors of Attention Network Test (ANT) Error Rates (N = 64)

Variable	B	SE B	β	p
Group	2.87	2.12	0.20	0.18
Age	0.26	0.15	0.28	0.10
Education	0.23	0.41	0.09	0.58
Having a daughter	0.49	1.91	0.03	0.80
Depressed mood	-0.10	0.28	-0.06	0.71
Mean number of symptoms	0.51	0.30	0.26	0.10

$R = 0.42$, $R^2 = 0.17$, $F = 1.97$, $p = 0.09$.

Overall reaction time on the Attention Network Test (ANT). To determine possible predictors of response speed in performing the ANT, the overall mean reaction time was used as a dependent variable. Again, being in the breast cancer group ($t = 2.42$, $p = 0.02$) and older age ($t = 4.50$, $p < 0.001$) predicted poorer actual performance, accounting for 46% of the variance in the overall reaction time on the ANT, multiple $R = 0.68$, $F(6, 57) = 7.95$, $p < 0.001$ (see Table 12). Education, having a daughter, depressed mood, and the mean number of symptoms were not found as significant predictors.

Table 12
Symptom Related Predictors of Attention Network Test (ANT) Reaction Times (N = 64)

Variable	B	SE B	β	p
Group	69.85	28.92	0.29	0.02
Age	9.43	2.10	0.61	0.00
Education	-2.21	5.61	-0.05	0.70
Having a daughter	6.32	26.07	0.03	0.81
Depressed mood	-4.84	3.85	-0.16	0.22
Mean number of symptoms	2.26	4.13	0.07	0.59

$R = 0.68$, $R^2 = 0.46$, $F = 7.95$, $p < 0.001$.

Attentional Function Index (AFI). Age and education were not significant predictors of the total mean score of the AFI. The four other variables were found as significant predictors, accounting for 71% of the variance in the AFI score, multiple R = 0.84, $F(6, 57) = 23.53$, $p < 0.001$ (see Table 13). Specifically, being in the breast cancer group ($t = -3.71$, $p < 0.001$), a higher number of symptoms ($t = -2.07$, $p = 0.04$), and greater depressed mood (-4.90, $p < 0.001$) predicted lower perceived effectiveness in cognitive functioning, while having a daughter ($t = 1.98$, $p = 0.05$) was a significant predictor of better perceived effectiveness in cognitive functioning.

Table 13
Symptom-Related Predictors of Attentional Function Index (AFI) (N = 64)

Variable	B	SE B	β	p
Group	-1.17	0.32	-0.33	0.00
Age	0.03	0.02	0.11	0.27
Education	-0.01	0.06	-0.02	0.85
Having a daughter	0.56	0.28	0.15	0.05
Depressed mood	-0.09	0.05	-0.19	0.04
Mean number of symptoms	-0.21	0.04	-0.46	0.00

$R = 0.84$, $R^2 = 0.71$, $F = 23.53$, $p < 0.001$.

Effects of Cultural Characteristics

The Pearson's correlation coefficients were calculated to examine relationships between cultural characteristics and cognitive function, and multiple regression analyses were performed to determine the potential cultural predictors of cognitive test performance and perceived effectiveness in cognitive functioning. Again, three variables of age, education, and having a daughter were used as possible predictors for further regression analyses.

Correlations between cognitive function and cultural characteristics. Cultural characteristics were described in terms of cultural attitude of collectivism, housework burden, and childrearing burden. As expected, the breast cancer group and the healthy control group showed similar mean scores on these three cultural characteristics (see Table 14). Specifically, the scores of cultural attitude of collectivism ranged from a low of 1.60 to a high of 4.80 with a mean of 3.13 (SD = 0.69). Stronger collectivistic attitude was correlated with lower total cognitive score and slower reaction time on the ANT (see Table 15). Regarding housework burden, scores of the housework burden measure ranged from 1.00 to 4.83 and a mean was 2.03 (SD = 0.90). No significant associations were found between housework burden and any cognitive function measure. The third cultural factor, childrearing burden, was scored between 1.00 and 4.00 and a mean was 1.94 (SD = 0.77). There were significant, small, and inverse correlations between the childrearing burden score and the total cognitive score ($r = -0.28$, $p < 0.05$) and the total score of the AFI ($r = -0.27$, $p < 0.05$). The finding indicated that greater childrearing burden was associated with poorer test performance on selected cognitive measures and lower perceived effectiveness in cognitive functioning (see Table 14 and 15). Taken together, cognitive test performance was moderately correlated with cultural attitude of collectivism and childrearing burden while the total mean score of the AFI was significantly associated with only childrearing burden.

Table 14

Means and Standard Deviations on Cultural Characteristics

	The total sample (N = 64)	Breast cancer group (n = 32)	Healthy control group (n = 32)
	Mean ± SD (Range)	Mean ± SD (Range)	Mean ± SD (Range)
Cultural attitude of collectivism	3.13 ± 0.69 (1.60 – 4.80)	3.23 ± 0.65 (1.80 – 4.60)	3.04 ± 0.72 (1.60 – 4.80)
Housework burden	2.03 ± 0.90 (1.00 – 4.83)	2.09 ± 0.97 (1.00 – 4.83)	1.97 ± 0.84 (1.00 – 4.33)
Childrearing burden	1.94 ± 0.77 (1.00 – 4.00)	2.03 ± 0.90 (1.00 – 4.00)	1.84 ± 0.62 (1.00 – 4.00)

Table 15

Correlations between Performance on Cognitive Function and Cultural Characteristics (N = 64)

	1	2	3	4	5	6
1. Cultural attitude of collectivism	-	-	-	-	-	-
2. Housework burden	0.11	-	-	-	-	-
3. Childrearing burden	0.03	0.63***	-	-	-	-
4. Total cognitive score	-0.30*	-0.10	-0.28*	-	-	-
5. Overall error rate[a]	0.04	-0.12	0.17	-0.33**	-	-
6. Overall reaction time[a]	0.37**	0.08	0.10	-0.64***	0.18	-
7. AFI	0.03	-0.21	-0.27*	0.25*	-0.16	-0.07

Note. AFI = Attentional Function Index.

[a] scores of the Attention Network Test.

* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Cultural predictors of cognitive function. Multiple regression analyses were conducted to determine possible cultural predictors of cognitive test performance (total cognitive score, overall error rate on the ANT, and overall mean reaction time on the ANT) and perceived effectiveness in cognitive functioning (total mean score of the AFI). All regression models used the same six independent variables including group (breast cancer survivors versus healthy controls), age, years of education (education), having a daughter, cultural attitude of collectivism and childrearing burden. These variables were selected based on correlation analyses conducted above. Again, the aforementioned prerequisite conditions for multiple regression analyses were tested by using the same methods. Detailed procedures were addressed in a previous section (see page 123-124). Except for the regression model for the overall error rates on the ANT, all regression models met these assumptions in terms of absence of violation of linearity, normality, homoscedasticity, and independence.

Total cognitive score. As presented in Table 16, the six selected variables including group (chemotherapy-treated breast cancer survivors versus healthy controls) age, educational level (education), having a daughter, cultural attitude of collectivism, and childrearing burden, were used in the regression model. These variables accounted for 56% of the variance in the total cognitive score, multiple $R = 0.75$, $F(6,57) = 11.90$, $p < 0.001$. Being in the breast cancer group ($t = -4.57$, $p < 0.001$), older age (-2.58, $p = 0.01$), and less education ($t = 2.45$, $p = 0.02$) were found to be significant predictors of lower total cognitive score, while cultural attitude of collectivism and childrearing burden were not significant predictors of the total cognitive score.

Table 16
Cultural Predictors of Total Cognitive Score (N = 64)

Variable	B	SE B	β	p
Group	-4.54	0.99	-0.42	0.00
Age	-0.21	0.08	-0.31	0.01
Education	0.56	0.23	0.29	0.02
Having a daughter	1.03	1.05	0.09	0.33
Cultural attitude of collectivism	-1.04	0.75	-0.13	0.17
Childrearing burden	-0.31	0.68	-0.04	0.65

$R = 0.75$, $R^2 = 0.56$, $F = 11.90$, $p < 0.001$.

Overall error rate on the Attention Network Test (ANT). The regression model was not significant, that is, a linear relationship of the dependent variable to the independent variables was not met (see Table 17).

Table 17
Cultural Predictors of Attention Network Test (ANT) Error Rates (N = 64)

Variable	B	SE B	β	p
Group	4.26	1.82	0.30	0.02
Age	0.21	0.15	0.22	0.18
Education	0.17	0.42	0.07	0.69
Having a daughter	0.48	1.92	0.03	0.81
Cultural attitude of collectivism	-0.36	1.36	-0.03	0.79
Childrearing burden	0.84	1.24	0.09	0.50

$R = 0.37$, $R^2 = 0.14$, $F = 1.52$, $p > 0.1$.

Overall reaction time on the Attention Network Test (ANT). Being in the breast cancer group ($t = 2.48$, $p = 0.02$), older age ($t = 4.76$, $p < 0.001$), and strong cultural attitude of collectivism ($t = 2.41$, $p = 0.02$) were found as significant predictors of longer reaction time on the ANT. These variables accounted for 51% of the variance in the overall reaction time on the ANT, multiple $R = 0.71$, $F (6, 57) = 9.78$, $p < 0.001$ (see Table 18). However, childrearing burden was not a significant predictor.

Table 18
Cultural Predictors of Attention Network Test (ANT) Reaction Time (N = 64)

Variable	B	SE B	β	p
Group	57.31	23.07	0.24	0.02
Age	9.15	1.92	0.59	0.00
Education	-1.72	5.32	-0.04	0.75
Having a daughter	-0.62	24.40	-0.00	0.98
Cultural attitude of collectivism	41.72	17.32	0.24	0.02
Childrearing burden	-20.30	15.73	-0.13	0.20

$R = 0.71$, $R^2 = 0.51$, $F = 9.78$, $p < 0.001$.

Attentional Function Index (AFI). Childrearing burden, group, and having a daughter, were found as significant predictors while cultural attitude of collectivism was not a significant predictor of perceived effectiveness in cognitive functioning. These variables accounted for 53% of the variance in the total score of the AFI, multiple $R = 0.74$, $F (6, 57) = 10.48$, $p < 0.001$ (see Table 19). Specifically, being in the breast cancer group ($t = -6.59$, $p < 0.001$) and greater childrearing burden ($t = -2.07$, $p = 0.04$) predicted lower perceived effectiveness in cognitive functioning, while having a daughter ($t = 2.63$, $p = 0.01$) predicted better effectiveness in cognitive functioning.

Table 19
Cultural Predictors of Attentional Function Index (AFI) (N = 64)

Variable	B	SE B	β	p
Group	-2.24	0.34	-0.62	0.00
Age	0.00	0.03	0.02	0.88
Education	-0.07	0.08	-0.11	0.36
Having a daughter	0.94	0.36	0.25	0.01
Cultural attitude of collectivism	0.14	0.26	0.05	0.60
Childrearing burden	-0.48	0.23	-0.20	0.04

$R = 0.74$, $R^2 = 0.53$, $F = 10.48$, $p < 0.001$.

- *Research Question 2.3. What is the relationship between self-blame tendencies and cognitive performance and perceived effectiveness in attention and working memory function in women treated with chemotherapy for breast cancer?*

Additional correlation analyses were conducted in the group of women treated for breast cancer in order to examine the association between self-blame tendency with breast cancer diagnosis and cognitive function (see Table 20). Both behavioral and characterological self-blame scores ranged from a low of 1.00 to a high of 4.00. The mean of behavioral self-blame was 2.06 (SD = 0.98) and the mean of characterological self-blame was 1.56 (SD = 0.80). Interestingly, behavioral and characterological self-blame showed different associations with cognitive test performance and perceived cognitive function, although these two types of self-blame are highly correlated with each other (see Table 20). Behavioral SB scores were moderately associated with the overall mean reaction time on the ANT ($r = 0.38$, $p < 0.05$), indicating that women with breast cancer who reported higher level of behavioral self-blame (i.e. how much do you blame yourself for the kinds of things you did?) showed longer reaction time on the ANT. No significant correlations were found between behavioral self-blame and other cognitive test performance and the total mean score of the AFI. In contrast, characterological self-blame (i.e. how much do you blame yourself for the kind of person you are?) was significantly correlated with the total mean score of the AFI ($r = -0.35$, $p < 0.05$) but not associated with actual performance on any cognitive test. The finding indicated that women with breast cancer who showed greater characterological self-blame perceived lower effectiveness in cognitive functioning. Self-blame was not used for regression analyses because this factor was assessed in only women treated for breast cancer.

Table 20
Correlations between Cognitive Function and Self-Blame (N = 32)

	1	2	3	4	5
1. Behavioral SB	-	-	-	-	-
2. Characterological SB	0.78***	-	-	-	-
3. Total cognitive score	-0.20	-0.09	-	-	-
4. Overall error rate[a]	0.07	-0.17	-0.34	-	-
5. Overall reaction time[a]	0.38*	0.15	-0.50**	0.13	-
6. AFI	-0.23	-0.35*	0.05	0.01	0.10

Note. SB = self-blame.
[a] scores of the Attention Network Test.
* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Summary

To determine possible predictors of cognitive test performance and perceived effectiveness in attention and working memory function in Korean women, correlation and multiple regression analyses were conducted. The total cognitive score, the overall error rates on the ANT, the overall mean reaction time on the ANT, and the total mean score of the AFI were used as dependent variables, respectively. To select potential predictors for each regression model of cognitive function, correlation coefficients were calculated between cognitive measures and demographic characteristics, physical and psychological symptoms (fatigue, anxiety, depressed mood, sleep, overall symptom severity, and mean number of symptoms), and cultural characteristics (cultural attitude of collectivism, housework burden, and childrearing burden). First, age, years of education (education), and having a daughter were selected and used as common variables of regression models. Second, depressed mood and the mean number of symptoms regardless of severity were selected as potential predictors having no risk of multicollinearity or conceptual redundancy. Last, two cultural characteristics, cultural attitude of collectivism and childrearing burden, were selected for regression analyses.

