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A Behavior Analytic Approach to Childbirth: A Contingency Analysis and Preliminary Investigation

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Abstract

The "cascade of interventions" associated with analgesia use during childbirth has contributed to the U.S. having some of the poorest birth outcomes of any developed nation (Clark, Belfort, Byrum, Meyers, & Perlin, 2008; Kuklina, Meikle, & Jamieson, 2009) and one of the highest rates of cesarean section, with 1 in 3 women delivering their babies via surgery (Boyle, Reddy, & Landy, 2013). In a report summarizing the World Health Organization's principles of perinatal care, appropriate methods for pain relief are suggested to all be behavioral (Chalmers, Mangiaterra, & Porter, 2001) and a meta-analysis of non-pharmacological approaches for pain management demonstrates better outcomes than use of medical pain management (Chaillet et al., 2014). Despite these conclusions, over 80% of women in the U.S. use an epidural during labor and almost 50% of women who do not want epidurals also end up receiving them (Goer & Romano, 2012). The lack of fluency with labor coping strategies and partner support skills has been highlighted as a contributing variable to the over-reliance on heavy narcotics during childbirth. Research has suggested that childbirth education is ineffective at generalizing learned coping strategies and that better methods of prompting non-pharmacological pain management strategies are needed (e.g., Slade, Escott, Spiby, Henderson, & Fraser, 2000). The purpose of this study was to address the common practices within childbirth; outcomes associated with such practices were discussed, contingency analyses of the barriers were identified, and a behavior analytic technology within the current system was proposed and evaluated. Results of this preliminary study conclude that the introduction of a behavior analytic software using in-vivo prompting and video modeling

increases the frequency of labor behaviors and variability of labor behaviors during unmedicated labor for women and their support partners.

Keywords: behavior analysis; behavioral medicine; childbirth

Acknowledgements

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Investigation

Childbirth in the United States is much different today than in centuries past.

Whereas childbirth was once considered a natural process that a majority of women

would experience in their lifetime, it is now though of as a process that needs to be

medically managed. Previously, women thought that the body was designed to be

capable of delivering a baby and many women gave birth in the comfort and privacy of

their own homes. With the advent of modern medicine, the once customary home birth

practices became taboo and women became more likely to deliver their baby in a hospital

setting, attached to a bed with monitors and other intrusive interventions (Leavitt, 1986).

Currently in the U.S., almost all births happen in a hospital setting with an obstetrician, a

formally trained medical physician and surgeon, managing the process of labor and

delivery. In many other developed countries such as the United Kingdom, Sweden, and

Japan, midwives, professionally trained medical professionals that manage normal birth,

are the primary birth attendants, whether the birth occurs in a hospital, free standing birth

center, or at home (Rooks, 1999).

Prior to the 20th century, midwives in the United States oversaw almost all births,

however midwifery laws varied by state (and still do) and were difficult to enforce with

regard to education, training and oversight (Rooks, 1999). Several events in the early

1900s resulted in the downfall of the midwifery profession and the rise of obstetricians

for management of childbirth.

The first major movement toward obstetrics occurred in 1910 when a report was

published that concluded that American obstetricians needed improved training and

recommended that all deliveries occur in a hospital setting to allow for that training. Lower-class women that were still being seen by midwives at the time began being seen in hospitals to allow for doctors in training to receive the necessary clinical skills outlined in the publication. Upper class women welcomed the opportunity to give birth in a hospital, as it was seen as a symbol of medical progress and status (Rooks, 1999).

Additionally, in 1915, Dr. Joseph DeLee, the author of one of the most influential obstetric textbooks of that time, declared birth as a pathological process that damages mothers and children and suggested that management and intervention be required during birth. These routine interventions included use of sedatives, ether, episiotomies and forceps for delivery. By the 1920s, midwives oversaw less than half of all births in the U.S., with physicians overseeing the other half (Leavitt, 1986). At the annual meeting of the American Association for the Study and Prevention of Infant Mortality during that same year, DeLee spoke out against the profession of midwives, explaining that the employment of midwives hindered obstetrical development and that the profession of midwifery lowered the standards of the field ("Society Reports," 1915).

It was not until years later that the dangers of routine medical management and unnecessary interventions during childbirth were revealed. At the White House Conference on Child Health and Protection in 1933, the results of a large study were discussed in which the 41% increase in maternal and infant mortality between the years 1915 and 1929 was attributed to medically managed labors by obstetricians and childbirth in hospitals. American obstetricians are still functioning under the same medical paradigm that was recommended and enforced by Dr. DeLee over a century ago (Rooks, 1999).

> Our evidence suggests that mainstream obstetric science follows mainstream obstetric practice. A patient and expectant approach to birth…where all is considered normal until proved otherwise, produces a science that proves intervention to be unnecessary. Alternatively, an aggressive approach to birth… where birth is regarded as normal only in retrospect, generates a science that demonstrates the need for monitoring and intervention, (De Vries & Lemmens, 2006, p. 2704).

This aggressive approach to birth that still exists in society has resulted in cascading interventions and a number of physical and psychological tribulations.

Despite the evidence against the routine use of interventions, a majority of women opt for the use of heavy pain medication during birth to escape or avoid the fearfully anticipated pain of labor. Fear and misconception of birth are largely a result of the history of medical management as well as mainstream media. This is not only the case in childbirth, but in our health system overall; we live in a society in which is it unacceptable to feel pain, neither physical nor emotional, and symptoms are effortlessly treated with pharmaceuticals. Women in our society have gone as far to schedule cesarean sections for a normal and healthy pregnancy to avoid any feelings of physical pain resulting from labor and delivery. The term "too posh to push" refers to a scheduled surgical birth for reasons that are less than critical (Song, 2004). While there are occurrences during childbirth that dictate the necessary use of medical or surgical techniques, the average childbearing woman in good health should not require interventions unless medically necessary (Goer & Romano, 2012).

