

Bodeum: Encouraging Working Parents to Provide Emotional Support for Stay-at-Home Parents in Korea

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ABSTRACT

Although gender equality is commonly found globally, many countries in Asia still show stereotypical gender roles within family relationships between fathers and mothers. In those countries, most stay-at-home mothers are mainly responsible for childcare and housework while fathers work so that some stay-at-home mothers are highly stressed by single childcare. To relieve their parenting stress, emotional support from their spouse is an important factor. However, working parents in single-income families tend to underestimate the childcare difficulties of their spouses. In this work, we propose *Bodeum*, a proof-of-concept mobile system to facilitate spousal communication by sharing stay-at-home parent's stress level, their childcare activities, and their baby's status with working parents to encourage emotional support for stay-at-home parents. A 2-week feasibility study with nine families in South Korea suggests that *Bodeum* enhanced spousal communication about parenting stress and showed potential for parenting mothers to lower their perceived parenting stress.

CCS CONCEPTS

• **Human-centered computing** → **Collaborative and social computing**; *Ubiquitous and mobile computing*.

KEYWORDS

Social support; emotional support; parenting stress; baby diary; parenting collaboration; behavior change

ACM Reference Format:

Seokwoo Song, Naomi Yamashita, and John Kim. 2020. Bodeum: Encouraging Working Parents to Provide Emotional Support for Stay-at-Home Parents in Korea. In *14th EAI International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth '20)*, May 18–20, 2020, Atlanta, GA, USA. ACM, New York, NY, USA, 12 pages. <https://doi.org/10.1145/3421937.3421973>

This work was done mainly while the first author was interning at NTT Communication Science Laboratories.

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PervasiveHealth '20, May 18–20, 2020, Atlanta, GA, USA

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ACM ISBN 978-1-4503-7532-0/20/05...\$15.00

<https://doi.org/10.1145/3421937.3421973>

1 INTRODUCTION

Childbirth is a momentous event that drastically affects the lives of new parents. Even though it provides joy for most parents, many new parents experience mental depression, which might include mild mood anxiety from which recovery is natural; unfortunately, 10-15% of new mothers [17, 29] and 8-10% of new fathers [15, 52] might slide into a severe conditions whose symptoms include sadness, fatigue, and irritability [35], can negatively affect not only a baby's emotional, behavioral, and cognitive development [10] but also their spouse's mental health [30], which can lead to marital discord and divorce [46]. Since depression and parenting stress are closely related [59, 62], prior work emphasized the importance of focusing on social factors such as marital relationships and social support to help reduce mental stress [21, 22]. For example, spousal support that includes assistance with childcare duties and emotional support [32, 34, 35, 58, 63] is a critical factor to reduce mental stress.

However, in Asia, most mothers have the primary responsibility for childcare and household chores [26] while working fathers' parenting involvement in single-income family is relatively low [47]. As a result, the working parent often underestimate the parenting stress of their spouses [31]. Furthermore, because childbirth is a major life event that changes their lives, working parents tend to be more interested in babies than their spouse and often overlook the parenting stress that their spouse are experiencing [13, 60]. A gap arises between dedicated parents for childcare who desire their spouse's support and working parents who underestimate the parenting stress while showing more interest in their babies than in their spouse.

To bridge this gap between working parents outside home and stay-at-home parents, we propose *Bodeum*¹ that allows stay-at-home parents to share their stress levels and their baby activities with their working spouses to induce working spouse's emotional support. This asymmetric design of *Bodeum* is caused by the asymmetrical roles of parental childcare where stay-at-home parents do most of the childcare chores while working parents work outside of the home. *Bodeum* helps balance it with opposite asymmetrical emotional support in the asymmetrical roles of parental childcare.

Bodeum is based insights from prior work [31, 33] that have shown working parents' (or often the fathers') indifference to childcare and underestimation of mother's parenting efforts cause conflicts in South Korean families. Another research from domain experts have shown how emotional support, particularly from their spouse's encouraging words, is a critical factor to reduce parenting

¹A Korean word that means embrace or hug.

stress [45]. We conducted a preliminary survey in South Korea to determine the three main components of *Bodeum* – 1) a wearable device that monitors stress levels of a stay-at-home parent based on their heart rate, 2) a tracking application that allows stay-at-home parents to add details about their parenting stress levels and to record their baby’s status, and 3) a communication feature that allows working parents to access the spouse’s stress level data and baby’s status while being able to provide simple feedback. As a result, *Bodeum* allows stay-at-home parents to record their baby’s status, similar to existing baby diary applications [1, 2, 9], but also communicate their own parenting stress levels and receive simple feedback from their spouse. *Bodeum* aims to fulfill stay-at-home parents’ needs by allowing them to share their stress levels with their spouses and get emotional support from them about their high stressful status.

To assess the potential of our approach, we conducted a 2-week feasibility study. Nine families were recruited in South Korea [47] whose fathers work full-time and whose mothers stay at home with infants younger than six months. The results suggest that *Bodeum* enhanced spousal communication about mothers’ parenting stress and improved the working fathers’ understanding of parenting difficulties. The feasibility study also demonstrated potential for parenting mothers to lower their perceived parenting stress. We finally suggest design considerations based on our findings from the feasibility study.

The main contributions of the paper are as follows:

- We propose *Bodeum* to induce the working parents to provide emotional support to their spouse in the asymmetrical roles of parental childcare within the cultural context.
- A two-week user study shows the feasibility of strengthening a spousal relationship.

2 BACKGROUND AND RELATED WORK

2.1 Inequality in Parenting Roles in East Asia

Generally, the inequality in parenting roles are associated with stereotypical gender roles within family relationships. Although fathers participate in more childcare and housework than before [50], significant fraction of mothers stay at home and are responsible for childcare in most Asian countries [26, 47]. According to the OECD report [47], which compared gender equality within family relationship among ten countries around the world, the discrepancy of the amount of time that fathers and mothers spend on parenting was the biggest in South Korea. Mothers in South Korea spent on average 117 minutes more a day with their under-school-age child than fathers. The study also showed that fathers in South Korea only spent 6 min/day for childcare, whereas fathers in the US spend 76 min/day [47]. *Bodeum* is proposed to balance the inequality of parenting roles with opposite asymmetrical emotional support in those inequality family relationships.