Being in the breast cancer group was consistently found to be a significant predictor in all regression models. Older age and lower educational level were significant predictors of poorer cognitive test performance including the total cognitive score and the overall reaction time on the ANT, while having a daughter was found as a culturally significant predictor of higher mean score of the AFI, that is, better effectiveness in cognitive function. Of physical and psychological symptoms, the mean number of symptoms regardless of severity was commonly found to be an important predictor of both actual test performance and effectiveness in cognitive functioning. Depressed mood was a significant predictor of perceived effectiveness in cognitive functioning but not of actual test performance. Interestingly, cultural attitude of collectivism was a significant predictor of cognitive performance and childrearing burden was found as a significant predictor of perceived cognitive function.

Based on findings of correlation and regression analyses, the theoretical framework of cognitive deficits suggested in this study could be revised (see Figure 18). Importantly, age and education are important variables which need to be considered when assessing attention and working memory function. Other demographic and health characteristics did not show significant influences on cognitive function. Having a daughter is another meaningful factor which may influence perceived effectiveness in cognitive function in Korean women. Of physical and psychological variables having significant correlations with cognitive function, the mean number of symptoms and depressed mood should be assessed to clearly understand factors associated with deficits in attention and working memory function. Notably, cultural attitude of collectivism and childrearing burden were main cultural characteristics which showed significant effects

on cognitive function in this sample of Korean women. Finally, self-blame tendency surrounding breast cancer diagnosis is worthy of notice. Specifically, higher behavioral self-balme impacts poorer cognitive performance and higher levels of characteroloical self-blame negatively influence lower effectiveness in attention and working memory function. This finding indicates that these two types of self-blame tendencies differently contribute to attention and working memory deficits.

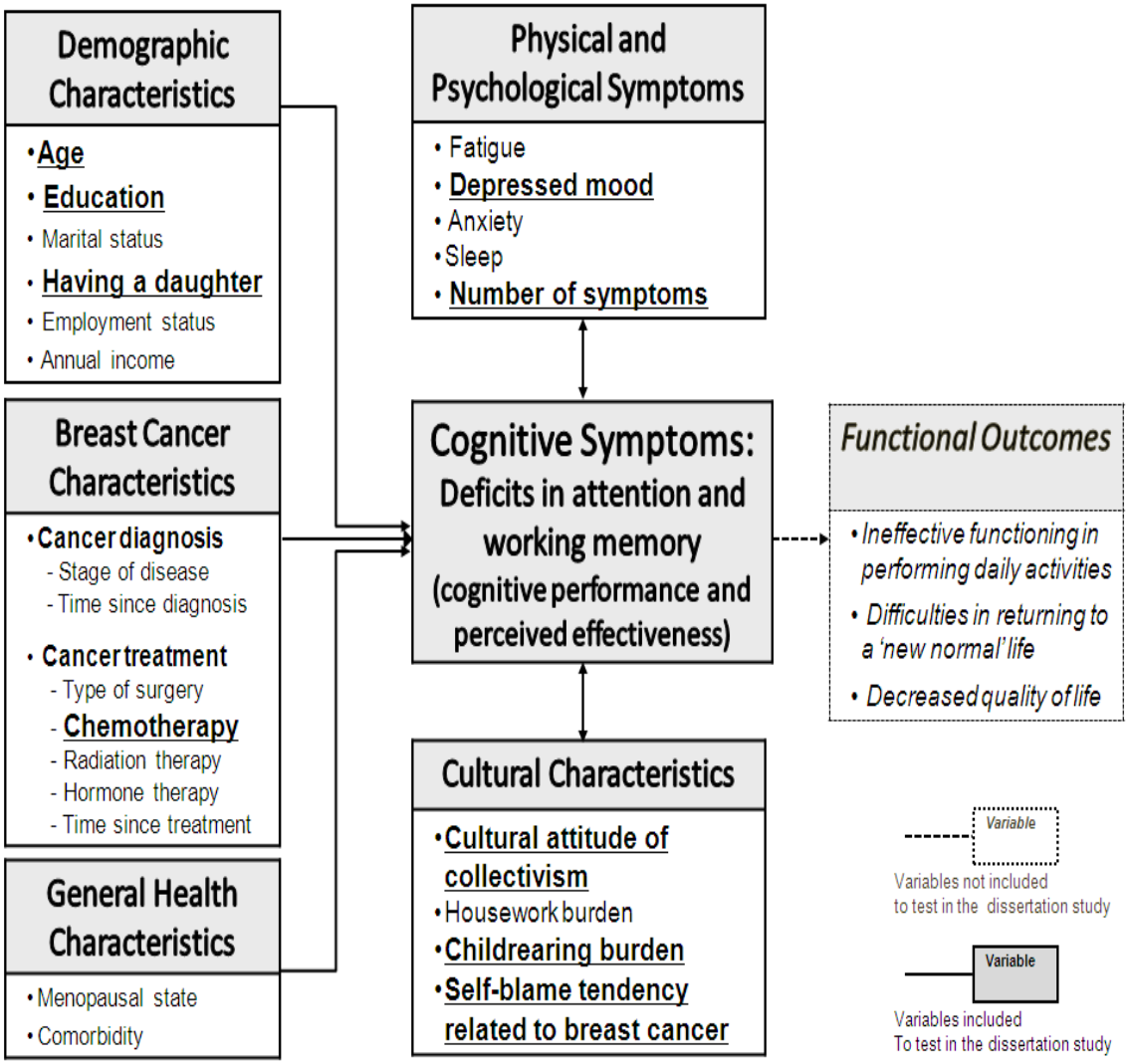


Figure 18. Revised Theoretical Framework of Cognitive Deficits in Korean Women with Breast Cancer. Potential predictors determined in this study were highlighted in bold and underlined.

CHAPTER VIII

DISCUSSION

This comparative cross-sectional study is the first to investigate cognitive deficits in Korean women treated with chemotherapy for breast cancer using a comparison of healthy women similar in age and education level. The purposes of this study were to examine the impact of adjuvant chemotherapy on attention and working memory function in Korean women treated with chemotherapy for early stage breast cancer and to explore potential predictors of cognitive deficits. Specifically, the incidence and severity of cognitive deficits were examined using standardized cognitive tests and a self-report measure of attention and working memory function. Due to the impact of a cancer diagnosis and treatment on cognitive function, it was hypothesized that Korean women treated with chemotherapy for breast cancer would experience greater deficits in attention and working memory than those without breast cancer. Furthermore, this study determined the effects of individual factors (demographic and general health characteristics, physical and psychological symptoms, and cultural characteristics) on cognitive test performance and perceived effectiveness in attention and working memory function.

Discussion of Sample Characteristics

Thirty two Korean women treated with chemotherapy for early stage breast cancer and 32 demographically similar healthy controls were enrolled in this study. Demographic and medical characteristics in the breast cancer group were consistent with

previous studies conducted in Korean women treated for breast cancer (Choi et al., 2011; S. H. Kim et al., 2008; Lee, 2005; Park et al., 2009; Suh, 2007; Yoo et al., 2009). The mean age was similar to that reported in Choi and her colleagues' systematic review of 32 intervention studies for Korean women with breast cancer (Choi et al., 2011). According to the recent report of cancer prevalence in the Statistics Korea, the highest incidence of breast cancer occurred in women between 40 and 49 years of age (39%) and the next highest incidence was in women between 50 and 59 years of age (26%) and in women between 30 and 39 years of age (14%) (Korean Statistical Information Service, 2011a). Of note, approximately 80% of breast cancer patients were diagnosed before 60 years of age, that is, breast cancer in Korea has been more prevalent in premenopausal women than in perimenopausal or menopausal women. The fact that only one third of the participants in this study were post-menopausal women reflected the characteristics of a Korean breast cancer population.

Most of participants in both groups were well educated and currently married, which is similar to reports in previous studies conducted in Korean breast cancer survivors (S. H. Kim et al., 2008; Park et al., 2009; Suh, 2007; Yoo et al., 2009). As most women treated with chemotherapy for breast cancer in this study were unemployed, other previous studies showed that a majority of women were not employed outside the home (S. H. Kim et al., 2008; Park et al., 2009; Suh, 2007). Further, the average number of children in women with breast cancer was consistent with that of one other study (Jeong & Park, 2007), but there were no studies reporting the number of sons and daughters, respectively. Finally, the annual household income of less than $36,000 reported by a majority of chemotherapy-treated breast cancer participants was also consistent with

other studies (Jeong & Park, 2007; S. H. Kim et al., 2008; Suh, 2007), indicating that the reported average annual income in this study was slightly lower than the average annual household income reported by the Statistics Korea Department (Korean Statistical Information Service, 2011b).

Taken together, chemotherapy-treated breast cancer participants in this study reflected demographic and medical characteristics of the Korean breast cancer population, and, importantly, demonstrated the relatively early onset of their illness as compared with age-specific breast cancer incidence in the United States (SEER, 2011). In addition, most participants were middle-aged married women with pre-adolescent or adolescent children. These women are responsible for caring for their children and maintaining a balance between the new responsibilities of taking care of themselves and their previous obligations to perform their duties at home.

Discussion of Results

The Impact of Chemotherapy on Cognitive Function

The first specific aim of this study was to investigate the incidence and severity of deficits in attention and working memory function in Korean women approximately four months following adjuvant chemotherapy for early stage breast cancer. Selected objective and subjective measures are theoretically congruent and sensitive methods for evaluating attention and working memory function (Cimprich et al., 2011; Lezak, 2004).

As hypothesized, Korean women treated for breast cancer showed poorer actual performance on attention and working memory tests than women in the healthy control group. In addition, effect sizes for these comparisons between two groups were moderate to large. These group differences were consistent with findings of other studies which

reported that chemotherapy adversely impacted cognitive function in western women with breast cancer (Ahles et al., 2002; Brezden et al., 2000; Castellon et al., 2004; Schagen et al., 2009; Schagen et al., 1999; van Dam et al., 1998; Wefel et al., 2010; Wieneke & Dienst, 1995). However, the findings of these other studies need to be interpreted with caution because of methodological heterogeneity, such as time interval between testing and completion of treatment, cognitive measures used, and types of control groups included for comparison. Nevertheless, an important finding of the present study showed a greater susceptibility to cognitive deficits in Korean women about four months following chemotherapy for breast cancer than healthy women similar in age and education without breast cancer. Findings of this study suggest that breast cancer and its treatment may lengthen the return to a "normal" level observed in healthy women without breast cancer or delay the full recovery from the cancer and cancer treatment. This finding also was supported by a recently published longitudinal study of 42 women with breast cancer assessed before, during, and after chemotherapy (Wefel et al., 2010). In that study, 24 participants (65%) had cognitive deficits during and two months after chemotherapy. All women (n = 9) with pre-chemotherapy cognitive deficits showed continued cognitive deficits following chemotherapy. Thus, the adverse effect of chemotherapy still needs to be considered as an important factor associated with cognitive deficits in Korean women following adjuvant chemotherapy for breast cancer.

Another important finding in this study is that deficits in specific attention and working memory domains were found in Korean women treated for breast cancer as compared with Korean women without breast cancer. Several studies in western populations also showed that attention and working memory were the most commonly

affected domains of cognitive function following chemotherapy (Ahles et al., 2002; Bender et al., 2006; Castellon et al., 2004; Hermelink et al., 2007; Jansen et al., 2011; Jim et al., 2009; Quesnel et al., 2009; Schagen et al., 1999; van Dam et al., 1998; Wefel et al., 2010; Wieneke & Dienst, 1995). Interestingly, recent neuroimaging studies also showed that chemotherapy-treated breast cancer survivors had poorer performance on attention and working memory tests than healthy women and breast cancer survivors treated with local therapy (Deprez et al., 2011; Ferguson, McDonald et al., 2007; Inagaki et al., 2007; McDonald et al., 2010; Saykin et al., 2006). Further, these studies reported that these domain-specific problems of cognitive function in chemotherapy-treated breast cancer survivors were associated with changes in brain structure and neuronal activity. Accordingly, it would be important in further research to evaluate domain-specific cognitive function in order to clearly understand the nature of cognitive deficits and to assist chemotherapy-treated breast cancer survivors to improve their quality of life through the transition period after treatment.

Notably, higher incidence and greater severity of cognitive deficits were found in Korean women treated with chemotherapy for breast cancer than in Korean women without breast cancer. Approximately 60% of women in the breast cancer group showed mild or moderate cognitive deficits assessed by performance on the DSF, the DSB, and the COWA tests. In order to gain more precise information about the incidence of cognitive deficits, further investigation is needed before, during, and following chemotherapy.