Dichotomy in Childbirth

There are two divergent philosophies of care in childbirth: the medical and physiological models. Generally speaking, the medical model aligns with practice of modern medicine, and interventions based on empirical data from randomized clinical trials are used as a prevention method to control for disease, disorders and other complications. The physiological model is a holistic approach to wellness that focuses on support techniques to prevent the need for use of medical intervention. The medical model is the primary focus of modern day maternity care in the U.S resulting from the medical advances in childbirth and obstetrics during the early 20th century (Goer & Romano, 2012).

The philosophy of the medical model is much like DeLee proposed in 1915 ("Society Reports", 1911), wherein physicians begin from the assumption that pregnancy and birth are inherently difficult and dangerous to both the woman and her fetus, and if left to occur naturally, would result in physical harm to one or both. Medically trained physicians (e.g., obstetricians and family practitioners) practice maternity care this way, as well as many classically trained nurses and some midwives. This model of care occurs in a hospital setting and involves routine use of continuous fetal monitoring and other aggressive interventions intended to produce best outcomes by preventing and treating complications (Goer & Romano, 2012). This type of routine care often leads to restricted movement for the woman, and unnatural environments, the repercussions of which will be discussed in detail further into this paper. According to this type of care, a best outcome scenario is defined as a live mother and a live baby in good physical condition and is focused on discharging a patient without serious complications or concerns (Goer & Romano, 2012). It is also important to consider the contingencies that the medical

field operates within, particularly in maternity care; the focus often is on avoidance of malpractice suits and relies upon proving all precautionary medical treatments were implemented.

In contrast to the medical model, the physiological model strives for wellbeing of the mother and child from both a physical and psychological perspective. These outcomes include the prevention of maternal and fetal morbidity while taking into consideration the overall woman's health history and the long-term impacts of the childbirth experience with regard to mother-baby bonding, breastfeeding, parenting and overall psychological wellbeing (Goer & Romano, 2012). Through the use of minimal medical monitoring and engaging the woman as an active participant during her labor, the physiological model of care is considered optimal for healthy women experiencing uncomplicated labor (Kennedy, 2006). This model of care is often overseen by professionals with differing levels of education (e.g., certified professional midwives, certified nurse midwives, and doulas) that serve the function of implementing practices that might reduce the need for medical intervention. The practices encouraged include nonpharmacological pain management, intermittent fetal monitoring, physical and emotional support, and use of medical interventions only as necessary (Goer & Romano, 2012).

Evidence for Change

The World Health Organization (2009) recommends that no more than 1 in 10 women should have a medical need to give birth via cesarean. Contrariwise, 1 in 3 women giving birth for the first time will have a cesarean section to deliver their babies (Boyle et al., 2013). Across the U.S., this rate varies between states ranging from a low

of 23% to a high of 40%, and between hospitals, ranging from 7.1% to 69.9% (ACOG, 2014). These rates are in stark contrast to the rates during the early 1970s when the average cesarean rate across the U.S. was less than 5% (U.S. Department of Health and Human Services, 1981).

Within the last 50 years, the nationwide increase in cesarean sections, often referred to as the Cesarean Epidemic (Goer & Romano, 2012), has begun to gain the attention of policy makers, insurance companies, hospitals, and perhaps most importantly, women of childbearing age. With the improvement in surgical techniques and analgesic medications, childbirth via surgery began to be considered as a safe alternative to the tribulations associated with vaginal delivery (Goer & Romano, 2012). Also contributing to the rise in cesarean births was the belief at the time that once you have had a cesarean, the safest method of future deliveries is also cesarean. These beliefs resulted in the cesarean rate rising to 17% during the late 1970s (U.S. Department of Health and Human Services, 1991). This striking increase in surgical births resulted in the National Institutes of Health convening a task force to address the concern over this quickly rising rate. In 1979, the NIH made recommendations: cesareans should be administered for labor arrest, repeat cesarean, breech presentation, and fetal distress (National Institutes of Health, 1979). The recommendations did not lower the rate of cesarean delivery at all, and the rate continued to increase through the 1980s (U.S. Department of Health and Human Services, 1991). These same recommendations for cesarean delivery still exist today (ACOG, 2014).

While there are life-saving benefits to the use of a cesarean section procedure when used for medically necessary reasons, there are also many risks to mother and baby

associated with it. In 2006, the National Institutes of Health reviewed available literature on risks and benefits of cesarean delivery and made the following conclusions: cesarean section results in longer maternal hospital stay, increased risk of maternal infection, increased risk of analgesia complications, increased risk of respiratory problems for the infant, reduced rates of breastfeeding for the infant, and greater complications in subsequent pregnancies including uterine rupture, problems with placental implantation, and the increased need for hysterectomy (ACOG, 2013a). "Given the balance of risks and benefits, the Committee on Obstetric Practice believes that in the absence of maternal or fetal indications for cesarean delivery, a plan for vaginal delivery is safe and appropriate and should be recommended to patients" (p. 904).

Considering the multiple identified risks of cesarean birth and their exponentially increasing rates, The Joint Commission, an independent non-profit organization that accredits health care organizations in the U.S., declared that beginning January 1, 2014, all hospitals with more than 1,100 births per year would report their annual cesarean rates (Dekker, 2013b). One of the top priorities of the commission with regard to perinatal outcomes are to lower caesarean section rates in low-risk women during hospitalization. With these goals in mind, it is important to consider the variables that put a woman at higher risk for cesarean section and what evidence exists in order to help prevent the need for cesarean delivery.