2.2 Parenting Stress and Depression

Although childbirth brings happiness to many families, it also introduces a significant amount of stress to them because childbirth causes a major change in their lives including changes in spousal relationships and daily routines of the family members. Postpartum

depression (PPD) is found worldwide in most cultures with the incidence ranging from 10-15% [17, 29]. The factor that appears to be associated most consistently with postpartum depression is that of social support. Indeed, research has shown that depression can be improved dramatically with the consistent support of a significant other.

However, such social support may not be readily available in single-income families in which one parent stays at home and the other works outside. In such families, the stay-at-home parents are subject to major changes in daily routines and responsible for looking after the baby during the day. Although working parents are also subject to postpartum stress, research showed that more stay-at-home parents suffer from postpartum depression than working parents [41].

Since there are high consistency between PPD and parenting stress [59, 62], much research has shown that spousal support to reduce parenting stress is an important recovery factor of PPD [32, 35, 58, 63]. Our work aims to encourage working parents to emotionally support stay-at-home parents to alleviate their parenting stress by facilitating spousal communication.

2.3 Technology Support for Stress

Many researchers have proposed systems that detect user stress with diverse technology and analysis, including mobility patterns [16], the human voice [39], passive smartphone sensor data [65], less invasive sensing approach [5], patterns of smartphone app usage [25], as well as such stress treatment as self-tracking and online interventions [24, 37, 40, 48, 55]. Beyond analyzing sensor data, the HCI community has recently argued for the potential of social SNS posting to identify both signs of postpartum depression and high-risk people after childbirth [18–20], strong associations between social network usage patterns and depression symptoms [49], the effective use of social media activities for estimating the degree of depression [64], and effective way of stress feedback through thermal [53]. In addition, because depression causes diverse behavior problems, which negatively affect the family caregiver [28, 67], ways for supporting the caregiver’s well-being with technologies were explored [69]. Health-tracking technologies have been designed to help family caregivers better cope with a depressed family member [70, 71]. In this work, we proposed a novel intervention to reduce parenting stress of stay-at-home parents by encouraging emotional support from working parents.

2.4 Computing System for New Parents

Significant previous work has focused on exploring tools to aid new mothers. For instance, better design for breast pumps based on new mothers’ engagement have been proposed [12, 23, 66]. Gibson explored how technology help new mothers and claimed that mothers use technology to help improve their confidence [27].

More recent works have focused on designing tools to facilitate communication between new mothers. Commercial applications such as CryingBEBE were developed for new mothers experiencing child-rearing stress to emotionally support each other [3]. Babywijzer [68] and Baby+ [57] were designed for pregnant woman to answer to their pregnancy related questions. Morris studied mothers’ usage of social networking sites to determine how they share

their information [42]. Patel et al analysed 25 smartphone applications designed for preconception health and pregnancy planning of new parents with other users' reviews[51]. While most studies focus on supporting new mothers, Ammari and Schoenebeck have studied how fathers use social networking to access information and social support from other parents in the similar situation [6–8].

Few work, if any, have focused on supporting spousal communication to encourage emotional support for stay-at-home new mothers. In our work, we propose a mobile system that facilitates working parents to better understand the stress of parenting and encourages them to emotionally support their spouse to reduce their spouses' parenting stress. To the best of our knowledge, this is one of the first attempts to provide such intervention.

3 PRELIMINARY STUDY

The key insights that motivated the need for *Bodeum* were based on observations from prior work [31, 33] that demonstrated some fathers' indifference to childcare and underestimation of mother's parenting efforts – often causing severe conflicts in Korean families. Another research showed how emotional support, particularly from their spouse's encouraging words, is a critical factor to reduce parenting stress [45].

Based on these insights, we conducted a survey to understand overall tendency of (1) stay-at-home parents' willingness of sharing baby status with their spouse and (2) working parents' understanding of their spouse parenting stress, and (3) to identify how technologies can be designed to foster emotional support from working parents to stay-at-home parents by inducing spousal communication about parenting stress.

Our survey consisted of three parts (using a Likert scale and open-ended questions). We first asked demographic questions and divided them into working parents group and stay-at-home parents group. Then, we asked working parents about their parenting roles, interests or concerns for their children or spouse when they are in a company and asked stay-at-home parents about the needs for their spouse's support and their interests or concerns for sharing their parenting stress and baby's status. In addition, we asked the same questions to all participants about the family's current practices of sharing information about their baby and the spouse's status, and their perceptions of parenting stress and their estimation on how their spouse perceive the stress. We tried to create a questionnaire as neutral as possible so as not to lead to specific answers. All the questions and quotations were translated from Korean to English.

3.1 Preliminary Survey Participants

In our study, the working parents were all fathers and the stay-at-home parents were all mothers. As noted earlier, such inequality in parenting and the stereotypical gender roles are common in South Korea [47]. We set an age limit of six-months for the child because we wanted participants who had been experiencing similar parenting stress types in a situation where a baby grows fast; this is also the period when parenting stress is high [17, 29].

Our survey was conducted in South Korea through a research survey company that recruited 32 fathers (age: 30s=26, 40s=6) and 35 mothers (age: 20s=6, 30s=28, 40s=1) who had at least one baby younger than six months. They were all single-income families

whose mothers stayed at home. The responded fathers and mothers were not necessarily couples. The participants were properly compensated by the company except the excluded participants who did not respond consistently.

3.2 Preliminary Survey Results

Different perceptions of childcare mental burden on a five-Likert scale (1: very easy, 5: very difficult): We asked both parents the following two questions: "(1) How would you rate the difficulty of childcare at home all day? and (2) Can you predict the response from your spouse's for Question (1)?" Although fathers seemed to estimate the childcare burden lower than mothers (fathers: $M=4.38$, $SD=0.74$; mothers: $M=4.57$, $SD=0.60$), a t-test indicated that the difference was not significant ($t(65)=1.18$, $p=.24$). Fathers seemed to have a relatively good understanding of the burden of parenting. However, interestingly, mothers felt that their husbands' estimation of the childcare burden was significantly lower than the actual burden ($t(68)=2.49$, $p<.05$). Some mothers reported that since their spouse did not get involved in childcare, they do not understand its difficulty.

M15: "He has never cared for his child for an entire day by himself, so there is no way he can understand the frustrations of full-time childcare."