Regarding the severity of cognitive deficits, poor performance on attention and working memory tests was observed in this study, as compared with findings of previous

studies conducted in western women with breast cancer. Specifically, the mean scores of digit span tests in the present study were slightly lower than DSF and DSB scores in other previous studies (Cimprich, 1993; Cimprich & Ronis, 2003). However, when comparing actual performance on digit span tests in other Koreans with illness, the severity of cognitive deficits in Korean breast cancer survivors was similar to those of other Korean groups with cognitive impairment. The mean on the DSF in this study was slightly lower than a span of 6.1 in Korean people with major depressive disorder and lower than that of 6.6 in Korean people with early stage Alzheimer's disease. The DSB score was similar to a mean score of 4.1 in Korean people with early stage Alzheimer's disease and lower than 4.4 in the group with major depressive disorder (Ahn, Kim, Kim, & Kim, 2000).

Actual performance on the COWA test in Korean women treated with chemotherapy for breast cancer was also lower than those in western breast cancer survivors treated with chemotherapy (Donovan et al., 2005; Vearncombe et al., 2009), although Korean and western participants showed similar characteristics in terms of age, educational level, menopausal state, and stage of disease. In particular, a study conducted in western women with breast cancer one month following chemotherapy showed lower COWA scores than that in Korean women with breast cancer four months following chemotherapy in this study (Vearncombe et al., 2009). When considering that longer time from treatment seems to be associated with better cognitive test performance (H. G. Fan et al., 2005), it can be expected that as time since completion of chemotherapy is longer, actual performance on cognitive tests may be better. However, the mean COWA scores in chemotherapy-treated Korean breast cancer survivors were still much lower than that of western breast cancer survivors following chemotherapy. This finding reflects that

chemotherapy-treated Korean breast cancer survivors may be at high risk for cognitive problems shortly after treatment.

Furthermore, women treated for breast cancer in this study showed lower scores on part A of the COWA test (mean score = 24) than Korean individuals with obsessive compulsive disorder or schizophrenia (36, and 34, respectively). In contrast, the mean score of 34 on part B of the COWA test in the breast cancer group was slightly higher than those of aforementioned groups (Ahn et al., 2000, Kim, 2005). Taken together, these findings reveal that chemotherapy-treated Korean women are more likely than western women with breast cancer and other Korean groups with mild cognitive impairments to have actual difficulties in attention and working memory function after chemotherapy for early stage breast cancer.

The Attention Network Test (ANT) was used to assess different aspects of attention (alerting, orienting, and executive control attention system) in this study. Significantly higher error rates and longer reaction times on all high demand conditions (no cue, center cue, and incongruent flanker) were exhibited in chemotherapy-treated breast cancer participants versus healthy women without breast cancer. These differences in behavioral performance on the ANT were still found even when controlling for age and educational level. In addition, significant group differences in error rates and reaction times on the executive control attention system were found, reflecting that women treated with chemotherapy for breast cancer showed poorer performance in controlling the interference effect of the incongruent flankers (pointing in opposite direction than a target arrow) than healthy women without breast cancer. The findings suggest that in the short-term following adjuvant chemotherapy for breast cancer women lacked the capacity to

suppress distracting information in performing tasks of executive function and thus easily lost focus on tasks when responding to increasing demands on attentional capacity.

In addition to poor performance on standardized cognitive tasks, chemotherapy-treated Korean breast cancer survivors in the present study perceived poorer cognitive function on the self-report measure, AFI, than western women prior to surgery, during adjuvant treatment, or following adjuvant chemotherapy (Cimprich, 1999; Jansen et al., 2011; Jansen et al., 2008; Merriman et al., 2011). Specifically, the total mean score of 5.3 on the AFI in Korean women with breast cancer was lower than those reported by western women with breast cancer in four other studies (mean scores ranging from 6.2 to 7.0). This finding indicates that Korean women treated with chemotherapy for breast cancer experienced a lower level of effectiveness in cognitive functioning as compared with western women treated for breast cancer. Furthermore, effect sizes for group mean difference in total score and three subscales of the AFI were large in this study. A recently published study determined effect sizes of differences in the AFI scores between 73 breast cancer patients and 82 prostate cancer patients before the start of adjuvant radiation therapy (Merriman et al., 2011). Prostate cancer patients did not receive any adjuvant treatment while 55% of breast cancer patients underwent adjuvant chemotherapy before radiation therapy. In that study, breast cancer patients reported significantly lower scores of the total AFI and one subscale, effective action, than prostate cancer. The effect sizes of the between-group differences were small to moderate (d = 0.42 for effective action, d = 0.32 for the total score), and were smaller than those reported in this study. The findings in the present study suggest that clinically meaningful differences in perceived cognitive function as measured by the AFI were observed

between Korean women treated with chemotherapy for breast cancer and healthy Korean women without breast cancer.

Potential Predictors of Cognitive Deficits

The second objective of this study was to determine the effects of potential factors (demographic and general health characteristics, physical and psychological symptoms, and cultural characteristics) on neuropsychological performance and perceived effectiveness in attention and working memory function.

Age and educational level were found to be significant predictors of actual performance on most of standardized cognitive tests even after controlling for other possible covariates. This finding was consistent with previous studies (Ahles et al., 2002; Cimprich et al., 2005; Schagen et al., 2002). These studies commonly showed that a younger age and a higher educational level yielded a better performance on attention and working memory tests in women following and even prior to breast cancer treatment.

In contrast, age was not significantly related to perceived effectiveness in cognitive functioning in this study. However, two previous studies reported that younger age was significantly correlated with lower scores of perceived cognitive function (Cimprich et al., 2005; Merriman et al., 2011). Thus, the effect of age on perceived cognitive function remains unanswered due to the difference in age ranges of participants across studies. For example, participants in the present study were young and middle-aged (31 – 61 years of age) women, while women with breast cancer in a study by Cimprich et al (2005) ranged from 28 to 86 years of age. Further examination of the age effect on perceived effectiveness in attention and working memory is needed in Korean women with breast cancer.

An unexpected finding was that having a daughter significantly predicted better perceived effectiveness in cognitive functioning. The positive effect of having a daughter on cognitive function still remained even when controlling for other individual covariates such as age, educational level, physical and psychological symptoms or cultural characteristics. Further, women with daughters did not show significant differences in age and educational levels as compared with women without daughters, indicating that the variable of having a daughter does not act as proxy for age or educational level. This finding seems to be worthy of notice in terms of supportive relationships between mothers and daughters observed in Korean families. Gender of parent-child dyad appears to influence the level of perceived support in Korean culture. Of interest, the most supportive relationship is shown in the mother-daughter pairing (Lee et al., 2008). When a mother is sick, this supportive relationship seems to be strengthened by shifting the mother's childrearing attitudes from protective parenting to recognizing her children as independent and strong beings. Although no studies have explored the changing pattern of relationships between Korean mothers with cancer and her daughters, a qualitative study to explore the impact of breast cancer on mothering in Korean women reported that women with breast cancer reframed their mothering roles as "letting-go" instead of taking care of their children who are dependent on their parents due to the cultural attribution of familism in Korea. Likewise, five other qualitative studies that assessed Korean women's experiences following breast cancer diagnosis and its treatment reported that a daughter having a mother with breast cancer tended to act as a supportive system in terms of mature attitudes as an independent being, assuming responsibilities for their own duties, and providing tangible assistance in performing household chores (Cho, 2002; Im et al.,

2002; Kim et al., 2011; Kim, 2011; Shin, 1995). This finding suggests that a mother-daughter relationship can contribute to women's perception of reduced cognitive demands in a way that improves perceived effectiveness in attention and working memory function for everyday activities.

Importantly, the present study is a first report demonstrating the detrimental impact of the number of symptoms on both objective performance and subjective perception on cognitive function. The mean number of symptoms reported on the BCPT checklist was found as an important covariate of deficits in attention and working memory as measured with standardized cognitive tests and a self-report. Previous studies showed that poorer cognitive function was significantly correlated with greater symptom distress or a higher number of symptoms in women with breast cancer (Cimprich, 1999; Cimprich et al., 2005). In particular, as women with breast cancer experienced higher numbers of symptoms, they reported lower effectiveness in cognitive functioning even before a start of treatment (Cimprich, 1999). A possible explanation may be that a higher number of symptoms regardless of severity increase physical discomfort requiring more cognitive effort in performing intended activities (Cimprich, 1999; Jansen & Keller, 1998). Therefore, Korean women with breast cancer are likely to encounter greater symptom burden, leading to deficits in attention and working memory following adjuvant chemotherapy.

Consistent with the theoretical framework of this study, depressed mood was significantly correlated with neuropsychological performance. Although this correlation was small, the finding is consistent with previous research suggesting that depression may detrimentally affect cognitive performance on neuropsychological measures in

breast cancer survivors following chemotherapy (Bender et al., 2006; Reich, Lesur, & Perdrizet-Chevallier, 2008; Schagen et al., 2002; Vearncombe et al., 2009). Although heterogeneous measures for assessing depression and cognitive function have been used across studies, the impact of depressed mood state on cognitive performance of attention and working memory has been consistently reported in breast cancer survivors treated with adjuvant treatment. Of interest, one study using PET imaging which was conducted in Korean breast cancer patients with clinically diagnosed depressive symptoms demonstrated that higher levels of depressed mood state were significantly correlated with worse behavioral performance of attention and reduced glucose metabolism in bilateral dorsolateral prefrontal cortices. That study suggested that depression in women with breast cancer may contribute to deficits in prefrontal-dependent cognitive function such as concentrating on target information and inhibiting irrelevant distractors (L. S. Kim et al., 2008)

Depressed mood was also significantly associated with perceived effectiveness in cognitive functioning, consistent with previous studies (Bender et al., 2006; Castellon et al., 2004; Reid-Arndt et al., 2010; van Dam et al., 1998). Although there was a difference in the strength of correlations between depression and objective and subjective measures of cognitive function, depression is another common important factor that can have a detrimental effect on both objective performance and perception of attention and working memory function. Of note, the mean score of 8.31 on depression measured by the HADS in the present study was higher than those reported in two other studies using the same measure (Li & Yuan, 2011; Vearncombe et al., 2009). Specifically, in a study conducted in 136 western women treated for breast cancer, participants had a mean depression score

of 3.57 one month following chemotherapy (Vearncombe et al., 2009). In the other study conducted in 252 Chinese women currently receiving chemotherapy, the mean depression score was 7.48 which was slightly lower than that reported in Korean women in the present study (Li & Yuan, 2011). This finding suggests that Korean women treated with chemotherapy for breast cancer may experience more depressive symptoms than western breast cancer survivors treated with chemotherapy, as well as other Asian breast cancer patients having a similar cultural background (collectivism). Further investigations are needed to explore why chemotherapy-treated Korean breast cancer survivors experience a greater depressed mood surrounding their disease and treatment and to provide a better understanding about the association between cognitive deficits and depression following chemotherapy.

Of cultural characteristics, cultural attitude of collectivism was significantly correlated with slower response time on the ANT, while childrearing burden was meaningfully related to perception of effectiveness in cognitive function measured by the AFI. Although there has been no systematic review about the effect of Korean culture on individual responses to breast cancer and its treatment, greater collectivist tendency may contribute to more cognitive burden requiring greater exertion of mental effort to effectively perform everyday activities. From the perspective of cultural psychology about the effect of collectivism, Korean women with strong collectivist tendency may 1) engage in holistic processing, a mode of thought emphasizing the relationship between objects and their contexts and contextual representations of self-knowledge (Markus & Kitayama, 1991; Nisbett et al., 2001), 2) be oriented toward significant others such as family members rather than toward themselves, 3) value restraint in emotional expression

for maintaining in-group harmony, and 4) avoid actions which may emphasize differences among group members (Cho, 1997; Kitayama et al., 2006; Nisbett & Masuda, 2003). In this regard, it is possible to note that having a breast cancer diagnosis can be associated with cognitive burden in Korean women requiring additional mental effort in restraining verbal expression about their illness and in dealing with a feeling of guilt associated with a belief that their families are sacrificed because of having a breast cancer patient as a family member (Ashing-Giwa et al., 2004;Im et al., 2002; Jun, 1994; Y. I. Kim, 1998; Park, 2003; Shin, 1995).

Participants in this study reported greater stress in performing household chores than other middle-aged Korean women (Chon & Kim, 2003), indicating that women's perceived burden associated with housework performance in this study was high, regardless of having a breast cancer diagnosis. Housework burden was not significantly associated with actual performance on any cognitive test, while greater perception of housework burden showed a tendency to be associated with lower effectiveness in cognitive functioning. However, it was not found to be a significant predictor of objective and subjective cognitive function. Over time, Korean women may have gradually adapted themselves to social expectations of their role performance. Accordingly, greater perceived housework burden may not directly act as a life demand which requires exerting additional cognitive effort in Korean women.

In contrast, childrearing burden seems to be a culture-specific life demand in Korean women with breast cancer. Generally, previous studies show that Korean women have higher levels of childrearing burden (Chang, 1999; D. W. Lee, 1997; Song & Kim, 2003). When Korean women are diagnosed with a life-threatening illness such as cancer,

they may suffer from significant physical difficulties and self-blame secondary to perceived functional weakness in taking care of their children, due to cultural expectation of protective mothering roles (Im et al., 2002; Jun, 1994; N. Kim et al., 2003; Youn & Tae, 2004). Furthermore, they may struggle to maintain a balance between focusing on themselves for self-care as a cancer survivor and fulfilling the existing obligations of caring for their children as a mother (Kim et al., 2011). Accordingly, Korean women with breast cancer are more likely than healthy Korean women to lose the needed balance, and the failure in balancing may act as an additional cognitive demand requiring the increased use of attention and working memory following breast cancer treatment.