Labor induction/augmentation. "Failure to progress," or slow progress during labor, is the leading cause for cesarean section in the U.S. with 35% of cesareans occurring for this reason alone (Boyle, Reddy, & Landy, 2013). The diagnosis of failure to progress can occur at several stages throughout labor: Stage 1 failure to progress

indicates that the woman is in the middle of her labor and the cervix fails to open or is taking longer to open than anticipated whereas failure to progress at Stage 2 indicates that a stalled progression is occurring during the pushing phase of labor and the baby fails to descend. About 40% of failure to progress diagnoses occur at stage 1 and the remainder occur at stage 2 (Boyle, Reddy, & Landy, 2013). It is worth mentioning that medical/artificial induction of labor, while beyond the scope of this paper, is a leading factor in the failure to progress diagnosis, with about half of the women who undergo a medical induction resulting in cesarean births (Caton et al., 2002).

For the purposes of this paper, the focus is placed on the medical augmentation or active management of labor (AMoL), in other words, the somewhat routine use medical interventions to speed labor along once it has already begun naturally. The need to facilitate progress during labor is largely attributed to Friedman (1955) who published a paper on the average time that it took women to dilate during labor. The distribution curve dictates that active labor, in the form of strong uterine contractions, should open or dilate the cervix by about 1 centimeter per hour, and the average duration of labor for a first-time mother is 14 hours, whereas the average duration for an experienced mother is about 8 hours (Friedman, 1955). Deemed the "Friedman's Curve," this model of the standardization of labor progress is still used in medical management of labor (Gabbe, Niebyl, & Galan, 2012) and a majority of providers use this model to dictate how they will manage a woman's labor (Zhang, Troendle, & Reddy, 2010). If a woman's cervix fails to dilate at a rate of 1centimeter per hour, AMoL is utilized, which consists of either amniotomy (mechanical rupture of the membrane surrounding the fetus, commonly referred to as the bag of waters) and/or administration of a synthetic form of the labor

hormone Oxytocin, commonly referred to as Pitocin (O'Driscoll, Meagher, & Boylan, 1993).

       Use of Pitocin to augment labor is one of the top contributors to the pedestrian phrase "cascade of interventions," or the treatment pathways that result from the use of medical interventions during labor, which can result in the cost of maternity care increasing by up to 50% for otherwise healthy women (Tracy & Tracy, 2004). Use of Pitocin to speed labor was initially recommended as a way to prevent the need for cesarean section due to a prolonged labor (O'Driscoll, Jackson, & Gallagher, 1969). However, a recent meta-analysis of the literature concluded that while the average length of labor with Pitocin was about 2 hours shorter than a natural labor, Pitocin did not aid in lowering the cesarean rates and its use comes with apparent risks (Bugg, Siddiqui, & Thornton, 2011). Use of Pitocin during labor often results in a hyper-stimulated uterus, in which contractions are stronger, more frequent and last longer than a naturally occurring pattern of uterine contractions (Bugg, Siddiqui, & Thornton, 2011). With contractions that are stronger and longer, women are more likely to request pain medication and require other interventions to manage their labor. "Labor induction in the U.S. leads to an intravenous (IV) line, bed rest, and continuous electronic fetal monitoring (EFM), and frequently amniotomy, significant discomfort, epidural analgesia/anesthesia, and a prolonged stay on the labor unit," (Simpson & Atterbury, 2003). Other maternal risks commonly associated with the use of Pitocin include changes in heart rhythm, high blood pressure, nausea and vomiting, post-partum hemorrhage and uterine rupture (ACOG, 2013b). Risks of Pitocin on the baby have not been adequately studied, however there are some known risks, including lower oxygen

levels, lower Appearance, Pulse, Grimace, Activity, Respiration (APGAR) scores, and higher risk of admittance to the Neonatal Intensive Care Unit (NICU). The American College of Obstetrics and Gynecology (ACOG) has recommended that further research be conducted on the effects of Pitocin, but use for labor augmentation should be continued in the meanwhile (2013b). For the purposes of the present study, consider that optimal fetal positioning, achieved through adequate movement and relaxation during labor, can help birth progress naturally and prevent the need for AMoL (Goer & Romano, 2012).

Electronic Fetal Monitoring. Electronic fetal monitoring (EFM) is the use of a Doppler ultrasound device to monitor the baby's heart rate during labor (Alfirevic, Devane, & Gyte, 2006). The purpose of EFM is to identify fetal distress and prevent complications (ACOG, 2009). There are two types of EFM: continuous and intermittent. Continuous EFM is used during 87% of labors in the U.S. (Declercq, Sakala, Corry, & Applebaum, 2007) although it is not required unless the mother is high-risk or has been given Pitocin (ACOG, 2009). The other options for fetal monitoring are both intermittent: 1) intermittent EFM occurs when the Doppler monitor is used every 20 to 30 minutes during each hour of labor, and 2) intermittent auscultation, used in less than 3% of labors, involves a hand-held Doppler to monitor the fetal heart rate for 60 seconds every 15-30 minutes (Declercq, Sakala, Corry, & Applebaum, 2007).

In a review of the literature on EFM that included more than 37,000 women, researchers concluded that there were no significant differences in mortality, cerebral palsy, APGAR scores, brain damage or other complications between women who received intermittent auscultation and continuous EFM. However, women who received

continuous EFM were 1.7 times more likely to have a Cesarean and were also at higher risk of having an assisted delivery through forceps or vacuum extraction. Women in the EFM groups were also more likely to require use of narcotic pain medication during labor (Alfirevic, Devane, & Gyte, 2006). For the purposes of the present analysis, it is most relevant to consider that researchers hypothesize that continuous EFM increase rates of cesarean, assisted deliveries and pain medication use as a result of the EFM restricting a woman to labor while laying on her back in a bed (Goer & Romano, 2012).