M26: "He might think that childcare is easy. Just cook for our baby and keep an eye on her."

Interests and concerns for sharing information about childcare at home : We expected that the different awareness levels of childcare might reflect a lack of communication and understanding about parenting stress when mothers do childcare at home while fathers are working. Therefore, sharing maternal status might fill the gap between mothers and fathers about their perceptions of childcare stress. However, sharing maternal status might raise privacy concerns or offend fathers if they get frequent information about the high stress levels of their wives. In such cases, sharing their baby's status may help maintain the attention of fathers and distract them from excessive focus on parenting stress. To determine what items to share between mothers and fathers, we asked mothers if they wanted to share their stress levels, parenting activities, and baby status with their spouse. If yes, we further asked the kinds of parenting activities they wanted to share with their spouse. For fathers, we asked if they wanted to know about their spouse's stress levels, parenting activities, and baby status. They were given the option of choosing from "yes", "neutral" or "no" with open-ended questions. The results are shown in Figure 1.

3.2.1 Mothers' answers : Interestingly, 74.3% of the mothers responded that they want to share their stress levels with their husbands which are measured by a smartband (Figure 1 (d)), especially their stressful status and activities related to childcare to increase their husbands' understanding of their work and their stress. Many mothers commented in the open-questions that they want to share their stress levels as evidence for their hard work but wanted to avoid sharing private activities that are unrelated to childcare:

M29: "I want my husband to understand how difficult it is for me, especially because I have no chance to relax. However, I prefer to

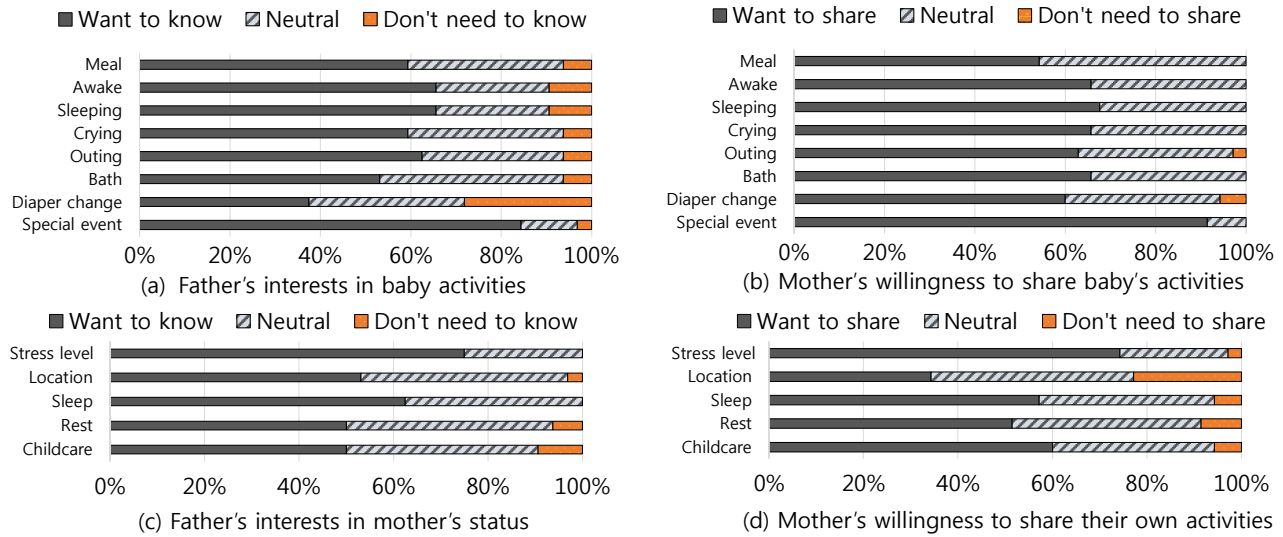


Figure 1: The survey results showing the fathers' interests in baby activities and mothers' status as well as the mothers' willingness to share their status and their baby's status with their spouses.

protect my privacy and don't want to share all activities such as my location."

Many mothers also wanted to share their baby's daily activities with their spouse. An average of 66.7% of the respondent mothers wanted to share with their spouse such daily baby activities as meals, awaking, sleeping, and bathing (Figure 1 (b)). A few mothers did not want share such baby's activities as being out of the house and diaper changes because they thought they were too trivial to share. Since most mothers believed that the responsibility of childcare should be shared by both parents, they felt it natural to share almost everything about their child with their spouse.

M5: *"I want to share things with my husband that he should be aware of as well as information that demonstrates the difficulty of childcare."*

Finally, 65.7% of the mothers reported that they wanted more appreciation about their childcare responsibilities from their husbands because such appreciation encourages them. These results match the previous finding that a partner's emotional support is an important factor for reducing parenting stress [32, 63]:

M8: *"A few words of support would provide significant encouragement."*

3.2.2 Fathers' answers : Many fathers wondered about their baby's status when they were working. The fathers reported that they communicated with their spouses a few times a day (62.5%) or a few times a week (31.3%) through text messages, image/video shares, and phone calls. However, 60.9% wanted to learn further details about their baby when they were working (Figure 1 (a)). In addition, most fathers were interested in the stress level of their wives (Figure 1 (c)). Many fathers commented in the open-questions that they wanted to know about such maternal health-related activities as eating meals or medicine that can be easily neglected during childcare:

F25: *"I'm curious about my baby's activities while I'm at work, and also whether my wife is eating properly."*

3.3 Design Implications

Based on our preliminary study, three design implications were drawn to share mother and baby status with the working father.

- (1) Mothers staying at home wanted to share about their baby status and childcare activities.
- (2) Mothers wanted to show some evidence (i.e. biological data) that they were actually experiencing some stress because they felt that fathers underestimated their parenting stress.
- (3) Working fathers wanted to know not only about their baby's lives but also the health-related activities of their spouses while they were away from home.

Therefore, we decided to develop a mobile application that allows stay-at-home parents to share their stress level, the baby activities with non-private health-related activities, such as eating and resting, to help working parents better understand the childcare activities and its associated stress.

4 SYSTEM DESIGN

In this section, we describe the features and implementation of *Bodeum*. Our main design goal is to help working parents understand the stress experienced by their spouses in relation to childcare and be more supportive of their spouses.