Blaming oneself is a particular characteristic in Korean women with breast cancer. Self-blame is suggested as a way that women have used to explain the cause of their illness (Bennett et al., 2005). Previous studies showed that Korean women had a tendency to attribute their breast cancer to their "bad" behaviors or personality (Ashing-Giwa et al., 2004; Im et al., 2002; Y. I. Kim, 1998; Park, 2003; Shin, 1995). Ruminating on negative information surrounding self may interfere with coping with affective demands when adjusting to life adversities (Glinder & Compas, 1999). This theoretical suggestion can be a possible explanation of the finding that greater self-blame was significantly associated with poorer actual performance and lower perceived effectiveness in attention and working memory function in women with breast cancer in this study.

Strengths and Limitations

This study is a first report to examine cognitive deficits in Korean women treated with adjuvant chemotherapy for early stage breast cancer and to explore whether Korean

culture affects cognitive function in these women. Based on findings of this study, breast cancer survivors with collectivistic culture such as Korean culture may have poorer cognitive performance and perceived reduced effectiveness in cognitive functioning as compared with healthy women with the same cultural background. Further, the present study can contribute to better understanding of cognitive deficits in ethnic minority women with breast cancer. Findings suggest the possibility that breast cancer survivors with a collectivistic culture may have greater cognitive problems than those in a western culture of individualism.

Another strength of this study is that it provides a theoretical neuro-cognitive model of cognitive deficits in relation to culture-specific characteristics and culture-general attributes of demographic characteristics and physical and psychological symptoms. Cognitive deficits were associated with demographic characteristics and selected physical and psychological symptoms. In addition to culture-general attributes, culture-specific characteristics were also found to be important predictors. Specifically, cultural tendency of collectivism was associated with deficits in cognitive performance while childrearing burden, a cultural characteristic of Confucian familism, was correlated with perceived effectiveness in cognitive functioning. Thus, the theoretical framework of this study can be an appropriate initial model to examine cognitive deficits in minority breast cancer survivors with strong tendency toward collectivism.

Finally, a strength of this study is that potential covariates of cognitive deficits were methodologically and statistically controlled. Methodologically, this study included the healthy control group with similar age and educational levels. In addition, most demographic and health characteristics were not significantly different between groups in

this study. Further, potential physical and psychological factors (fatigue, anxiety, depressed mood, sleep, and symptom distress) were selected on the basis of a systematic review of published studies. These factors were statistically controlled to clearly identify the effect of chemotherapy for breast cancer on cognitive function assessed by standardized cognitive tests and a self-reported measure.

The findings of the present study should be interpreted with careful attention to limitations. First, this study used a cross-sectional design with cognitive function being assessed at one time about four months following the completion of adjuvant chemotherapy. Participants were not evaluated before the initiation of adjuvant treatment and, likewise, long-term outcomes were not obtained in this study. As a consequence, it is unclear whether the current findings reflect an improvement, deterioration, or any change from baseline level of cognitive function prior to treatment. Further, this study cannot provide information about the late effects of chemotherapy on cognitive function.

A second limitation of this study is the absence of a comparison group of women with breast cancer receiving only local treatment such as radiation therapy and no chemotherapy. Findings indicate that cognitive deficits were observed in women treated with chemotherapy for breast cancer. However, it remains unclear whether cognitive problems may be associated with cancer diagnosis itself or even with cancer treatment other than chemotherapy.

A third limitation of the study is that potential treatment effects of other treatment modalities such as radiation or hormone therapy on cognitive function were not investigated due to the small sample size and the timing of assessment. All women in the breast cancer group were tested within four months following chemotherapy. Because

other adjuvant treatment is typically initiated after the completion of chemotherapy, a small number of participants were currently receiving radiation and/or hormone therapy as a part of the treatment plan. Thus, the sample for each of these treatment modalities was relatively small and possible effects of other treatments could not be determined.

Finally, participants were recruited by using convenience sampling. Although most demographic and health variables were similar in women with and without breast cancer, a difference in employment status was observed. Interestingly, there are no Korean studies that suggest employment status as a potential predictor of cognitive symptoms and no significant effect of employment status on cognitive deficits was found in this study. However, this finding may not reflect whether changes in employment status induced by breast cancer diagnosis and treatment are associated with cognitive function.

Recommendations for Future Research

Future studies are needed to examine whether there is a changing pattern of cognitive function across the entire period of cancer treatment. A longitudinal examination can shed light on several important research questions: 1) Which variables account for cognitive deficits before, during, and after cancer treatment?; 2) When is the critical period in providing therapeutic interventions to restore cognitive function?; and 3) Which cultural variables significantly influence a pattern of cognitive deficits in Korean women with breast cancer?

Next, extension of the study is needed with regard to examination of cognitive deficits and stage of disease, type of cancer treatment, and older women with breast cancer. The sample of this study represented main characteristics of Korean breast cancer

patients. On the other hand, the present study did not include women with older age, advanced or recurrent breast cancer, only local treatment such as radiation therapy, or hormone therapy, which may affect cognitive function. Accordingly, future studies are needed to establish better understanding about factors that may influence cognitive deficits in Korean women with breast cancer.

Another recommendation is replication of the study in breast cancer survivors between collectivist and individualist cultures. The cross-cultural comparison of cognitive deficits will provide important information about the effect of culture on cognitive problems in women with breast cancer and cultural attributes which need to be considered in designing therapeutic intervention to relieve cognitive problems.

Finally, a qualitative study is recommended to explore the influence of mother-daughter dyad relationships on perceptions of cognitive function. Interestingly, the finding of this study showed that women with a daughter reported better effectiveness in attention and working memory function than women without a daughter, although this study did not examine the mechanism of mother-daughter relationship on cognitive function. A future qualitative study would contribute to the investigation of how having a daughter can positively influence effectiveness in cognitive function in women with breast cancer.

Implication for Nursing Practice

Since 2001 the awareness of symptom distress related to breast cancer treatment has increased rapidly in advanced oncology nursing practice in South Korea. However, no studies have been conducted to identify cognitive problems in chemotherapy-treated Korean breast cancer survivors after treatment. This study is the first report of cognitive

deficits in Korean women with breast cancer versus those without breast cancer. This study demonstrates that chemotherapy-treated breast cancer survivors can experience cognitive deficits shortly after treatment. In this regard, the study findings can contribute to a better understanding of Korean women's cognitive deficits. Furthermore, application of findings to practice can enable Korean nurses to help breast cancer survivors return to their usual life pattern, improve their coping skills, and maintain their quality of life after the completion of cancer treatment. Accordingly, Korean nurses as primary care providers need to understand the impact of cancer treatment and other associated factors on cognitive function.

Assessment of attention and working memory is indispensible for identifying cognitive deficits in women treated for breast cancer. Standardized neuropsychological tests have been widely administered in studies of western women with breast cancer. However, many tests are not feasible for application in daily nursing practice because most take a relatively long time and specific training to administer. For this reason, assessment of attention and working memory function is not routinely conducted by Korean health care providers. Findings of the study suggest that a self-report measure, the Attentional Function Index, may be a useful tool in clinical assessment. This measure can be simply administered in a clinical setting and appears to be sensitive for detecting cognitive changes (Cimprich et al., 2010). Also, this self-report appears to be culturally relevant and appropriate for specifically evaluating attention and working memory function in Korean women with breast cancer. Nurses are in an ideal position to observe women's experiences with cognitive deficits. The application of this measure can help Korean nurses to identify cognitive problems in breast cancer survivors and to begin to

accurately estimate the impact of cancer treatment on daily activities requiring attention and working memory.

Various interventions such as cognitive behavioral therapy or nature-based interventions have been shown to be effective for reducing treatment-related symptoms and improving cognitive functioning in western women with breast cancer (Cimprich 1992a; Cimprich & Ronis, 2003; Ferguson, Ahles et al., 2007; Ferguson et al., 2010). These proven interventions can be considered for application to restore cognitive function for Korean breast cancer patients with cognitive deficits related to cancer diagnosis. Further research, however, is needed to evaluate the efficacy of these interventions and to modify techniques appropriate to Korean situations.

Cultural characteristics should be especially considered when tailoring proven interventions for Korean breast cancer survivors. In this study, a stronger tendency of collectivism was significantly associated with poorer cognitive function. Furthermore, perceived burden related to culturally ascribed role performance and self-blame tendency were shown to be important factors associated with cognitive problems. Health care providers can intervene with aforementioned cognitive approaches to lessen women's burden associated with collectivistic tendency and an overwhelming sense of responsibility toward women's role performance.

The beneficial effect of having a daughter is another culturally important factor which can be used in designing interventions for breast cancer survivors in a collectivistic culture. Many breast cancer participants in this study were frequently accompanied by their daughters or husbands for outpatient clinic visits. Women who visited the clinic alone were very rare. Active participation of family members in caring for women with

life-threatening illness is a typical feature in Korean culture and female family members often act as primary caregivers in the majority of cases. In this regard, this study suggests that family-centered interventions may be an important approach to encourage Korean breast cancer survivors in performing self-care to improve their attention and working memory function.

Conclusions

The findings of the present study support the hypothesis that chemotherapy exposure is significantly associated with deficits in cognitive function in Korean breast cancer survivors shortly after the completion of chemotherapy. Specifically, significant differences were observed in cognitive performance and perception between women treated with chemotherapy for breast cancer and healthy women without breast cancer. Likewise, women in the breast cancer group showed significantly higher rates of cognitive deficits defined with norm-referenced cut-off scores than women in the control group. Task performance on three attention systems measured by the ANT differed considerably between these two groups. Chemotherapy-treated participants had significantly higher error rates and longer reaction times particularly in the more demanding task conditions and in overall performance than healthy women without breast cancer. Significant alteration in the executive control system also was found in the breast cancer group compared with the healthy control group. Women treated with chemotherapy for breast cancer had reduced performance in the executive control system due to the greater interference from distractors. This suggests that women in the breast cancer group lacked the capacity to suppress confusing irrelevant information in performing tasks and were thus easily distracted when responding to increasing demands

on attention function. Consistent with cognitive deficits measured by standardized cognitive tests, women in the breast cancer group reported lower scores on self-reports of effectiveness in cognitive functioning than women in the control group. These differences in objective and subjective cognitive measures still existed even when controlling for other potential variables such as age and education. These findings indicated that adjuvant chemotherapy for breast cancer can detrimentally affect both neuropsychological performance and perceived effectiveness in attention and working memory functioning. The effect sizes for these group mean differences were moderate to large.

The study findings are in keeping with the emerging understanding that cognitive deficits are significantly correlated with demographic and medical characteristics and physical and psychological symptoms. Age and education were significantly correlated with cognitive test performance but not associated with perception of cognitive function, indicating that older age and lower educational level may predict poor actual performance in cognitive function, especially attention and working memory. Having a daughter was found to predict perceived effectiveness in cognitive function, indicating that having a daughter was associated with better effectiveness in attention and working memory function. Of physical and psychological symptoms, the number of symptoms regardless of severity was a common predictor of actual performance and perception on attention and working memory function while depressed mood predicted poorer perceived effectiveness in cognitive functioning. Cultural effects on cognitive function were found. Stronger cultural attitude of collectivism was a predictor of poorer performance on actual cognitive tests, while greater childrearing burden was found as a significant predictor of

poorer effectiveness in cognitive functioning. Finally, higher levels of behavioral self-blame regarding having a breast cancer diagnosis were significantly associated with lower test performance and higher levels of characterological self-blame were correlated with poorer perceived effectiveness in attention and working memory in the breast cancer group.

APPENDICES

Appdendix A

Measures

Appendix A1.
Digit Span Forward and Backward
(English Version)

Digits Forward

I am going to say some numbers. Listen carefully, and when I'm through, say them right after me. For example, if I say, 4 – 3, then you say, 4- 3. Ready? (Recite 1 digit/second)

Series			
3	7-4-9	1-7-4	_____(3)
4	8-5-2-1	5-2-9-7	_____(4)
5	2-9-6-8-3	6-3-8-5-1	_____(5)
6	5-7-1-9-4-6	2-9-4-7-3-8	_____(6)
7	8-1-5-9-3-6-2	4-1-9-2-7-5-1	_____(7)
8	3-9-8-2-5-1-4-7	8-5-3-9-1-6-2-7	_____(8)
9	7-2-8-5-4-6-7-3-9	2-1-9-7-3-5-8-4-6	_____(9)

Digits Backward

Now I'm going to say some more numbers, but this time when I stop, I want you to say the numbers backwards – exactly reversed – from the last to the first. For example, if I say, 4 – 3, then you would say, 3 – 4. Ready?