Routine IVs. During the 1940s, policies were created to restrict food intake for people undergoing general anesthesia to prevent aspiration of vomit during surgical procedures (Ludka & Roberts, 1993). The policy extended to women during childbirth, many of whom were heavily medicated or undergoing general anesthesia (Ludka & Roberts, 1993). In 1999, The American Society of Anesthesiologists adopted the position that oral intake of clear liquids during labor improves maternal and fetal outcomes, and women in labor should be allowed a modest amount of these fluids (American Society of Anesthesiologists, 1999). In a 2005 survey, only 40% of laboring women drank fluids during labor and 15% ate solid food (Declercq, Sakala, Corry, & Applebaum, 2007). While policies for childbirth have since changed, practices have not, and routine use of food restriction during labor is still used today. There are a host of complications that can arise from restricted food intake and over hydration through routine use of IV fluids (Goer & Romano, 2012). For the purposes of this paper, we will consider the enhanced exhaustion associated with lack of food consumption and restriction of movement that occurs when patients are attached to an IV.

Epidural analgesia. In the U.S., epidural use has become routine during labor with approximately 80% of women receiving this pain relieving intervention. Nicknamed the "Cadillac of Anesthesia," an epidural is a catheter of blended narcotics placed in the spinal column which allows a woman to be awake and alert, yet pain free, throughout childbirth (Goer & Romano, 2012). In a systematic review of the literature on epidural use for pain management during labor, the authors concluded that use of epidurals during labor are useful for controlling pain but have associated risks which include an increase in frequency of assisted and caesarean deliveries, maternal fever, neonatal sepsis, and a negative impact in the infant's ability to breastfeed immediately following birth (Nystedt, Edvardsson, & Willman, 2004).

While many women do not experience negative side effects with epidurals, their use is associated with the "cascade of interventions" in which an otherwise healthy birth requires several additional interventions to negate side effects. One common side effect of the epidural is a drop in maternal blood pressure, which affects how much blood is pumped to the placenta, and ultimately, how much oxygen the baby is receiving (Webb & Kantor, 1991). Additionally, epidurals often slow labor and consequently increase the rate of Pitocin use by three times, (Ramin, Gambling, & Lucas, 1995). The epidural numbs a woman's pelvic floor muscles and restricts movement so the baby's head cannot enter the birth canal in the optimal position for delivery, resulting in dystocia, or poor progress, during the second stage of labor. Having an epidural doubles a woman's chance of having a cesarean delivery for dystocia (Thorp, Meyer, & Cohen, 1994). A meta-analysis (N=6162) of epidural vs. non-epidural use found a 40% increase in rates of high-risk assisted delivery with epidural use, wherein forceps (large metal tongs) or a

vacuum (highly pressurized suction cup) are used to physically pry the baby by its head

out of the birth canal (Paterson, Saunders, & Wadsworth, 1992). Additional common

side effects of epidural use include catheterization to pass urine (Goer & Romano, 2012),

episiotomy, or the cutting of the perineum in order to aid in delivery (Goer & Romano,

2012), experience of ongoing shivering to regulate body temperature (Buggy & Gardiner,

1995), nausea and vomiting (Paull, 1991), pruritis, or generalized itching of the skin

(Caldwell, Rosen, & Shnider, 1994; Lirzin, Jacquintot, Dailland, 1989), and maternal

fever resulting in infant tachycardia, a dangerous increase in heart rate (Camman, Hortvet,

& Hughes, 1991; Kennel, Klaus, & McGrath, 1991). In addition to the common side

effects, less common side effects include puncture of the spinal cord dura, resulting in

prolonged and severe headache (Stride & Cooper, 1993), ongoing numbness in areas

affected by the epidural, lasting up to three months (Stride & Cooper, 1993), difficulty

breathing (Rawal & Arner, 1982), or most seriously, permanent nerve damage,

convulsions and death (Paull, 1991).

With the potential above-mentioned side effects and complications resulting from

epidural use, the high rates of medical pain management during labor might be surprising,

however a contingency evaluation provides a great deal of support and understanding for

the environmental selection of this treatment. The first of these contingencies follows a

well-researched primary reinforcer involving the reduction of maternal pain (Declercq,

Sakala, Corry, & Applebaum, 2007). Some additional contingencies from a systems

level provide further insight into the pro-epidural movement wherein a laboring woman

receiving an epidural positively or negatively reinforces several behaviors: obstetric

anesthesiologists are paid financially for administering an epidural (Marmor & Krol,

2002); nurses often view providing a medical form of pain relief as meeting their nursing responsibilities (Gale, Fothergrill-Bourbonnais, & Chamberlain, 2001); nurses and doctors can easily monitor vitals of mother and baby when the mother is quietly laboring in bed (Goer & Romano, 2012); a laboring woman's behavior or vocalizations may be distressing to caregivers or other hospital patients (Walsh, 2007); and spousal anxiety is reduced (Declercq, Sakala, Corry, & Applebaum, 2007). There are likely additional economic contingencies involved in epidural use as mentioned by an anesthesiologist: "While there may be problems with high epidural usage, in the presence of our nursing shortages and economic or business considerations, having a woman in bed, attached to an intravenous line and continuous electronic fetal monitor and in receipt of an epidural may be the only realistic way to go," (Leeman, Fontaine, King, Klein, & Ratcliff, 2003, p. 1024). In addition to the listed considerations, several sources demonstrate that women are not provided with adequate information on risks to make an informed choice (Boschert, 1998).