Bodeum consists of three components: (1) a wearable device to monitor stay-at-home parents' stress, (2) a tracking application to track the states of a stay-at-home parent and their baby, (3) a communication feature that allows working parents to access the data and give simple feedback to their spouses. Note that we chose a wearable device for tracking the stress level of stay-at-home parents rather than self-reported psychometric measures (e.g., [14]) because

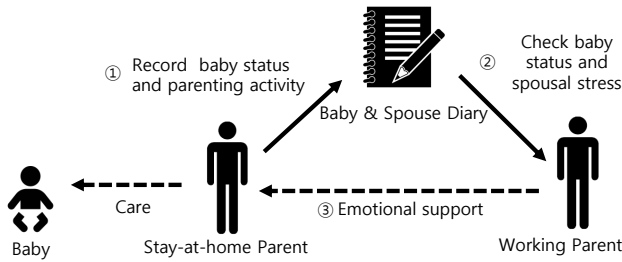


Figure 2: High-level overview of Bodeum system and communication between parents.

it provides a relatively objective way of tracking their stress and lower burden for participants.

We expect that stress scores detected by a device can be used as evidence for their actual stress, and induce communication about parenting difficulties. It is also worth noting that *Bodeum* is similar to prior baby diary applications [1, 2, 9] with only some added new features that include measuring mother’s stress level and allow working parents’ response. Integrating new intervention methods into what people already use is more acceptable and increase accessibility [43]. Figure 2 shows the overall process of our system: ① stay-at-home parents record their baby’s situation and their own stress level on mobile application. ②. The recorded information is shared with working parents who can check it through the application. ③ working parents can see when their spouses are stressed and provide emotional support.

4.1 Application Description

Figure 3 shows the interface of our system. It has 12 rows of time slots, each of which represents one hour, and one screen page represents either the morning or the afternoon because of the limitations of the screen size. The date can be changed by swiping left for the previous day or right for the next day. Parents can record or express their status by dragging the status icons and dropping them into the proper slot. The saved activities are shared with their spouses.

4.1.1 Activity icons. Figure 4 shows all the activity icons available to the parents. The mother icons have meals and resting for their health-related activities and emotions to express their levels of subjective stress. The father icons include a few simple encouragements, asking for input, and suggesting healthy behavior to their wives. Mothers and fathers can only use their own icons as well as those for the baby. The special icons cannot be chosen because they are automatically shown when a mother’s high-stress is detected by the band.

4.1.2 Baby activities (Figure 3 (a)-(5)). The parents can record such simple activities of their baby as meals, diaper changes, sleeping, and bathing, all of which are based on baby diary applications [1, 2, 9]. Except for sleep, all the other baby activities require care from caregivers. In addition, *Bodeum* provides a *Hold* icon that is associated with a baby’s status but it also places a high burden on stay-at-home parents.

4.1.3 Stress monitor with a wearable device. We used Garmin vivosmart 3 (Figure 5) to monitor the mothers’ objective stress. It

analyzes its wearer’s stress level based on heart rate variability (HRV) [61], which denotes the variations intervals between consecutive heartbeats and is extensively used as an indicator of mental stress in research and clinical studies [54]. The device calculates stress levels from 0 to 100 every three minutes and automatically uploads stress data to its server when the Garmin application is executed [4]. A level from 0 to 25 is a state of rest, 26 to 50 is a low stress level, 51 to 75 is medium stress, and 76 to 100 is high stress. However, stress levels can vary on the individual characteristics of users. In addition, they do not differentiate between positive and negative stress because human physical responses to positive and negative stress are physiologically similar [61]. Thus, *Bodeum* loads maternal objective stress levels measured by the smartband and allows mothers to annotate their subjective emotions (positive or negative) whenever their objective stress levels are high.

4.1.4 Mother’s objective stress level (Figure 3 (a)-(1)). *Bodeum* monitors maternal stress with a smartband (as described above) and shows a stress graph that resembles what is shown on the Garmin application [4].

4.1.5 Mother’s subjective stress level (Figure 3 (a)-(2)). Since one of *Bodeum*’s main goals is to share the stress of wives with their husbands, clarifying the types of maternal stress is crucial. *Bodeum* gives mothers the chance to input their five-scale subjective emotions that includes both high and negative stress when their stress level exceeds a pre-calculated threshold ².

4.1.6 Father’s reaction and suggestion (Figure 3 (a)-(4)). As a quick reaction to maternal status or activity, fathers can encourage their wives with such simple icons as a smile or a rose. They can also ask for input when they see empty slots or suggest that their wives take a rest or get something to eat.

4.1.7 Triggering communication between parents. When a mother’s objective stress is high and her subjective stress is negative, *Bodeum* notifies the father that high stress levels have been detected in his wife, and a red triangle icon will blink on his screen in the column of the *Father Comment* to entice the father to touch it, described in Figure 3 (a)-(4). When the father touches the blinking stress icon, a pop-up message will recommend that he contact his wife (Figure 3 (b)), and the stress icon will change to a waiting icon in Figure 4. After the parents discuss the stress and touch the waiting icon again, it becomes a talk icon (Figure 3 (c)).

4.2 Bodeum Implementation (Figure 5)

Bodeum was implemented on the Android operating system. A server was developed in Java to save parent’s application usage pattern. It loads the participant’s stress level data from Garmin’s server through Garmin RestAPI. It also automatically sends push notifications to fathers when high stress emotion of mothers is recorded.

²We used a threshold in the top 25 percentile of the maternal stress from the previous day. If it is too low, it might bother mothers to input too many subjective emotions. On the other hand, if it is too high, there might be no chance to express the mother’s stress.