Series			
3	6-2-9	4-1-5	_____(3)
4	3-2-7-9	4-9-6-8	_____(4)
5	1-5-2-8-6	6-1-8-4-3	_____(5)
6	5-3-9-4-1-8	7-2-4-8-5-6	_____(6)
7	8-1-2-9-3-6-5	4-7-3-9-1-2-8	_____(7)
8	9-4-3-7-6-2-5-8	7-2-8-1-9-6-5-3	_____(8)
9	1-4-2-9-5-3-7-8-6	7-2-1-8-5-9-4-3-6	_____(9)

Digit Span Forward and Backward
(Korean Version)

앞으로 숫자 외우기
제가 몇개의 숫자를 불러드릴 것입니다. 주의해서 듣고, 제가 불러드리는 것이 끝나면, 들으신 숫자를 정확하게 불러주십시요. 예를들면, 제가 '사-삼'이라고 말했다면, 그 다음에 귀하께서 '사-삼'이라고 동일하게 말해주시면 됩니다. 준비되셨습니까? (초당 한 숫자씩 읽어주세요)

시리즈			
3	7-4-9	1-7-4	_____(3)
4	8-5-2-1	5-2-9-7	_____(4)
5	2-9-6-8-3	6-3-8-5-1	_____(5)
6	5-7-1-9-4-6	2-9-4-7-3-8	_____(6)
7	8-1-5-9-3-6-2	4-1-9-2-7-5-1	_____(7)
8	3-9-8-2-5-1-4-7	8-5-3-9-1-6-2-7	_____(8)
9	7-2-8-5-4-6-7-3-9	2-1-9-7-3-5-8-4-6	_____(9)

거꾸로 숫자 외우기
제가 몇개의 숫자를 더 불러드릴 것입니다. 하지만 이번에는 제가 불러드리는 것이 끝나면, 들으신 숫자를 정확하게 거꾸로, 뒤쪽에서 앞쪽으로, 암송해 주십시요. 예를들면, 제가 '사-삼'이라고 말했다면, 그 다음에 귀하께서 '삼-사'라고말해주시면 됩니다. 준비되셨습니까?

시리즈			
3	6-2-9	4-1-5	_____(3)
4	3-2-7-9	4-9-6-8	_____(4)
5	1-5-2-8-6	6-1-8-4-3	_____(5)
6	5-3-9-4-1-8	7-2-4-8-5-6	_____(6)
7	8-1-2-9-3-6-5	4-7-3-9-1-2-8	_____(7)
8	9-4-3-7-6-2-5-8	7-2-8-1-9-6-5-3	_____(8)
9	1-4-2-9-5-3-7-8-6	7-2-1-8-5-9-4-3-6	_____(9)

Appendix A2.
Controlled Oral Words Association Test
(English Version)

I will say a letter of the Korean alphabet. Then would you give me as many words that begin with that letter of the alphabet as quickly as you can?

For instance, if I say 'ㅂ (=bee-eub)', you might say: 'bagagi (=dipper)', 'booja (=richness)', 'berseut (=mushroom)' or booserk (=jewel)'.

Please do not say words that are proper nouns like 'boomunsan (=Boomun mountain)' or 'Busan (=Busan city; the name of city in Korea)'.

Also, please do not use the same word with a different ending such as 'booserk (=jewel)', and 'booserksangja (=jewel box)'. Use only one of them.

Any question?
Begin when I say the letter.
The first letter is "ㄱ (=gierk)". Go ahead.

Allow one minute for each letter: 'ㄱ, gierk', 'ㅅ, seeot', and 'ㅇ, eeung'

Now, I somewhat change a rule. Let's start speaking about names of 'animal.' Would you give me as many names of 'animals' within a minute?

Begin when I say 'start'
Are you ready?
'Start!'

Next category is "supermarket lists'
Are you ready?
"Start!"

Controlled Oral Words Association Test
(Korean Version)

제가 어떤 글자를 말한 뒤에 '시작'하면 그 글자로 시작하는 낱말을 빨리 많이 말씀하셔야합니다.

예를 들어서 제가 'ㅂ'자로 시작하는 낱말을 말씀하십시오'하면 '바가지, 부자, 버섯, 보석…'이런 식으로 말씀하시면 됩니다.

'보문산'이나 '부산'같은 고유 명사는 사용하지는 말아주세요.

또한 '보석' '보석상자'과 같이 단어의 뒤만 바꾼 단어들은 사용하지 말아주세요. '보석'이나 '보석상자' 중에 하나만 선택하여 사용해 주세요.

질문 있으세요?
제가 자음을 말하면 시작해 주세요.
자 그럼 시작합니다. 준비되셨져?
첫 번째 자음은 'ㄱ'입니다. 'ㄱ'자로 시작하는 낱말을 말씀해 주십시오. '시작'

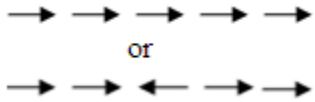
1 분후 그만이라고 말씀해 주세요.
각 자음당 1분씩 드립니다: 'ㄱ', 'ㅅ', 그리고 'ㅇ'

이번에는 규칙을 조금 바꾸겠습니다. '동물' 이름대기부터 시작하겠습니다. 제가 '시작'이라고 하면 동물의 이름을 아시는대로 빨리 말해 주세요. 준비되셨습니까?
"시작!"

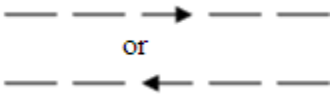
이번에는 "가게물건"입니다. 가게에서 파는 물건에 대해서 아시는대로 말씀해 주시면 됩니다. 준비되셨습니까?
"시작!"

Appendix A3.
Attention Network Test
(English Version)

Test Instructions:
This is a test of attention. Your task is to respond to the direction of the center arrow in a group of arrows. Sometimes, the arrow will be flanked by two arrows to the left and two arrows to the right for example:



Sometimes the arrow will be flanked by straight lines, for example:



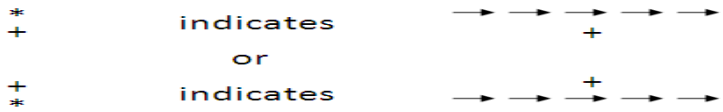
Again, your task is to respond to the direction of the CENTER arrow. You should press the left mouse button with your index finger if the center arrow points to the left or press the right mouse button with your middle finger if the center arrow points to the right. Please make your response as quickly and accurately as possible. Your response time and accuracy will be recorded.

There will be a plus sign (" + ") in the center of the screen. You should try to focus on the plus sign throughout the experiment.

Sometimes there will be an asterisk (*) showing when or where the arrow will occur.

For example to show WHEN the arrows will occur you might see:

For example to show WHERE the arrows will occur you might see:



The experiment has 4 parts:

1) Practice: 1 part, 2 minutes
2) Experiment: 3 parts, 5 minutes each

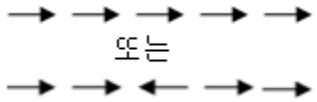
After each experiment part, there will be a message "take a break" and you may take a short rest. After your short rest, you can press the space bar to begin the next experiment part. The whole test takes about 15 minutes.

Are you ready?

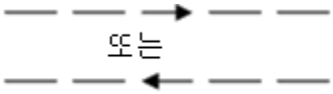
Put your right hand on the mouse and use your left hand to press the SPACE bar to start the practice session.

Attention Network Test
(Korean Version)

Test Instructions:
이것은 집중력 테스트입니다.가운데 위치한 화살표의 방향이 어느쪽을 향하고 있는지를 확인하여 답해주십시요. 때로는, 아래의 예와 같이 다른 화살표가 오른쪽 왼쪽에 각각 2 개씩 추가되어 나타날 수 있습니다:



또는, 화살표대신 직선이 양 옆에 나타날 수 있습니다. 예를 들면,

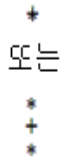


즉, 당신은 중앙에 위치한 화살표의 방향을 확인하여 답하는 것입니다. 중앙에 있는 화살표가 왼쪽을 향하고 있다면 검지손가락으로 왼쪽 버튼을 눌러주십시요. 만약 중앙에 있는 화살표가 오른쪽을 가르키고 있다면 중지손가락으로 마우스 버튼을 눌러주십시요.

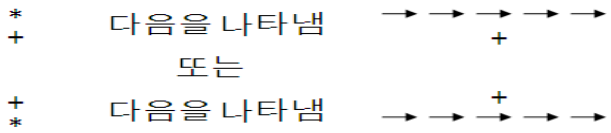
가능한 빠르고 정확하게답해주십시요. 귀하의 답변의 정확도와 소요시간이 기록될 것입니다.

스크린의 중간에 십자 표시("+")가 나타날 것입니다. 테스트동안 이 표시에 집중해 주십시요. 때때로, 화살표가 나타날 장소와 시간을 보여주는 별표(*)가 스크린에 나타날 것입니다.

첫째로, 화살표가 나타날 시간을 보여주는 별표 (*)에 대한 예입니다. 별표가 나타난 후 바로 화살표가 나타날 것입니다:



다음은, 어디에 화살표가 나타날지를 표시해주는 별표 (*)에 대한 예입니다.



테스트는 총 4 세트로 구성되어 있습니다.
1) 연습용: 첫 번째 세트로 2 분 소요
2) 실제 테스트: 총 3 세트로, 각 세트당 5 분 소요

매 세트가 끝날때마다, "휴식" 메시지가 표시되며 이때 짧은 휴식시간을 가질 수 있습니다. 휴식후, 스패이스 바를 눌러주시면 다음 테스트가 실행됩니다. 총 소요시간은 15 분입니다. 준비 되셧습니까?

오른손을 마우스에 올려주십시요.
연습용 테스트를 시작하시려면 왼손으로 스패이스 (SPACE) 바를 눌러주십시요.

Appendix A4.
Attentional Function Index
(English Version)

At this time, how well do you feel you are functioning in each of the areas below? Circle the number that best describes how you are doing in each area at present.

1. Getting started on activities (tasks, jobs) you intend to do.										
Not at all										Extremely well
0	1	2	3	4	5	6	7	8	9	10
2. Planning your daily activities.										
Not at all										Extremely well
0	1	2	3	4	5	6	7	8	9	10
3. Following through on your plans.										
Not at all										Extremely well
0	1	2	3	4	5	6	7	8	9	10
4. Doing things that take time and effort.										
Not at all										Extremely well
0	1	2	3	4	5	6	7	8	9	10
5. Making your mind up about things.										
Not at all										Extremely well
0	1	2	3	4	5	6	7	8	9	10
6. Finishing things you have started.										
Not at all										Extremely well
0	1	2	3	4	5	6	7	8	9	10
7. Keeping your mind on what you are doing.										
Not at all										Extremely well
0	1	2	3	4	5	6	7	8	9	10
8. Remembering to do all the things you started out to do.										
Not at all										Extremely well
0	1	2	3	4	5	6	7	8	9	10

9. Keeping track of what you are saying or doing (keeping your train of thought).

Not at all — Extremely well

0 1 2 3 4 5 6 7 8 9 10

10. Keeping your mind on what others are saying.

Not at all — Extremely well

0 1 2 3 4 5 6 7 8 9 10

11. Keeping yourself from saying or doing things you did not want to say or do.

Not at all — Extremely well

0 1 2 3 4 5 6 7 8 9 10

12. Being patient with others.

Not at all — Extremely well

0 1 2 3 4 5 6 7 8 9 10

II. At this time, how would you rate yourself on:

13. How hard you find it to concentrate on details.

Not at all — A great deal

0 1 2 3 4 5 6 7 8 9 10

14. How often you make mistakes on what you are doing.

Not at all — A great deal

0 1 2 3 4 5 6 7 8 9 10

15. Forgetting to do important things.

Not at all — A great deal

0 1 2 3 4 5 6 7 8 9 10

16. Getting easily annoyed or irritated.

Not at all — A great deal

0 1 2 3 4 5 6 7 8 9 10

Attentional Function Index
(Korean Version)

현 시점에서 볼 때, 귀하께서 다음의 질문에 해당되는 일들을 얼마나 잘 수행하고 있다고 생각하십니까? 귀하의 상태를 가장 잘 반영하고 있다고 생각되는 번호에 동그라미 쳐주십시요.

1. 하고자 의도한 활동 (일, 업무)를 시작하기										
전혀 못함										아주 잘함
0	1	2	3	4	5	6	7	8	9	10
2. 매일 할 일들을 계획하기										
전혀 못함										아주 잘함
0	1	2	3	4	5	6	7	8	9	10
3. 계획한 것을 수행하기										
전혀 못함										아주 잘함
0	1	2	3	4	5	6	7	8	9	10
4. 시간과 노력을 필요로 하는 일들을 수행하기										
전혀 못함										아주 잘함
0	1	2	3	4	5	6	7	8	9	10
5. 할 일을 결정하기										
전혀 못함										아주 잘함
0	1	2	3	4	5	6	7	8	9	10
6. 시작한 일을 끝까지 마무리하기										
전혀 못함										아주 잘함
0	1	2	3	4	5	6	7	8	9	10
7. 하고 있는 일에 전념하기										
전혀 못함										아주 잘함
0	1	2	3	4	5	6	7	8	9	10
전혀 못함										아주 잘함
0	1	2	3	4	5	6	7	8	9	10
8. 이미 시작한 일들을 잊지 않고 지속적으로 수행하기										
전혀 못함										아주 잘함
0	1	2	3	4	5	6	7	8	9	10

9. 일련의 생각들을 유지하기 (말하거나 행동할 때 무슨 말을 하거나 행동하는지를 중간에 잊지 않고 그대로 유지하기)

전혀 못함 아주 잘함

0 1 2 3 4 5 6 7 8 9 10

10. 남에게 할려고 했던 말을 마음에 담아두기

전혀 못함 아주 잘함

0 1 2 3 4 5 6 7 8 9 10

11. 하고 싶지 않은 말이나 행동들을 억제하기

전혀 못함 아주 잘함

0 1 2 3 4 5 6 7 8 9 10

12. 다른 사람에 대해 참기

전혀 못함 아주 잘함

0 1 2 3 4 5 6 7 8 9 10

II. 현재 시점에서 볼 때, 몇 점에 해당됩니까?

13. 자세한 부분까지 집중하는 것이 어렵다

전혀 못함 아주 잘함

0 1 2 3 4 5 6 7 8 9 10

14. 어떤 일들을 하다가 종종 실수를 한다

전혀 못함 아주 잘함

0 1 2 3 4 5 6 7 8 9 10

15. 해야할 중요한 일을 잊어버린다

전혀 못함 아주 잘함

0 1 2 3 4 5 6 7 8 9 10

16. 쉽게 당황하거나 흥분한다

전혀 못함 아주 잘함

0 1 2 3 4 5 6 7 8 9 10

Appendix A5.
Functional Assessment of Cancer Therapy-Fatigue Scale
(English Version)

Below is a list of statements that other people have said are important. By circling one number per line, please indicate how true each statement has been for you during the past four weeks.