Intravenous or intramuscular analgesia. Although not as effective as epidural anesthesia in providing pain relief, approximately 40% of women use opiates either intravenously or intramuscularly during labor (El-Wahab, & Robinson, 2011). Efficacy of IV analgesia is questionable, given that there are non-pharmacologic approaches to relieve labor pain that have similar, if not better, outcomes (Simkin & Bolding, 2004). While there are several opiates that may be used during labor, the most commonly used today are Fentanyl and Pethidine, both with a maternal half-life of about 3 hours (Bricker & Lavender, 2002). Opiates delivered intramuscularly or intravenously have numerous side effects, with the most concerning being that they cross the placental barrier and can

result in neonatal respiratory depression, less effective suckling, less effective breastfeeding, and lower APGAR scores (Bricker & Lavender, 2002). Additional maternal side effects of IV analgesia include nausea, vomiting, and respiratory depression (El-Wahab & Robinson, 2011).

Cascade of Interventions

The following is a hypothetical summary of the obstetrical "cascade of interventions" (Tracy et al., 2006) to demonstrate the relationship between the above-mentioned interventions. A healthy low-risk woman in labor will be admitted to the hospital, placed on fetal monitors, and will likely be given IV fluids. From there, one of two possible scenarios may unfold: (1) being in a new place surrounded by bright lights and unfamiliar faces may stall labor resulting in the need for Pitocin to augment progress, causing contractions to become longer and stronger than naturally occurring contractions, resulting in a request for pain medication or (2) the pain of being confined to the bed and otherwise lack of adequately trained labor support persons may become overwhelming, resulting in a request for pain medication. These requests for pain medication will most likely be met with epidural analgesia, the "gold standard" for pain relief during labor (El-Wahab & Robinson, 2011). Once the epidural is placed, labor will slow and high doses of Pitocin will be used in both scenarios, as the mother cannot feel the strength of the contractions and Pitocin will conveniently hurry along the labor. As a result of the epidural and Pitocin, the mother will be restricted to the bed, hooked up to continuous fetal and contraction monitoring, have regular assessments using a blood pressure cuff, and be catheterized for urination. She may also be given additional medication to reduce the common side effects of nausea and itchiness. The mother is completely immobile

and the labor is completely medically managed. The immobility of the mother prevents the fetus from entering the birth canal in an optimal position, thereby significantly increasing the chances of labor dystocia, or failure to progress. If the side effects of the medications result in dystocia or in fetal distress, a caesarean section will be performed. If the side effects of the interventions do not result in fetal distress, and there is no dystocia, a vaginal delivery will be attempted. The mother, numb from the breastbone down, will not be able to feel or adequately use her pelvic floor muscles, resulting in an inability to engage in effective pushing to help aid the baby down the birth canal. As a result, an assisted delivery using forceps or vacuum extraction will be attempted. If the assisted delivery is unsuccessful, meaning the baby is still stuck in the birth canal or the baby shows signs of increased fetal distress, a caesarean will be performed.

The culmination of the cascade of interventions resulting from an otherwise healthy women utilizing the non-medically-necessary but often routine practices discussed above, contribute to the U.S.'s poor outcomes in maternal and infant health. A troubling statistic released by the United Nations in September of 2010 placed the U.S. 50th in the world for maternal mortality, higher than almost all European countries (Coeytaux, Bingham, & Langer, 2011; World Health Organization, 2010). Additionally, data show that between 1990 and 2008, while most countries' maternal mortality rates were decreasing, the U.S. maternal mortality rate doubled (World Health Organization, 2010).   The U.S. spends more money ($86 billion per year) than any other country on maternity care (Andrews, 2008), yet the outcome data are shockingly disturbing. While there are many factors that contribute to the U.S.'s poor maternity outcomes, including low socio-economic status (Regenstein & Huang, 2005), inability to access affordable

healthcare (Thacker, Stroup & Chang, 2003), cultural disparities (U.S. Department of Health and Human Services, 1991), and overall health of the woman during pregnancy (Coeytaux, Bingham, & Strauss, 2011), studies have shown that the overreliance on drugs and mechanical interventions by well-meaning practitioners have contributed to the rise in maternal (Clark, Belfort, Byrum, Meyers, & Perlin, 2008; Kuklina, Meikle, & Jamieson, 2009) and infant morbidity (Tita, Landon, & Spong, 2009).

While "healthy mom, healthy baby" (Goer & Romano, 2012) is the ideal outcome for obstetric practitioners, there are additional psychological factors to consider in the long-term wellbeing of mother and child. According to Beck and Watson (2008), 34% of new mothers report traumatic birth experiences. Additionally, 9% of new mothers will meet the DSM criterion for posttraumatic stress disorder and experience effects such as difficulty relating to family members, difficulty breastfeeding their newborn, and a delay to having future children (Beck & Watson, 2010). There are many factors in childbirth that contribute to traumatic experiences including not feeling cared for, feeling scared or panicked, dissociation from the process, psychological stress, and physical pain (e.g., Ayers, 2007; Beck, 2004, 2009). Birth trauma is a risk factor for post-partum depression (PPD), which affects up to 25% of women, and is the most common complication of pregnancy and childbirth (Wisner, Parry, & Piontek, 2002). Women suffering from PPD have higher rates of suicide, lower maternal self-esteem, increased negative perceptions of the mother-infant relationship, greater parenting stress, and are less responsive to their infants' cues (Paris, Bolton, & Weinberg, 2009).

Evidence for Promoting the Natural Progression of Labor

Childbirth is a healthy and normal event for both women and babies (Goer &

Romano, 2012). In the U.S., 98.8% of women give birth in a hospital (Martin, Hamilton, & Ventura, 2012) and approximately 85% of those women are considered healthy and low-risk (Martin, Hamilton, & Sutton, 2009). Birth centers, or independent home-like settings where care providers, usually midwives, oversee the births of healthy low-risk women, exemplify the focus on natural progression of labor. In a large study (N=15,574) conducted on birth center outcomes, results suggested that only 6% of low-risk women delivered via caesarean section, compared to the 27% of low-risk women in hospital settings (HealthyPeople.gov, 2013). These results are comparable to the World Health Organization's (WHO) recommendations that no more than 10% of women should require a surgical birth (Wong, McCarthy, & Sullivan, 2009).