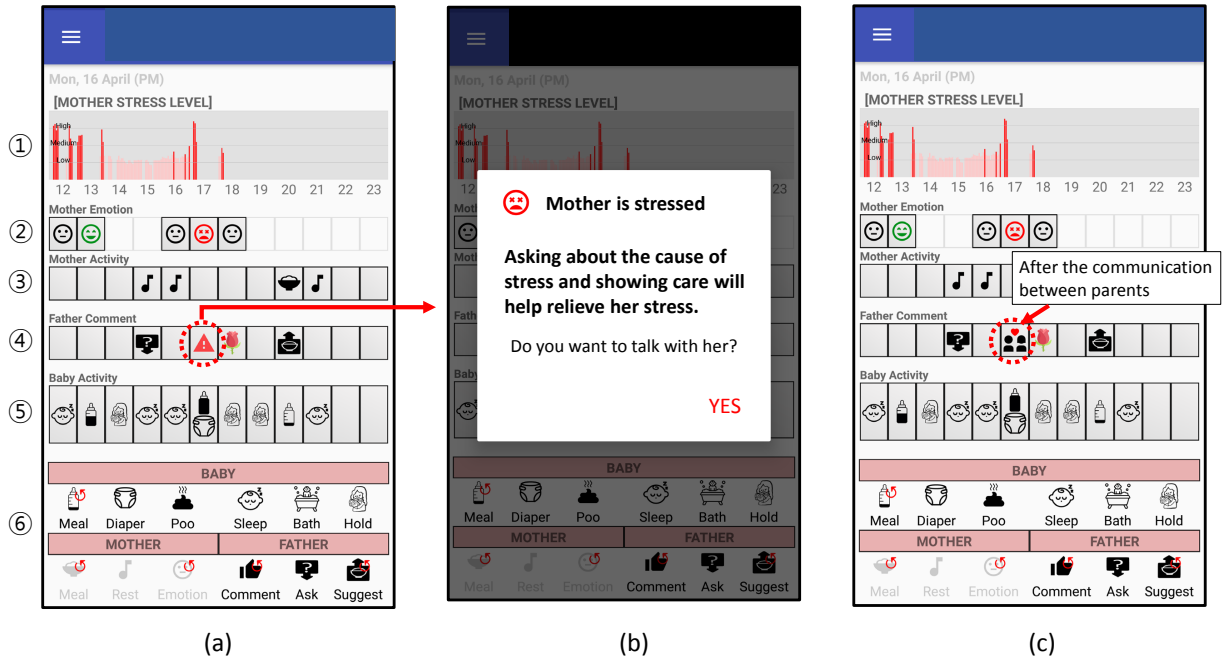


Figure 3: (a) Screenshot of *Bodeum* interface that contains ① mother’s stress level measure by a smartband, ② mother’s subjective emotion, ③ mother’s activity, ④ father’s comment, ⑤ baby’s activity, and ⑥ activity and emotion icons, (b) pop-up message to trigger communication between parents, and (c) change in icon after the communication. All interfaces are translated from Korean to English and mother’s icons on lower-left in the screen are blurred since this is a paternal screen snapshot.

BABY						
MOTHER						
FATHER						
SPECIAL						

Figure 4: Icons used in *Bodeum* for communication between the parents.

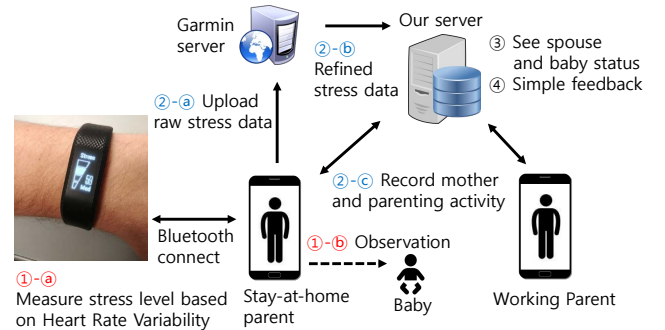


Figure 5: Overall *Bodeum* architecture and data flows.

5 FEASIBILITY STUDY

To assess the potential of *Bodeum*, we performed a feasibility study that included (1) initial surveys, (2) two-week feasibility study of *Bodeum*, and (3) post surveys.

The study sought to determine whether *Bodeum* can increase working parents’ understanding of stay-at-home parents’ parenting stress and baby status to alleviate stay-at-home parents’ perceived parenting stress.

5.1 Method

We recruited 9 families (9 mothers and 9 fathers) in South Korea for the feasibility study through a research company consisting of single-income families where fathers worked outside of the home

and stay-at-home mothers who were responsible for childcare with at least one baby younger than six months³. Both parents had to agree to participate in the study, and the mothers had to agree to wear a smartband during their spouse’s working time for sharing their stress level. We provided one Garmin vivosmart 3 among each family to analyze the maternal stress levels. Finally, nine families (18 participants, 9 fathers and 9 mothers) were recruited and the demographics of them are summarized in Table 1. Each participant was compensated approximately \$50 after completing post survey. Institutional Review Board approval was obtained prior to the study.

³We controlled target population as working parents were fathers and stay-at-home parents were mothers to match the participant configurations with the preliminary survey.

Initial survey: Before starting the feasibility study, our researchers visited each participant and helped set up *Bodeum* and explained how to use the application. We then conducted a survey to figure out their basic parenting environment and childcare perceptions.

More specifically, we were interested in (1) perception of parenting stress and prediction of their spouse's answer for the same question, (2) father's hours of working and participating in childcare, (3) frequency and way of communicating about children and mothers status when fathers are in the company, (4) frequency and way of father's emotional support, or perception and needs of father's emotional support.

Feasibility study of two weeks: During the 2-week study, we asked the mothers to wear a smartband while their husbands were away from home (or at least from 9 am to 6 pm). We did not ask them to wear it after their husbands came back home because *Bodeum* was intended for communication when the parents were apart and to reduce the burden of wearing for 24 hours. We excluded the weekends because we assumed that the fathers were at home. The stress level threshold that asked about the mother's subjective emotions changed every midnight depending on the previous stress level data. The program usage patterns were recorded on the server for analysis, including the number of log-ins and the usage times.

Post survey: After the 2-week period, we administered a post-study survey that asked the participants their changes after using *Bodeum* using 5-point Likert scale to compare the change of the participants' answers or perceptions (ex., "Q. The frequency of father asking about baby's status was changed (1: decrease, 3: no change, 5: increase)"), following open questions for each answer to understand why their answer (or score) was changed, and new questions asking the experience of using *Bodeum*.