		Not at all	A little bit	Some what	Quite a bit	Very much so
1.	I feel fatigued	0	1	2	3	4
2.	I feel weak all over	0	1	2	3	4
3.	I feel listless(“washed out”)	0	1	2	3	4
4.	I feel tired.	0	1	2	3	4
5.	I have trouble starting things because I am tired.	0	1	2	3	4
6.	I have trouble finishing things because I am tired.	0	1	2	3	4
7.	I have energy.	0	1	2	3	4
8.	I am able to do my usual activities.	0	1	2	3	4
9.	I need to sleep during the day.	0	1	2	3	4
10.	I am too tired to eat.	0	1	2	3	4
11.	I need help doing my usual activities.	0	1	2	3	4
12.	I am frustrated by being too tired to do the things I want to.	0	1	2	3	4
13.	I have to limit my social activity because I am tired.	0	1	2	3	4

Functional Assessment of Cancer Therapy-Fatigue Scale
(Korean Version)

다음은 당신과 같은 질병을 앓고 있는 사람들이 중요하게 여기는 내용의 문항들입니다. 각 문항에 대한 지난 일주일 동안 당신이 얼마나 그랬는지 나타내고 있는 곳에 ○ 표시하시면 됩니다.

	전혀 그렇지 않다	조금 그렇다	보통 이다	다소 그렇다	매우 그렇다
1. 피곤하다.	0	1	2	3	4
2. 온몸이 약해진것 같다.	0	1	2	3	4
3. 기운이 다 빠졌다.	0	1	2	3	4
4. 지친다.	0	1	2	3	4
5. 지쳐서 무언가를 시작하기 어렵다.	0	1	2	3	4
6. 지쳐서 무언가를 끝내기 어렵다.	0	1	2	3	4
7. 기운이 있다.	0	1	2	3	4
8. 일상 생활을 하는데 문제가 없다.	0	1	2	3	4
9. 낮잠이 필요하다. (낮잠을 자야한다).	0	1	2	3	4
10. 너무 지쳐서 먹기도 힘들다.	0	1	2	3	4
11. 일상 생활을 하는데 도움이 필요하다.	0	1	2	3	4
12. 지쳐서 원하는 일을 할수 없기 때문에 낙심된다.	0	1	2	3	4
13. 지쳐있기 때문에 사회 생활에 제약을 두어야 한다.	0	1	2	3	4

Appendix A6.
Hospital Anxiety and Depression Scale
(English Version)

Doctors are aware that emotions play an important part in most illness. Read each item and check (with "V") the reply which comes closest to how you have been feeling in the past week.

1. I feel tense or 'wound up': ☐ Not at all ☐ From time to time, occasionally ☐ A lot of the time ☐ Most of the time	8. I feel as if I am slowed down: ☐ Not at all ☐ Sometimes ☐ Very often ☐ Nearly all the time
2. I still enjoy the things I used to enjoy: ☐ Definitely as much ☐ Not quite so much ☐ Only a little ☐ Hardly at all	9. I get a sort of frightened feeling like 'butterflies' in the stomach: ☐ Not at all ☐ Occasionally ☐ Quite often ☐ Very often
3. I get a sort of frightened feeling as if something awful is about to happen: ☐ Not at all ☐ A little, but it doesn't worry me ☐ Yes, but not too badly ☐ Very definitely and quite badly	10. I have lost interest in my appearance: ☐ I take just as much care as ever ☐ I may not take quite as much care ☐ I don't take so much care as I should ☐ Definitely
4. I can laugh and see the funny side of things: ☐ As much as I always could ☐ Not quite so much now ☐ Definitely not so much now ☐ Not at all	11. I feel restless as if I have to be on the move: ☐ Not at all ☐ Not very much ☐ Quite a lot ☐ Very much indeed
5. Worrying thoughts go through my mind: ☐ Only occasionally ☐ From time to time but not too often ☐ A lot of the time ☐ A great deal of the time	12. I look forward with enjoyment to things: ☐ As much as ever I did ☐ Rather less than I used to ☐ Definitely less than I used to ☐ Hardly at all
6. I feel cheerful: ☐ Most of the time ☐ Sometimes ☐ Not often ☐ Not at all	13. I get sudden feelings of panic: ☐ Not at all ☐ Not very often ☐ Quite often ☐ Very often indeed
7. I can sit at ease and feel relaxed: ☐ Definitely ☐ Usually ☐ Not often ☐ Not at all	14. I can enjoy a good book or radio or TV programme: ☐ Often ☐ Sometimes ☐ Not often ☐ Very seldom

Hospital Anxiety and Depression Scale
(Korean Version)

감정 상태는 당신의 질환이나 상태에 영향을 많이 줄 수 있습니다. 다음 글을 읽고 지난 일주일간의 당신의 상태를 가장 잘 나타낸다고 생각되는 문항을 골라 "V"를 하십시오.

1. 나는 긴장감 또는 "정신적 고통"을 느낀다. ☐ 전혀 아니다 ☐ 가끔 그렇다 ☐ 자주 그렇다 ☐ 거의 그렇다	8. 나는 기력이 떨어진 것 같다. ☐ 전혀 아니다 ☐ 가끔 그렇다 ☐ 자주 그렇다 ☐ 거의 항상 그렇다
2. 나는 즐겨오던 것들을 현재도 즐기고 있다. ☐ 똑같이 즐긴다 ☐ 많이 즐기지는 못한다 ☐ 단지 조금만 즐긴다 ☐ 거의 즐기지 못한다	9. 나는 초조하고 두렵다. ☐ 전혀 아니다 ☐ 가끔 그렇다 ☐ 자주 그렇다 ☐ 매우 자주 그렇다
3. 나는 무언가 무서운 일이 일어날 것 같은 느낌이 든다. ☐ 전혀 아니다 ☐ 조금 있지만 걱정하지 않는다 ☐ 있지만 그렇게 나쁘지는 않다 ☐ 매우 분명하고 기분이 나쁘다	10. 나는 나의 외모에 관심을 잃었다. ☐ 여전히 관심이 있다 ☐ 전과 같지는 않다 ☐ 이전보다 확실히 관심이 적다 ☐ 확실히 잃었다
4. 나는 사물을 긍정적으로 보고 잘 웃는다. ☐ 나는 항상 그렇다 ☐ 현재는 그다지 그렇지 않다 ☐ 거의 그렇지 않다 ☐ 전혀 아니다	11. 나는 가만히 있지 못하고 안절부절한다. ☐ 전혀 그렇지 않다 ☐ 가끔 그렇다 ☐ 자주 그렇다 ☐ 매우 그렇다
5. 마음속에 걱정스러운 생각이 든다. ☐ 거의 그렇지 않다. ☐ 가끔 그렇다 ☐ 자주 그렇다 ☐ 항상 그렇다	12. 나는 일들을 즐거운 마음으로 기대한다. ☐ 내가 전에 그랫던 것처럼 그렇다 ☐ 전보다 조금 덜 그렇다 ☐ 전보다 확실히 덜 그렇다 ☐ 전혀 그렇지 않다
6. 나는 기분이 좋다. ☐ 항상 그렇다 ☐ 자주 그렇다 ☐ 가끔 그렇다 ☐ 전혀 그렇지 않다	13. 나는 갑자기 당황스럽고 두려움을 느낀다 ☐ 전혀 그렇지 않다 ☐ 가끔 그렇다 ☐ 꽤 자주 그렇다 ☐ 거의 항상 그렇다
7. 나는 편하게 긴장을 풀 수 있다 ☐ 항상 그렇다 ☐ 대부분 그렇다 ☐ 대부분 그렇지 않다 ☐ 전혀 그렇지 않다	14. 나는 좋은 책 또는 라디오, 텔레비젼을 즐길 수 있다. ☐ 자주 즐긴다 ☐ 가끔 즐긴다 ☐ 거의 못 즐긴다 ☐ 전혀 못 즐긴다

Appendix A7.
Pittsburgh Sleep Quality Index
(English Version)

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month.

1. During the past month, when have you usually gone to bed at night?
   Usual bed time: _____

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?
   Number of minutes: _____

3. During the past month, when have you usually gotten up in the morning?
   Usual getting up time: _____

4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spend in bed)
   Hours of sleep per night: _____

5. For each of the remaining questions, how often have you had trouble sleep because you …

	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
(a) Cannot get to sleep within 30 minutes	☐	☐	☐	☐
(b) Wake up in the middle of the night or early morning	☐	☐	☐	☐
(c) Have to get up to use the bathroom	☐	☐	☐	☐
(d) Cannot breathe comfortably	☐	☐	☐	☐
(e) Cough or snore loudly	☐	☐	☐	☐
(f) Feel too cold	☐	☐	☐	☐
(g) Feel too hot	☐	☐	☐	☐
(h) Have pain	☐	☐	☐	☐
(i) Other reason(s), please describe				
How often during the past month have you had trouble sleeping because of this?	☐	☐	☐	☐

6. During the past month, how would you rate your sleep quality overall?
    - ☐ Very good
    - ☐ Fairy good
    - ☐ Fairy bad
    - ☐ Very bad

7. During the past month, how often have you taken medicine (prescribed or "over the counter") to help your sleep?
    - ☐ Not during the past month
    - ☐ Less than once a week
    - ☐ Once or twice a week
    - ☐ Three or more times a week

8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?
    - ☐ Not during the past month
    - ☐ Less than once a week
    - ☐ Once or twice a week
    - ☐ Three or more times a week

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?
    - ☐ No problem at all
    - ☐ Only a very slight problem
    - ☐ Somewhat of a problem
    - ☐ A very big problem

10. Do you have a bed partner or roommate?
    - ☐ No bed partner or roommate
    - ☐ Partner/roommate in other room
    - ☐ Partner in the same room, but not same bed
    - ☐ Partner in same bed

Pittsburgh Sleep Quality Index
(Korean Version)

다음의 질문들은 **지난 날**동안의 귀하의 평상시 수면 습관에 대한 것입니다.

1. 보통 밤 몇 시에 주무십니까?
   _____시 _____분

2. 잠드는 데 몇 분 정도 걸립니까?
   _____분

3. 보통 아침 몇 시에 일어나십니까?
   _____시 _____분

4. 몇 시간 정도 주무십니까 (실제 수면시간으로 잠드는데 걸린 시간은 제외됨)?
   _____시간

5. 다음과 같은 이유로 수면을 취하기 어려웠다면, 그에 해당하는 곳에 표시해 주십시요.