In a report summarizing the WHO's principles of perinatal care, appropriate methods for pain relief are all behavioral: "Avoid the use of medications in labor. Preferably pain management should use nonpharmacological methods, such as ambulation, changing positions, massage, relaxation, breathing, acupuncture, and others. Avoid epidural analgesia as a routine method of pain management," (Chalmers, Mangiaterra, & Porter, 2001). Movement during labor helps the mother cope with contractions and also helps the baby into the pelvis and birth canal (Shilling, 2009). Pain experienced during contractions can actually help guide the movements that the mother engages in, as finding comfort during a contraction helps to ensure that the baby is in the best position and the labor will progress (Lothian, 2009). Walking and changing positions during labor decreases the likelihood of assisted delivery or cesarean section (Storton, 2007). According to a recent meta-analysis comparing 57 RCTs for non-drug strategies, researchers concluded that use of non-drug coping modalities such as

immersion in warm water, relaxation techniques and massage resulted in better outcomes than their comparison groups at relieving pain and had no adverse side effects (Chaillet et al., 2014).

Partner support during labor is another recommendation by the WHO, wherein a woman labors better when encouraged and supported by people she knows and trusts (Green & Hotelling, 2014). Research shows that appropriate and adequate labor support reduces the use of pain medication, reduces the need for Pitocin, increases the likelihood of spontaneous vaginal birth, and reduces birth trauma and post partum depression (Hodnett, Gates, Hofmeyr, Sakala, & Weston, 2012).

Labor support is so important that a profession exists around providing continuous labor support, the role of a doula. A doula is a professional trained in childbirth that provides continuous emotional and physical support to a woman during labor (Dekker, 2013a). Having a doula provides continuous emotional and physical support during labor has been shown to significantly decrease the use of Pitocin, decrease the risk of caesarean section, and increase birth satisfaction (Hodnett, Gates, Hofmeyr, Sakala, & Weston, 2012). While research supports the use of doulas, a survey conducted in 2006 revealed that only 3% of women in the U.S. used a doula during childbirth (Declercq, Sakala, Corry, & Applebaum, 2007).

Finally, there are several studies that discuss the concept of personal control during labor as a contributing factor in progression of labor. Personal control during childbirth can be defined as a laboring woman's involvement in her childbirth (Wright, McCrea, Stringer, & Murphy-Black, 2000). Broken down further, having previous exposure to education on the childbirth process, hence awareness of and language to

describe thoughts, behaviors, pain management, and physical functioning during labor are associated with improved birth outcomes and maternal satisfaction (Ford, Phil, Ayers, & Wright, 2009).

Barriers to the Natural Progression of Labor

Over 90% of women who want epidurals receive them, but almost 50% of women who do not want epidurals also receive them (Goer & Romano, 2012). Given this information, there are quite obviously barriers to effective labor support and labor coping strategies. This section will identify these barriers through an environmental contingency analysis.

There is no doubt that childbirth is a painful experience, and perhaps one of the most physically and emotionally exhausting experiences that a woman will have throughout her lifetime (Goer & Romano, 2012). There are several different factors that contribute to a woman's experience of pain throughout labor, including physical, emotional and postural variables (Simkin & Ancheta, 2011). Physically, there are many different muscle groups that are working to move the baby down the birth canal. The muscles of the uterus contract which causes a tightening sensation while the muscles in the pelvic floor are stretching, often causing a burning sensation. Posture plays a large role in labor as the baby's head molds to the pelvic bone structure of the woman's body. If the woman remains in one position for an extended time, the baby may descend at an angle that is not ideal, contributing to the extreme pressure that the woman feels as the bones of the baby's skull press into the bones of her pelvis and back. If the woman is moving around and changing positions often throughout labor, the baby can descend into

the birth canal in a timely manner and in the most efficient position possible (Goer & Romano, 2012).

Emotional responses to labor also play a role in childbirth experience and outcome. Emotions such as fear and anxiety can result in a longer labor as adrenaline counteracts oxytocin, the hormone responsible for labor. Additionally, fear resulting in tension in the body can create a more painful experience as the woman is fighting against her tightening uterine muscles (Goer & Romano, 2012).

The physical environment during labor should be accommodating of the needs to move and relax during labor, however most hospital settings around the world, the U.S. included, provide a small room with a hospital bed, a chair for the partner, and many medical machines and other emergency equipment. In a study conducted determining outcomes of labor in different environments, women who had access to alternative settings that offered control over furniture and other sensory stimulation found women to engage in more mobility during labor (Hauck, Rivers, & Doherty, 2008). An additional study on visual stimulation found that by covering the anxiety-provoking medical equipment in the room with a visually pleasing stimulus, women had shorter labors and fewer requests for analgesia (Duncan, 2011). "If we put women in hospitals with restrictive policies—they're hooked up to everything, they're expected to be in bed—of course they're going to go for the epidural because they're unable to work through their pain" (Block, 2007, p. 175).

To prepare for childbirth and learn the necessary pain management skills, many women and their labor coaches participate in antenatal education classes. Several studies have concluded that current antenatal education strategies may not be an effective

technique to improve women's ability to perform pain management skills during labor and delivery. Wuitchik, Hesson, and Bakal (1990) conducted a study to determine if practice of pain management skills and confidence in using them would result in better coping during labor. Results suggested that during the shift from latent to active labor, anxieties overwhelmed the women's confidence in their pain management skills and these skills no longer aided in lessening the experience of pain during labor. Slade, Escott, Spiby, Henderson, and Fraser (2000) conducted a study in which they assessed the use of antenatal education strategies during labor. Results of the study suggested that the use of breathing strategies learned during antenatal education was used, however postural and relaxation techniques were not. The authors suggest examining alternative ways to increase coping strategies during labor.