The new questions were consisted of 5-point Likert scale and following open questions asking the reason for the answer. The main topics were (1) *Bodeum*'s usability of stress and status sharing with a father, mother's subjective stress assessment, baby diary, and father's comment through *Bodeum*, (2) (mother only) change of their perceived parenting stress and father's understanding, usage experience of exaggerating or minimizing their subjective stress and of triggering communication between the parent about their parenting stress, and their feeling when the father did or did not contact them when their high stress was detected, (3) (father only) change of their understanding about mother and baby status, usage pattern in the company, and usage experience of triggering communication about mother's stress through *Bodeum*, and (4) additional questions for the specific participants whose usage pattern was unusual (ex., used *Bodeum* even beyond required times). Then, we analyzed the participants' answers following open-coding and axial-coding procedures to examine their responses [44].

6 FINDINGS

This section presents our findings from the feasibility study on how the participants used *Bodeum* with their spouses, how they shared the daily activities of mothers and babies, and the paternal emotional support for their wives' stress based on survey answers. All the questions and quotations were translated from Korean to English.

ID	Occupation (father)	Work hours in a day (weekdays)	Childcare hours in a day (weekdays)	# of children	Younger children age (months)
1	Professional	8-10h	4-5h	2	0-2
2	Professional	8-10h	4-5h	1	0-2
3	Sales	10-12h	0-1h	2	5-6
4	Officer	8-10h	0-1h	2	0-2
5	Production	8-10h	1-2h	2	3-4
6	Professional	10-12h	2-3h	1	3-4
7	Officer	8-10h	1-2h	2	3-4
8	Officer	8-10h	2-3h	2	0-2
9	Professional	8-10h	3-4h	2	5-6

Table 1: Participant families and demographics.

6.1 Overall Usage Pattern

Figure 6 shows the number of execution of *Bodeum* from all the participants. The y-axis of the graph represents the number of times *Bodeum* was executed each hour during the feasibility study. For each day, the mothers executed *Bodeum* an average of 13.5 times (SD=5.8) and the participating fathers executed it an average of 3.1 times (SD=0.9). While mothers usually used *Bodeum* regularly while fathers were away, fathers seemed to use *Bodeum* during their micro-spare and lunch time at work and after they finished working.

6.2 Father's Understanding of Mother and Baby Status

To examine whether working fathers and stay-at-home mothers felt any changes about the father's understanding of parenting stress, we asked them the following question: "Changes in father's understanding about their wives' parenting stress (1:decrease, 5:increase)", and most participants agreed that it did (father: M=4.1, SD=0.93, mother: M=4.1, SD=0.87). The fathers also answered that their understanding of baby's activity improved: "Changes in father's understanding about baby's daily status" (father: M=4.1, SD=0.33). The fathers generally admitted that their understanding of childcare had been vague. But after checking the stress data together with the detailed parenting activities and baby status, they seemed to get a better understanding of why their wives were stressed.

F4: "I simply assumed that childcare was difficult without much actual understanding of it. By getting detailed information about childcare, I learned to have more sympathy for my wife and her difficulties."

F6: "My wife usually doesn't talk about her parenting stress. However, after using *Bodeum*, which clearly expressed difficulties and stress, we were able to discuss what caused her stress."

We also compared the post-study survey answers with the pre-study survey answers to see if the working fathers' perception of parenting burden has changed after the study. We particularly focused on the question: "To what extent do you think mental burden is required for childcare?" All the fathers who did not give the highest score (in the pre-study survey) for parenting burden raised their scores after the study (pre-: M=4.22, SD=1.31, post-: M=4.89, SD=0.31). Those who underestimated the difficulties of parenting seemed to realize its heavy burden.

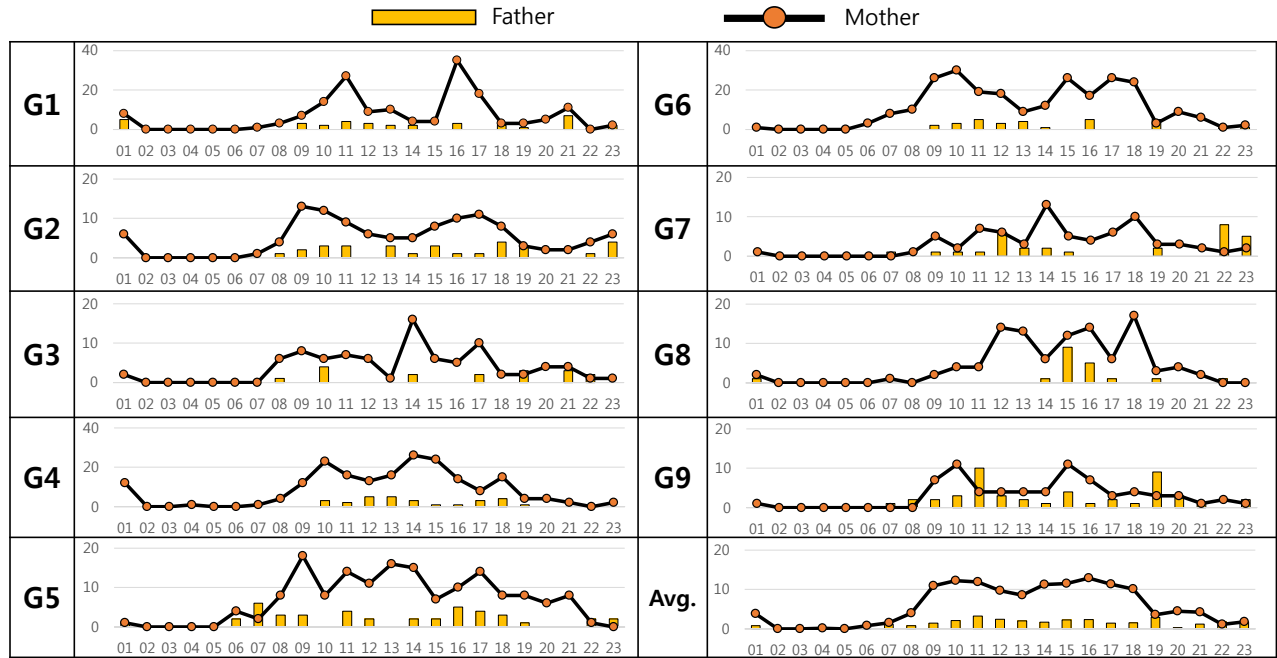


Figure 6: Overall usage pattern by the 9 families during 2-week feasibility study. The x-axis of the graphs represents 24 hours and the y-axis represents the number of times *Bodeum* was used during at each hour during the feasibility study.