	전혀 없음	일주일에 1 회 미만	일주일에 1-2 회	일주일에 3 회 이상
(a) 30분 내에 잠들 수 없다.	☐	☐	☐	☐
(b) 밤중이나 이른 아침에 깬다.	☐	☐	☐	☐
(c) 화장실에 가기 위해 잠에서 깬다.	☐	☐	☐	☐
(d) 편하게 숨을 쉴 수 없다.	☐	☐	☐	☐
(e) 크게 기침을 하거나 코를 곤다.	☐	☐	☐	☐
(f) 너무 춥게 느껴진다.	☐	☐	☐	☐
(g) 너무 덥게 느껴진다.	☐	☐	☐	☐
(h) 악몽을 꾼다.	☐	☐	☐	☐
(i) 통증이 있다.	☐	☐	☐	☐
(j) 또 다른 이유가 있다면, 그 내용을 서술해 주십시요:	☐	☐	☐	☐

6. 당신의 수면의 질을 어떻게 평가하십니까?
   - ☐ 매우 좋음
   - ☐ 다소 좋음
   - ☐ 다소 좋지 않음
   - ☐ 매우 좋지 않음

7. 수면을 취하기 위해 얼마나 자주 약을 복용하십니까?
   - ☐ 전혀 없음
   - ☐ 일주일에 1 회 미만
   - ☐ 일주일에 1-2 회
   - ☐ 일주일에 3 회 이상

8. 운전, 식사, 사회 활동 중 얼마나 자주 졸립니까?
   - ☐ 전혀 없음
   - ☐ 일주일에 1 회 미만
   - ☐ 일주일에 1-2 회
   - ☐ 일주일에 3 회 이상

9. 어떠한 일에 계속해서 열중하는 데 얼마나 많은 어려움이 있습니까?
   - ☐ 없음
   - ☐ 아주 약간
   - ☐ 약간
   - ☐ 매우 큼

10. 집에서 함께 생활하는 사람이 있습니까?
   - ☐ 없음
   - ☐ 각기 다른 방
   - ☐ 같은 방, 다른 침대 (잠자리)
   - ☐ 같은 침대 (잠자리)

Appendix A8.
Breast Cancer Prevention Trial Symptom Checklist
(English Version)

We are interested in knowing how much you have been bothered by one of the following problems during the past 4 weeks (Circle one number on each line. If you do not have the problem, circle "not at all"). During the past 4 weeks, how much were you bothered by:

	Not at all	Slightly	Moderately	Quite a bit	Extremely
Hot flashes	0	1	2	3	4
Nausea	0	1	2	3	4
Vomiting	0	1	2	3	4
Difficulty with bladder control when laughing or crying	0	1	2	3	4
Difficulty with bladder control at other times	0	1	2	3	4
Vaginal dryness	0	1	2	3	4
Pain with intercourse	0	1	2	3	4
General aches and pains	0	1	2	3	4
Joint pains	0	1	2	3	4
Muscle stiffness	0	1	2	3	4
Weight gain	0	1	2	3	4
Unhappy with the appearance of my body	0	1	2	3	4
Forgetfulness	0	1	2	3	4
Night sweats	0	1	2	3	4
Difficulty concentrating	0	1	2	3	4
Easily distracted	0	1	2	3	4
Arm swelling (lymphedema)	0	1	2	3	4
Decreased range of motion in arm on surgery side	0	1	2	3	4

Breast Cancer Prevention Trial Symptom Checklist
(Korean Version)

귀하께서 지난 4 주간 아래에 나열된 문제들에 의해얼마나 불편하셨는지를 알고자 합니다.

	전혀 없음	조금 있음	보통 있음	꽤 있음	아주 심함
일과성 열감	0	1	2	3	4
오심	0	1	2	3	4
구토	0	1	2	3	4
웃거나 울때 소변을 참기 어려움	0	1	2	3	4
평소에 소변을 참기 어려움	0	1	2	3	4
질 건조증	0	1	2	3	4
성교시 통증	0	1	2	3	4
전신이 쑤시거나 아픔	0	1	2	3	4
관절 통증	0	1	2	3	4
근육이 뻣뻣함 (근육 경직)	0	1	2	3	4
체중 증가	0	1	2	3	4
외모에 만족스럽지 않음	0	1	2	3	4
건망증	0	1	2	3	4
식은땀 (야한증)	0	1	2	3	4
집중하기 어려움	0	1	2	3	4
쉽게 산만해짐	0	1	2	3	4
팔 부종 (림프 부종)	0	1	2	3	4
수술받은 쪽 팔의 운동범위 감소	0	1	2	3	4

Appendix A9.
Cultural Characteristics
(English Version)

Please check (with "V") the reply which comes closest to how you have been feeling.

1. Cultural Attitude

	Strongly agree	Agree	Un-decided	Disagree	Strongly disagree
1. Men's tasks are different from women's ones within domestic setting in terms of household chores.	☐	☐	☐	☐	☐
2. A man is the main person who is responsible for making a livelihood although his wife/female family members work outside.	☐	☐	☐	☐	☐
3. The main role of women is to take care of children and to do housework.	☐	☐	☐	☐	☐
4. A woman should have a job that does not interfere with her taking care of children and doing housework	☐	☐	☐	☐	☐
5. A woman should stay home when the rate of unemployment is high.	☐	☐	☐	☐	☐

2. Household burden

	Not at all	Slightly	Moderately	Quite a bit	Extremely
1. It was difficult to take care of family member such as children or husband.	☐	☐	☐	☐	☐
2. There were a lot of household chores.	☐	☐	☐	☐	☐
3. It was difficult to have my private time because of performing household chores.	☐	☐	☐	☐	☐

4. I am always worn out because of performing household chores.	☐	☐	☐	☐	☐
5. My family did not help me to carry out household chores.	☐	☐	☐	☐	☐
6. I perceived that a household chore was worthless.	☐	☐	☐	☐	☐

3. Child-rearing Burden

Question: When you think of your experience as a parent, how _____ do you feel?					
	Rarely	Slightly	Moderately	Very much	Not appropriate
1. Frustrated	☐	☐	☐	☐	☐
2. Tense	☐	☐	☐	☐	☐
3. Worried	☐	☐	☐	☐	☐
4. Bothered or upset	☐	☐	☐	☐	☐
5. Unhappy	☐	☐	☐	☐	☐
6. Emotionally worn out	☐	☐	☐	☐	☐
7. Unsure of yourself	☐	☐	☐	☐	☐

Cultural Characteristics
(Korean Version)

귀하의 생각과 가장 일치하는 곳에 "V" 표시해 주십시오.

1. 집안일에 대한 성역할 태도

	매우 동의 한다	동의 하는 편이다	보통 이다	반대 하는 편이다	매우 반대 한다
1. 집안일에는 남자가 할 일과 여자가 할 일이 따로 있다.	□	□	□	□	□
2. 여자가 일을 하더라도 가정의 주된 생계책임은 남자가 져야 한다.	□	□	□	□	□
3. 여자의 본분은 자녀를 키우고 가사 일을 돌보는 것이다.	□	□	□	□	□
4. 여자는 자녀와 가사에 지장을 주지 않는 한도내에서 직업활동을 해야 한다.	□	□	□	□	□
5. 실업률이 높을 때에는 기혼여성들은 가정에 머물러 있어야 한다.	□	□	□	□	□

2. 가사노동

	전혀 아니다	약간 그렇다	어느 정도 그렇다	자주 그렇다	매우 그렇다
1. 남편과 자녀들을 뒷바라지하기가 힘들었다.	□	□	□	□	□
2. 집안 일이 너무 많았다.	□	□	□	□	□
3. 집안 일 때문에 내 시간을 갖기가 어려웠다.	□	□	□	□	□
4. 집안 일 때문에 항상 지치고 피곤하다.	□	□	□	□	□
5. 가족들이 집안 일을 협조해 주지 않았다.	□	□	□	□	□
6. 가사 일이 무의미하게 느껴졌다.	□	□	□	□	□

3. 자녀양육

질문: 부모로써 당신의 역할을 돌아볼때, 어떻게 느끼십니까?					
	거의 안그렇다	조금 그렇다	보통이다	많이 그렇다	관계없음 (미혼)
1. 좌절감을 느낀다	☐	☐	☐	☐	☐
2. 긴장감을 느낀다	☐	☐	☐	☐	☐
3. 걱정이 된다	☐	☐	☐	☐	☐
4. 괴롭다	☐	☐	☐	☐	☐
5. 불행하다	☐	☐	☐	☐	☐
6. 정서적으로 지쳐있다	☐	☐	☐	☐	☐
7. 자신감이 없다	☐	☐	☐	☐	☐

Appendix A10.
Self-blame Tendency
(English Version)

Self-Blame Interview

We have found that some women blame themselves for their breast cancer and some women don't blame themselves at all. I'd like to ask you two questions about whether, and how much, you blame yourself for your cancer.

1. On a scale of 1 (not at all) to 4 (extremely), how much do you blame yourself for the kinds of things you did (in other words, for having engaged in any specific behaviors that you feel led to your cancer)?

2. On a scale of 1 to 4, how much do you blame yourself for the kind of person you are (in other words, for being the kind of person who has had things like cancer happen to them)?

Answer Sheet

Question 1:

Not at all	Moderately	Quite a bit	Extremely
☐	☐	☐	☐

Question 2:

Not at all	Moderately	Quite a bit	Extremely
☐	☐	☐	☐

Self-blame Tendency
(English Version)

자기 비난 인터뷰

어떤 여성들은유방암에 대한 책임이 자신에게 있다고 스스로를 탓하고, 다른 여성들은 전혀 자신을 탓하지 않는다는 것을 발견했습니다.암이 발생한 것에 대해서 스스로의 탓으로 여기는지, 그렇다면 어느정도 그러하신지에 대해서 두 가지 질문을 드리고 싶습니다. 설문지 마지막 장에 제시된 표에 'V"로 표기에 주시기 바랍니다.

1. 자신이 했던 일들 때문에 스스로를 비난하고 계십니까? 다시 말해서, 당신의 어떤 행동들이 암을 유발했을지도 모른다고 생각해서, 스스로를 비난한 적이 있습니까? 그렇다고 그 행동 때문에 어느정도 자신을 탓하십니까?

2. 자신이 암과 같은 것이 발생할 수 밖에 없는 종류의 사람이였다고 스스로를 비난하고 계십니까? 그렇다면, 그것에 대해 어느 정도 자신을 탓하십니까?

응답지

질문 1:

전혀 자책하지 않는다	다소 자책한다	꽤 자책한다	매우 자책한다
☐	☐	☐	☐

질문 2:

전혀 자책하지 않는다	다소 자책한다	꽤 자책한다	매우 자책한다
☐	☐	☐	☐

Appendix A11.
Demographics Characteristics
(English Version)

1. Your age: _____ years

2. Date of birth: _____ (MM/DD/YYYY)

3. Present marital status: (Please circle the number which indicates your state)
   1) Single 2) Married 3) Widowed
   4) Divorced 5) Separated 6) Living with a partner

4. Numbers of children: How many sons _____ age(s) of son(s): _____
   How many daughters: _____ age(s) of daughter(s): _____

5. Living with family members (Please circle the number which indicates your situation)
   1) husband/partner
   2) Children Number of:_____
   3) Parents/Parents-in-law Number of:_____
   4) Relative(s) Number of:_____
   5) Others Number of:_____
   6) No one else

6. Your highest education: (Please circle the number which indicates your educational history)
   1) Elementary school
   2) Middle school
   3) High school
   4) College/University Years of education: _____ years
   5) Graduate school Years of education: _____ years
   6) Other schooling Years of education: _____ years

7. Current occupation:
   1) No
   2) Yes Job description: _____

8. Current employment:
   1) House
   2) Full-time work Hours of work: _____ hours/week
   3) Part-time work Hours of work: _____ hours/week
   4) Retired
   5) Others:

9. Your residential district
   1) Urban area the name of your residential district: _____
   2) Rural area the name of your residential district: _____

10. Monthly family income:
   1) Less than $1,000 2) $ 1,000 ~ less than $2,000
   3) $2,000 ~ less than $3,000 4) $3,000 ~ less than $4,000
   5) $4,000 ~ less than $5,000 6) $5,000 ~ less than $7,500
   7) $7,500 ~ less than $10,000 8) More than $10,000

Demographics Characteristics
(Korean Version)

다음의 질문들은 인구학적 특성에 대한 조사를 위한 것입니다.

1. 귀하의 연령: _____세
2. 생년 월일: _____년 _____월 _____일
3. 현재 결혼상태: (귀하의 경우에 해당되는 답변에 동그라미해 주십시요)
   1) 미혼
   2) 기혼
   3) 사별
   4) 이혼
   5) 별거
   6) 동거
4. 현재 자녀수: 아들: _____명 아들(들)의 연령: _____
   딸: _____명 딸(들)의 연령: _____
5. 현재 함께 사는 가족 (귀하에 경우에 해당되는 답변에 동그라미해 주십시요)
   1) 배우자/동거인
   2) 자녀(들) 인원: _____명
   3) (시)부모님 인원: _____명
   4) 친적(들) 인원: _____명
   5) 그 외 인원: _____명
   6) 혼자 산다
6. 최종 학력: (귀하의 경우에 해당되는 답변에 표기해 주십시요)
   1) 초등학교 졸업
   2) 중학교 졸업
   3) 고등학교 졸업
   4) 대학교 중퇴 교육 기간: _____년
   5) 대학교 졸업 교육 기간: _____년
   6) 대학원 졸업 교육 기간: _____년
   7) 기타 교육 기간: _____년
7. 현재 직업:
   1) 없음
   2) 있음 직업 종류: _____
8. 현재 취업 상태:
   1) 가정 주부
   2) 정규직 주간 노동 시간: _____시간
   3) 임시직 또는 아르바이트 주간 노동 시간: _____시간
   4) 퇴직
   5) 기타: _____
9. 거주 지역
   1) 도심 지역명: _____
   2) 외곽 지역명: _____
10. 월간 가족 수입
   1) 100 만원 미만
   2) 100 만원 ~ 200 만원 미만
   3) 200 만원 ~ 300 만원 미만
   4) 300 만원 ~ 400 만원 미만
   5) 400 만원 ~ 500 만원 미만
   6) 500 만원 ~ 750 만원 미만
   7) 750 만원 ~ 1,000 만원 미만
   8) 1000 만원 이상

Appendix A12.
Medical Characteristics
(English version)

Medical Information; Interview

1. Current menopausal status:
   _____ Pre Last menstrual period: _____
   _____ Peri
   _____ Post
2. Other major health problems:
   _____ Yes If yes, detailed: _____
   _____ No
3. Current medication you are taking

Drugs	Start date	End date	Dosages	Frequency	Others

Medical Information; Chart

1. Date of breast biopsy: _____
2. Kind of breast cancer
   _____ DCIS
   _____ Invasive ductural carcinoma
   _____ Invasive lobular carcinoma
   _____ Other:
3. Stage of breast cancer
   _____ Stage 0
   _____ Stage I
   _____ Stage II
   _____ Stage IIIa
4. Surgery