More recently, studies have been conducted on alternative forms of childbirth education prior to labor and delivery. Bergstrom (2009) examined the effects of natural childbirth preparation versus standard antenatal education. The natural childbirth training utilized psychoprophylactic techniques to teach specific skills such as breathing and relaxation whereas the standard antenatal education focused on general childbirth strategies and parenting. Results suggested that there was no difference in rate of epidural use, nor did natural childbirth training improve the overall birth experience. Ip (2008) conducted a randomized control study with 116 participants, half of whom received a self-efficacy based training workshop during the third trimester of their pregnancy. Results concluded that self-efficacy based training improved the use of coping skills during labor as compared to the control group, but only during the early

stages of labor. Ip concluded that additional strategies were needed to increase coping skills during the later stages of labor.

The unavailability of ongoing labor support is a major contributing factor in high requests for pain medication and limited use of non-pharmaceutical pain management strategies (Goer & Ramano, 2012). Empirically demonstrated non-pharmaceutical coping strategies include continuous labor support, baths, touch, massage, maternal movement and maternal positioning (Spiby, Slade, Escott, Henderson, & Fraser, 2003). In an extensive survey on labor support, 91% of women found immersion in water, heat/cold packs or use of a birth ball to be somewhat or very helpful in managing labor pain, however only 7% of women used these strategies (Declercq, Sakala, Corry, & Applebaum, 2007). It is important to remember that many women expect the nurse to provide both physical comfort and emotional support during labor, however nurses have multiple patients that they manage and other responsibilities including medical charting and maintaining contact with the overseeing physician (Tumblin & Simkin, 2001). Without continuous labor support, both physically and emotionally, women are likely to opt for pain medication in the face of no functional alternatives.

Factors including engagement during birth and partner support play a critical role in birth outcome and perception of pain. In a survey analysis conducted by Heinze and Sleigh (2003), the authors conclude that higher pain during childbirth is associated with high fear about the birth, an external locus of control, as well as passive interaction during the birth. Another survey analysis following childbirth concluded that less control, passivity, and limited partner support all contributed to a higher perception of pain (Ayers & Pickering, 2005). Additionally, Stockman and Altmaier (2001) concluded that self-

efficacy of the mother, as defined by confidence or control in completion of tasks and the overcoming of barriers during labor, significantly predicted lower pain during childbirth.

Applied Behavior Analysis

Applied Behavior Analysis (ABA) is a discipline that uses the science of how people learn to change behavior in meaningful ways; more technically, the primary focus is on environmental assessment and intervention of objectively defined behavior targeted for reduction or acquisition. ABA is an application of behavior science based on the premise that behavior change occurs largely due to its consequences. ABA and medicine are complementary in their goals (i.e., socially significant improvements), but differ in their approach to treatment (i.e., environmental vs. medical intervention respectively). Whereas medical practitioners often look for a phenotype or biological explanation for occurrences of behavior and accordingly prescribe medical treatment, ABA researchers and practitioners evaluate environmental conditions and accordingly make relevant changes. ABA does not discount biological influence, but analyzes the pattern of interaction within the environment when physiology is relevant and when it is not (Cooper, Heron, & Heward, 2007).

A behavior analytic intervention is defined in the discipline when it adheres to seven dimensional criteria. In a seminal paper in 1968, Baer, Wolf, and Risley identified these dimensions that are still referenced today as: (1) it is important to society, (2) the physical behavior is observed to be altered, (3) the events that changed the behavior are clearly demonstrated, (4) all aspects and contingencies of the intervention can be clearly identified and described, (5) technology involved can be related back to basic behavioral principles, (6) the intervention must be effective and

demonstrative of practical importance, and (7) the behavior change must be durable and appear effective across other environments or behaviors (Bear, Wolf, & Risley, 1968).

The role of the practitioner of ABA is largely to promote the treatment of health-related conditions through the use of environmental contingency management (Cooper, Heron, & Heward, 2007). The interdisciplinary field of behavioral medicine largely originated from ABA, however a drift away from behavior analytic principles and methodology has occurred in recent decades (Greenwald, Roose, & Williams, 2015). Despite s's many contributions to health behavior, behavior analysis is rarely used in conjunction with medical interventions for a variety of reasons: (1) a lack of understanding of the scientific field, (2) a lack of understanding of its methodologies, and (3) a view of behavior analysts as not recognizing emotional factors that are widely accepted as contributing to medical conditions (Blum & Friman, 2000). Hayes and Fryling (2009) discuss that the nature of an interdisciplinary science involves both the subject matters of the multiple disciplines as well as the subject matter of the interdisciplinary work. Technological advances in behavior analysis, such as the one presented in this paper, will likely foster enhanced interdisciplinary collaboration between behavior science and medicine (Morford, Witts, Killingsworth, & Alavosius, 2014).

Applications of ABA to Birth

There is a clearly defined need for improvement in maternity practices in the U.S., however very little research in childbirth has been conducted from a behavior analytic approach. There are a plethora of variables to consider during labor and while they can be explained from a behavioral standpoint, many of these behavioral constructs have not yet

been addressed. The majority of the literature on childbirth and labor occurrences and strategies is published in medical journals and there is very little from a behavior analytic perspective, however a couple of articles from the 1970s and 1980s looked at a more behavioral account of childbirth variables.