6.3 Mother's Stress and Father's Emotional Support

Improvement in father's emotional support : Most participants reported that fathers contacted their spouses more frequently to talk about parenting stress (Q1-father: $M=3.3$, mother: $M=4$), baby's status (Q2-father: $M=3.5$, mother: $M=4.125$) and appreciation for mother's work (Q3-father: $M=3.6$, mother: $M=3.625$). Interestingly, mothers' scores tended to be higher than fathers, which means mother felt father's change more sensitively.

According to the fathers, some of the contacts they made to their spouse were triggered by *Bodeum*. When they received notifications about their spouse's high stress, they tried to contact their spouses, sometimes immediately or later depending on their availability at the moment. They seemed to discuss the causes of their wives' stress while simultaneously expressing appreciation:

F8: "I knew that my wife was still recovering from childbirth, but when I noticed that she was stressed, I talked to her more and expressed my concern for her."

F9: "Even if I noticed my wife's high levels of stress, I couldn't check on her immediately because of my work schedule. We talked about the cause of her stress on my way home or after I got back home, and I encouraged her."

Decrease in mothers' perceived stress : When mothers were asked to whether *Bodeum* had changed their parenting stress, most of them answered it helped decrease their parenting stress (mother: $M=2.125$, $SD=1.36$). As explained above, fathers normally contacted their spouse when they noticed the high stress of their wives. It

appears that such caring behavior of the husbands led the wives to feel better:

M8: "He called me when my stress level was high on *Bodeum*. So I explained the difficulty of getting my baby to sleep and how stressful it was. Simply sharing this information provided some comfort."

Another mother reported that she liked wearing the smartband and sharing her stress data with her husband because she felt cared for:

M5: "My husband asked what went wrong with me and the baby when my stress level was high. I liked wearing the smartband because I felt that I was being watched over."

Improving communication between parents : The main intervention of *Bodeum* was to encourage communication between parents about the difficulties of childcare and maternal stress. As we can already see from the previous quotes, *Bodeum* seemed to successfully provide topics about childcare and stress. Most participants reported that their frequency of communication by phone or face-to-face conversations after work increased:

M6: "My husband asked me why I was so stressed. I told him that our baby was sick and wasn't sleeping. It was good to talk with him about my stress. He generally gets home very late, so I never feel that we have enough time to talk. After using this app, he often called me from work."

M8: "I always just vaguely described myself as tired, and *Bodeum* sends a notification when I felt very stressed, so we can talk at that time. That improved our communication."

6.4 Issues Raised by Participants

From the improvements suggested by the participants, we identified a few limitations of our approach as outlined below.

Mother who entered false information about her subjective emotions : When the smartband detected high level of stress, *Bodeum* gave mothers a chance to input their subjective emotion as either positive or negative. To investigate the maternal use of subjective emotion icons, we asked if they had always entered their true emotions, and whether they had ever entered a false emotion. Although most participating mothers seemed to enter their true emotions, one mother reported that she often entered a negative icon to exaggerate her stress to her husband.

M8: “When I was cleaning up a dirty diaper, I was actually not stressed, but *Bodeum* showed high stress. So I entered a negative icon. He called me and I pretended to be stressed.”

Such exaggeration potentially increases the frequency of notifications to fathers. Unfortunately, however, some fathers reported that repeated notifications made them insensitive. For example, one father commented:

F3: “I got an average of two high stress notifications every day. It was difficult to suddenly contact my wife because of my work, and even when I did contact her, the situation didn’t really seem so serious.”

This quote implies that the father expected a more serious problem related to his wife’s status when the application prompted him to contact her. Such paternal expectations may lead to miscommunication with a wife who is simply craving appreciation or emotional support. This result suggests the importance of bridging the gap between the expectations of both parents.

In contrast to the mother who exaggerated her stress level by entering a negative icon, some mothers reported that they entered a happy icon when they were actually stressed. 3 out of 9 mothers reported that they often hid their negative stress by entering a happy icon. Two were concerned about disturbing their spouses at work.

M4: “I couldn’t send my actual stressful status because I knew my husband was also probably tired or stressed from work.”

M5: “He might think I’m a bad mother if I complain about the difficulty of childcare.”

The mothers couldn’t express their stress because of their concern about their spouses at work. This result suggests that mothers want their husbands to understand the parenting stress to the extent that it doesn’t get too overwhelming for their husbands.

Asymmetries of *Bodeum* : To balance out the asymmetric parenting roles where stay-at-home parents do most of the childcare chores, we designed an opposite asymmetric emotional support where the working parents provide emotional support for stay-at-home parents. However, some parents complained that this design was unfair since fathers are also stressed from work and sometimes need emotional support, too.

F5: “I know my wife is stressed by childcare, but I also want to express my stress to her. It is unfair to allow only mother can express her stress.”

Although there was no case in the study, if fathers thought their wives were highly stressed, the dissatisfaction is likely to decrease [70,

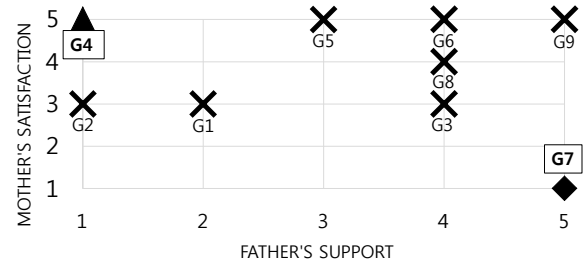


Figure 7: Relationship between mother’s expectation and father’s support from the feasibility study. Gx denotes Group x consisted of Mother x and Father x.

71]. In addition, some fathers noted the need for sharing their availability with their wives to reduce potential miscommunication:

F4: “*Bodeum* doesn’t consider us fathers. For example, when I cannot answer my wife, she might feel bad but maybe I’m pre-occupied at work. So I think fathers also need some icons to express availability.”

Indeed, one mother reported that she became more stressed when her husband didn’t react to her high stress on *Bodeum*:

M7: “I sometimes became angry When I used a negative icon but if my husband still didn’t contact me. Waiting for a reaction from him was also stressful.”

This situation reflects the insufficient communication about her husband’s status.