	Type	Date (MM/DD/YY)
_____	Lumpectomy/Quadrantectomy	/ /
_____	Re-excision lumpectomy	/ /
_____	Simple mastectomy	/ /
_____	Modified radical mastectomy	/ /
_____	Breast conservation	/ /
_____	Breast reconstruction	/ /
_____	Other:	/ /

5. Chemotherapy
   (1) Start date: _____
   (2) End date: _____
   (3) Total cycle received: _____
   (4) Was chemotherapy delayed or discontinued for the reason?
   No: _____ Yes: _____
   (5) Chemotherapeutic regimens and agents

Date	Chemotherapeutic agents	Dosages

Medical Characteristics
(Korean version)

건강 상태: 인터뷰

1. 현재 월경상태:
   _____ 규칙적 생리 ⟶ 마지막 생리일: _____
   _____ 폐경전
   _____ 폐경기
2. 다른 건강 문제:
   _____ 예 상세질명명: _____
   _____ 아니오
3. 현재 복용하는 약

약품명	복용시작일	복용정지일	용량	복용간격	기타

건강 상태: 의료기록지

1. 조직 생검 날짜: _____
2. 유방암 종류
   _____ DCIS
   _____ Invasive ductural carcinoma
   _____ Invasive lobular carcinoma
   _____ Other:
3. 유방암 단계
   _____ Stage 0 (0 단계)
   _____ Stage I (1 단계)
   _____ Stage II (2 단계)
   _____ Stage IIIa (3a 단계)
4. 수술 정보

	종류	날짜
_____	Lumpectomy/Quadrantectomy	/ /
_____	Re-excision lumpectomy	/ /
_____	Simple mastectomy	/ /
_____	Modified radical mastectomy	/ /
_____	Breast conservation	/ /
_____	Breast reconstruction	/ /
_____	기타:	/ /

5. 항암 치료
   (1) 시작일: _____
   (2) 종료일: _____
   (3) 총 횟수: _____
   (4) 항암치료를 연기하거나 중단한 적이 있는가?
   아니오: _____ 예: _____
   (5) 항암치료 약물

날짜	항암제명	용량

Appdendix B

Additional Analyses

Appendix B1.
Structural Analysis of the Attention Network Test

Differences in Left-pointing and Right-pointing Targets

A preliminary analysis showed that there were no differences in error rates between left-pointing and right-pointing targets in any condition. Likewise, there were no significant differences in mean reaction times between left-pointing and right-pointing targets in all conditions except for the incongruent flanker condition ($p < 0.05$). Thus, left-pointing and right-pointing targets were included to compute behavioral performance (error rates and reaction times) for further analyses.

Correlations among Three Attention Network Functions

Pearson correlation coefficients were computed to determine whether three attention networks (alerting, orienting, and executive control) were correlated. As presented in Table 1, correlations were examined among three attention networks and assessed between each attention network and overall performance. No significant correlations among three attention networks were found, although the overall mean error rates had a small correlation with the alerting network scores and were strongly associated with the executive control network performance. This finding was consistent with the theoretical assumption underlying functional independence of these three attention networks (Fan et al., 2002).

Analysis of Variance

Table 2 displayed error rates and reaction times by four cue (no, center, double, spatial) and three flanker (congruent, incongruent, neutral) conditions. There were significant main effects of cue ($F(3,189) = 103.97$, $p < 0.001$) and of flanker type ($F(2,124) = 156.89$, $p < 0.001$). Furthermore, there was a significant interaction between

cue condition and flanker type ($F(6,372) = 3.69$, $p < 0.01$). Additionally, three attention networks were examined to determine effects of alerting cues, orienting cues, and a conflict flanker in performing the task. The significant differences in reaction times between the no cue and the double cue, between the center cue and the spatial cue, and between the congruent flanker and the incongruent flanker conditions were found respectively (alerting effect: $F(1,63) = 140.81$, $p < 0.001$; orienting effect: $F(1,63) = 98.95$, $p < 0.001$; executive control effect: $F(1,63) = 155.60$, $p < 0.001$). The error rates were consistent with reaction time scores in showing that incongruent flankers increased percentage of wrong answers.

Table 1
Correlations between Three Attention Networks (N = 64)

	Error rates (%)			Reaction times (msec)		
	1	2	3	1	2	3
1. Alerting	-	-	-	-	-	-
2. Orienting	0.04	-	-	0.01	-	-
3. Executive control	0.21	0.03	-	-0.16	0.00	-
4. Overall mean	0.29*	-0.10	0.93**	0.04	0.22	0.22

* $p < 0.05$, ** $p < 0.001$

Table 2
Error Rates and Reaction Times by Cue Condition and Flanker Type (N = 64)

	Warning			
Flanker	No	Center	Double	Spatial
Error rates (%)				
Congruent	1.33 (4.39)	0.45 (2.27)	0.44 (1.76)	0.89 (3.00)
Incongruent	6.14 (20.40)	6.23 (18.73)	6.16 (20.21)	5.90 (19.03)
Neutral	1.45 (3.38)	0.89 (2.91)	1.02 (3.12)	0.89 (3.85)
Reaction times (msec)				
Congruent	671.30 (125.32)	640.54 (130.09)	617.89 (122.78)	602.04 (121.06)
Incongruent	757.61 (137.91)	752.73 (153.84)	725.20 (138.16)	698.98 (146.53)
Neutral	659.86 (115.26)	634.59 (120.43)	609.47 (115.81)	597.23 (110.70)

Appendix B2.
Validity and Reliability of the Korean-Translated Attentional Function Index

Table 1
Original AFI Scale and Item Analysis (N = 64)

AFI scale (16 items)			Item information			
M	SD	Reliability	Item	M	SD	Range
6.44	1.81	0.93	Getting started on activities (tasks, jobs) you intend to do	6.02	2.73	0 - 10
			Planning your daily activities	6.23	2.81	0 - 10
			Following through on your plans	6.50	2.64	0 - 10
			Doing things that take time and effort	6.16	2.64	0 - 10
			Making your mind up about things	7.06	2.18	1 - 10
			Finishing things you have started	7.44	2.26	1 - 10
			Keeping your mind on what you are doing	7.25	2.52	1 - 10
			Remembering to do all the things you started out to do	6.94	2.58	0 - 10
			Keeping track of what you are saying or doing (keeping your train of thought)	5.97	2.48	0 - 10
			Keeping your mind on what others are saying	6.00	2.57	0 - 10
			Keeping yourself from saying or doing things you did not want to say or do	6.73	2.45	0 - 10
			Being patient with others	6.83	2.52	1 - 10
			How hard you find it to concentrate on details[a]	5.86	2.47	0 - 10
			How often you make mistakes on what you are doing[a]	6.20	2.39	0 - 10
			Forgetting to do important things[a]	6.27	2.63	0 - 10
			Getting easily annoyed or irritated[a]	5.62	2.88	0 - 10

Note. [a]Data for reversed items transformed .

Table 2

Descriptive Analysis, Reliability, and Communalities after Extraction of Modified 13-Item AFI

AFI scale (13 items)			Item information				
M	SD	Reliability	Item	M	SD	r^2	Range
6.42	1.81	0.92	Getting started on activities (tasks, jobs) you intend to do	6.02	2.73	0.56	0 – 10
			Following through on your plans	6.50	2.64	0.83	0 – 10
			Doing things that take time and effort	6.16	2.64	0.81	0 – 10
			Making your mind up about things	7.06	2.18	0.73	1 - 10
			Keeping your mind on what you are doing	7.25	2.52	0.82	1 – 10
			Remembering to do all the things you started out to do	6.94	2.58	0.81	0 – 10
			Keeping track of what you are saying or doing (keeping your train of thought)	5.97	2.48	0.69	0 – 10
			Keeping yourself from saying or doing things you did not want to say or do	6.73	2.45	0.91	0 – 10
			Being patient with others	6.83	2.52	0.93	1 - 10
			How hard you find it to concentrate on details[a]	5.86	2.47	0.51	0 – 10
			How often you make mistakes on what you are doing[a]	6.20	2.39	0.72	0 – 10
			Forgetting to do important things[a]	6.27	2.63	0.73	0 – 10
			Getting easily annoyed or irritated[a]	5.62	2.88	0.57	0 – 10

Note. [a]Data for reversed items transformed.

Table 3

Mean, Standard Deviation, and Internal Reliability Coefficients for Three Subscales

New subscales	Mean	Standard deviation	Internal reliability coefficients
Factor I: effective actions (7 items)	6.56	2.16	0.94
Factor II: Attentional lapses (4 items)	5.99	2.04	0.79
Factor III: Effective interpersonal relations (2 items)	6.78	2.39	0.92

Table 4

Relationships between Attentional Function Index (AFI) and Cognitive Test Performance

	Factor I[a]	Factor II[b]	Factor III[c]	Total mean of 13-item AFI
DSF	0.06	0.12	-0.03	0.07
DSB	0.18	0.23*	-0.10	0.17
COWA part A	0.18	0.19	0.09	0.20
COWA part B	0.34***	0.21*	0.23*	0.34***
The total cognitive index	0.24*	0.23*	0.09	0.25**
ANT				
Overall mean	-0.16	-0.07	-0.18	-0.16
Alerting network	-0.24*	-0.14	-0.02	-0.21*
Orienting network	-0.09	-0.00	0.03	-0.05
Executive control network	-0.16	-0.04	-0.18	-0.15
Reaction time (msec)				
Overall mean	-0.09	-0.04	-0.01	-0.07
Alerting network	-0.15	-0.03	-0.09	-0.13
Orienting network	0.04	-0.10	0.16	0.02
Executive control network	-0.10	-0.29**	-0.13	-0.19

[a] Effective actions. [b] Attentional lapses. [c] Effective interpersonal relations.

* p < 0.1. ** p < 0.05. ***p < 0.01.

Table 5

Relationships between Attentional Function Index (AFI) and Cognitive Items in the Breast Cancer Prevention and Trial Symptom Checklist

	Factor I[a]	Factor II[b]	Factor III[c]	Total mean of 13-item AFI
Forgetfulness	-0.43***	-0.57***	-0.26**	-0.52***
Difficulty concentrating	-0.57***	-0.57***	-0.31**	-0.63***
Easily distracted	-0.49***	-0.57***	-0.29**	-0.57***

[a] Effective actions. [b] Attentional lapses. [c] Effective interpersonal relations.

* p < 0.1. ** p < 0.05. ***p < 0.01.

Appendix B3.
Mean and Standard Deviations of the ANT performance without an Outlier

	Breast cancer group (n = 31) Mean ± SD (Range)	Healthy control group (n = 32) Mean ± SD (Range)
Error rates (%)		
Alerting network	0.81 ± 2.26 (-5.00 – 6.00)	0.03 ± 1.26 (-3.00 – 4.00)
No cue	4.32 ± 9.09** (0.00 – 33.00)	0.63 ± 1.41 (0.00 - 7.00)
Double cue	3.52 ± 8.46* (0.00 – 33.00)	0.59 ± 1.10 (0.00 - 3.00)
Orienting network	0.06 ± 1.98 (-4.50 – 4.50)	-0.28 ± 1.40 (-4.50 – 1.50)
Center cue	3.58 ± 7.62** (0.00 – 29.00)	0.47 ± 0.92 (0.00 - 3.00)
Spatial cue	3.52 ± 8.18* (0.00 – 32.00)	0.75 ± 1.20 (0.00 - 5.00)
Executive control network	7.10 ± 20.98* (-1.00 – 95.00)	0.66 ± 1.36 (-2.00 – 5.00)
Congruent flanker	1.29 ± 3.73 (0.00 – 21.00)	0.31 ± 0.59 (0.00 - 2.00)
Incongruent flanker	8.39 ± 21.65* (0.00 – 95.00)	0.97 ± 1.43 (0.00 - 6.00)
Overall mean scores	3.74 ± 8.28** (0.00 – 32.00)	0.60 ± 0.75 (0.00 – 3.00)
Reaction times (msec)		
Alerting network	47.22 ± 28.34 (0.24 – 129.87)	42.25 ± 29.79 (-26.27 – 102.86)
No cue	721.31 ± 133.32* (496.64 – 1003.44)	668.14 ± 106.11 (494.14 – 940.67)
Double cue	674.09 ± 122.11 (470.60 – 934.32)	625.88 ± 116.08 (450.67 – 894.90)
Orienting network	42.81 ± 38.35 (-19.24 – 138.62)	42.26 ± 31.28 (-6.75 – 131.84)
Center cue	701.86 ± 134.11* (491.00 – 1023.67)	647.04 ± 118.36 (472.90 – 935.24)
Spatial cue	659.05 ± 131.44* (450.78 – 936.59)	604.77 ± 105.59 (431.16 – 873.65)
Executive control network	117.56 ± 72.55* (5.58 – 376.94)	84.68 ± 58.82 (-7.08 – 332.15)
Congruent flanker	658.65 ± 132.10 (439.86 – 929.36)	611.41 ± 109.18 (449.54 – 904.46)
Incongruent flanker	776.21 ± 140.26** (528.31 – 1095.35)	696.09 ± 130.11 (496.06 – 1091.38)
Overall mean scores	694.79 ± 127.16* (477.25 – 966.91)	636.64 ± 110.49 (464.31 – 891.98)

* $p < 0.1$. ** $p < 0.05$.

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