7 DISCUSSION

7.1 Factors for Mother’s Satisfaction

Overall, the mothers seemed to perceive less parenting stress after getting more emotional support from their husbands. However, one mother (M7) actually reported that her stress *increased* because of *Bodeum*, especially when her spouse’s response was late. Interestingly, her spouse (F7) appeared to contact her regularly when he was notified by *Bodeum*, similar to the other fathers who participated. So we deepened our investigation into the differences between the mothers who felt satisfied with *Bodeum* and those who did not.

Figure 7 shows the post-survey results which asked fathers about their perceived frequency of providing emotional support to the mothers, and mothers about their satisfaction level. The result shows that Group 7 (M7, F7) was an extreme case where the father’s support was high and the mother’s satisfaction was low, and Group 4 (M4, F4) was the exact opposite of Group 7. The difference between Groups 4 and 7 is that the mothers’ satisfaction was based on their expectations for support from their spouses. For example, M4 even showed satisfaction after a small change in her husband’s demeanor:

F4: “My spouse asked me about my stress level, and I told him I was stressed because our baby was not sleeping very well. Since I knew his usual demeanor, I recognized he was starting to show more concern for me. It made me feel better.”

In comparison, M7 was annoyed (i.e., Section 6.4) whenever she felt that her spouse’s reaction/contact was delayed. Therefore, we believe that both the maternal expectation of a husband’s support

and its amount are important factors for determining maternal satisfaction. This realization contributed to the design implications described in the next section.

7.2 Controlling for Mother’s Expectations

Maternal satisfaction was affected by the expectations of mothers and the amount of paternal support. Even if a husband tries hard to support his wife, she might not feel better if they do not understand the father’s effort. In our feasibility study, some mothers started to expect contact from their spouses from the moment they selected a high stress negative emoticon. M7 felt disappointed or stressed about her spouse when he failed to respond quickly enough. One approach to resolve such an issue is to allow the husbands to share their availability during work. By sharing paternal availability with mothers, we expect that mothers will obtain a better understanding on the status of their husbands, allowing them to understand why they failed to immediately contact them. A feature that shares whether fathers checked the application, and their availability can be useful. Another approach is to share the data (i.e. mothers’ stress levels and the amount of feedback they receive from working fathers) with similar others. For example, if M7 realizes that his husband was supportive and provided more feedback compared to others, she may feel pleased.

7.3 Sharing Father’s Stress with Mothers

Bodeum focused on sharing the status of stay-at-home mothers to encourage emotional support from their working spouses. While this asymmetric design makes sense in terms of balancing out the unequal parenting roles, our findings suggest the importance of having a more symmetric design for sharing their status. For example, fathers felt unfairness in the system design and expressed the need to receive emotional support about work-related stress from their spouse. In addition, some mothers expressed hesitation in expressing their parenting stress because they worried about their husband’s work and did not want to pose extra burden on them. Thus, a feature that shares the working fathers’ stress with the stay-at-home mothers may alleviate the issue by improving understanding of each others’ stress/status and providing emotional support to each other.

7.4 Outsized Burden and Privacy Concern

Based on our preliminary survey, *Bodeum* was motivated by stay-at-home parents wanting and willing to share their information with their spouse when the fathers are not home. Even though stay-at-home parents are introduced with more burden to record status/events, to minimize such burden, we developed *Bodeum* that is similar to prior baby diary applications [1, 2, 9], which are well-used mobile applications to track babies among new mothers. We introduced only a few new features that include measuring mother’s stress level and allow working parents’ response. Moreover, automatic tracking system for baby diary is being developed (e.g., Beblog [36]) that records baby activities semi-automatically which can further reduce the burden on the parents. However, our main contribution lies on the sharing mother stress with their spouses, inducing father’s emotional support based on their understanding of mother’s parenting stress which might not be seen with only the share of baby diary. In addition, because the mothers have the advantage of receiving emotional support from their spouse by

sharing their stress with more burden to record status/event, they were willing to do sharing work. Therefore, at least in the asymmetrical roles of parental childcare context, the privacy concerns between the spouses were limited.

7.5 Impact of Using Bodeum

While our study found increase in spousal communication from using *Bodeum*, it is possible that the improvement can not necessarily from using *Bodeum* but from merely participating in the study – i.e., simply participating in the study itself may have increased fathers’ awareness of parental stress. Since the feasibility study required both parents to participate, we can assume that none of the parents were in a destructive relationship. However, the quotes from the participants in the post-study provide some evidence that the system did trigger spousal communication by providing concrete information about when and how frequently mothers experienced stress during the day. In addition, the main contribution of our study is to show the potential usefulness and risks of our approach.

7.6 Effect of Self-Tracking Stress

In our study, we tracked the stress of mothers with a smartband. None of the participants in our feasibility study had ever used a wearable device for such self-tracking. Since much research has identified the benefits of self-tracking [11, 38, 56], these positive effect of self-tracking may be related to the fact that the mothers reported that their perceived stress decreased after using *Bodeum*. The result that mothers perceived less stress after using *Bodeum* may be combined with both the effect of self-tracking stress and paternal emotional support. However, our approach, which encourages emotional support from their husbands, is based on related works that showed that paternal support is a critical factor for relieving parenting stress. Therefore, we believe that our approach provides its own intervention effect and can complement self-tracking methods.

7.7 Diverse Family Considerations

We limited our focus to a specific family type: a working father and a stay-at-home-mother who looks after at least a baby younger than 6 months. Although such parenting style is very common in Asia, the system does not address the parenting issues present in other family types where parents have equal parenting roles. However, we believe that our findings can be extended to family types having unequal parenting roles (e.g., a stay-at-home-father and a working mother). Furthermore, since spousal support is an important factor to relieve parenting stress [35] in any family, we believe that our study provides insight to the domain of family health and healthcare informatics.

8 CONCLUSIONS

In this paper, we presented *Bodeum*, a novel, asymmetrical system design to induce working parent’s emotional support for the stay-at-home parent. A two-week feasibility study with nine families showed that *Bodeum* improved the understanding of working parents about spousal parenting stress and facilitated spousal communication. This improvement showed the potential of *Bodeum* reducing stay-at-home parent’s parenting stress. We also suggested new design considerations based on the findings.

9 ACKNOWLEDGMENTS

We would like to thank the anonymous reviewers for their valuable comments and feedback. This work is supported by Grant for Scientific Research (A) 17H00771 from Japan Society for the Promotion of Science (JSPS) and in part by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2018S1A3A2075274).

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