Interestingly, The Lamaze Method, a popular method of childbirth education to this day, is based on Pavlovian conditioning. According to Lamaze (1972), pain is a conditioned response wherein thoughts of childbirth can elicit painful stimulation as a result of previous exposure to fear inducing stories from women who have previously given birth, including tales portrayed in the media. Lamaze assumed that if pain responding could be conditioned, so too could the absence of a pain response. The Lamaze method aims to accomplish this through exposure to controlled muscle relaxation during exposure to mock uterine contractions, most often in the form of ice water submersion of the hand. Coping strategies in Lamaze typically include concentration on a focal point, breathing training to promote muscle relaxation, and the tensing of a voluntary muscle group to allow for the relaxation of an involuntary muscle group (Lamaze, 1972).

Stone, Demchik-Stone and Horan (1977) evaluated a component analysis of Lamaze coping strategies in an analogue situation. Participants were exposed to imagery training, visualization training, breathing training, a placebo or a no treatment control group. The participant engaged in submerging their hand in ice water for a period of time, assumed to mimic contraction intensity. Results suggested that the visualization training proved to be most effective for enhancing tolerance to ice water discomfort with little to no distinction among controlled variables.

Brasted and Callahan (1984) conducted the only study on childbirth published in the Journal of Applied Behavior Analysis where they evaluated labor experience based on the effects of biofeedback resulting from the Electronic Fetal Monitors (EFM). They evaluated the effects of watching the EFM contraction feedback (concluded to be a warning stimulus for onset of painful stimulation) on the threshold, or latency, of pain recognition of eight women in labor. The researchers used an ABAB design across sets of three contractions. Results of the study indicated that the threshold of pain recognition did not reliably change between or across participants, but that 7 of the 8 women chose to continue viewing the contraction feedback following the completion of the experimental conditions. An interesting anecdotal observation by the researchers indicated that when the EFM feedback was provided, the labor coach/partner increased their interactions with the laboring woman. Authors concluded that, "EFM may have provided them [coaches] with specific tasks (e.g., providing feedback, comforting responses such as massaging) in a somewhat alien environment and consequently may have increased their interactions" (Brasted & Callahan, 1984, p. 265). Additionally, they made the assumption that 7 of 8 women chose to continue using EFM feedback as a result of the reinforcing properties of the increased interactions with their coach.

Biofeedback, as used in the above intervention, is considered a behavioral intervention whereby an individual is trained to control involuntary bodily processes through observation of physiological reactions. Biofeedback has been widely studied in relation to pain and several studies have been specifically conducted around relaxation during childbirth. As early as the 1970s, results of biofeedback on relaxation were being investigated during childbirth and shown to have positive outcomes including shorter

duration of labor and fewer requests for pain medication (Gregg, 1978). As recently as 2015, studies still suggest that biofeedback methodologies during labor can improve labor outcome (Janula, 2015), however these procedures are rarely used. It can be speculated that the time and equipment for such interventions may be too cumbersome to introduce into mainstream obstetrical care systems.

Principles of Behavior Analysis in Birth

Behavioral coaching is a term often used by behavior analysts to describe the training of an individual to perform a specified task (Cooper, Heron, & Heward, 2007). Components of behavioral coaching include identifying specific behaviors to train, conducting a task analysis to break down the components of a behavior chain or task, and individually teaching each skill using modeling and feedback. Studies have shown behavioral coaching to be effective across a variety of skills including sports and staff training (Seniuk, Witts, Williams, & Ghezzi, 2013). Behavioral coaching for labor could be said to take place during childbirth education classes, however the effectiveness of the generalization of skills is questionable (Spiby, et al., 1999). Additional coaching around labor support may vary from person to person, depending on the level of behavioral support provided by the health care staff at their location of birth.

Establishing operations (EOs) are quite prevalent during labor and childbirth as the onset of a painful stimulus serves as a motivating operation to engage in behavior that is probable to reduce the likelihood of the aversive stimulation (Michael, 1982). An EO is a behavioral concept used to describe the momentary effectiveness of a consequence (value altering) of a particular behavior and the likelihood that the behavior will be engaged in (behavior altering). In the scenario of labor, a woman is likely to engage in

behavior that will reduce or prevent the painful stimulation resulting from uterine contractions, making the reinforcing value of escape or avoidance from pain extremely high.

Stimulus control occurs when a behavior is consequated in the presence of a stimulus and not consequated in its absence (Cooper, Heron, & Heward, 2007). During labor, it is likely that the nursing staff typically develop some stimulus control, providing pain management suggestions, thereby reducing pain and reinforcing whatever behavior was engaged in, or by providing punishment through painful examinations or procedures. Unfortunately, given the lack of skill generalization from childbirth education classes (Slade, Escott, Spiby, Henderson, & Fraser, 2000), there is very little stimulus control over labor behaviors in the hospital birth environment.

Reinforcement, a fundamental principle in behavior analysis, by definition will increase the likelihood of the occurrence of behavior in the future (Cooper, Heron, & Heward, 2007). During labor, the ultimate reinforcer is the birth of the baby. However other reinforcers for appropriate labor behavior are likely present: reduction of painful stimulus, support and other positive interactions provided by birth partners, and proximity to delivery in which the painful stimulation will end and the baby will arrive may function as a conditioned reinforcer. In the third scenario, for example, a care provider might update the woman on her labor progress assuring her that her hard work is paying off and she is getting closer to delivering her baby. The proposed software program will provide opportunity for reinforcement through providing empirically demonstrated pain relieving suggestions and enhanced opportunity for partner interaction. Additionally, the participant will be able to update labor progress, if known, and be

provided with a visual display of progress, potentially functioning as a conditioned reinforcer for getting closer to the end of labor and meeting the baby. All of these reinforcers combined will ideally increase the likelihood that the woman and her partner will continue using the software throughout a good portion or the entirety of their labor.

Research on choice is extensive in behavior analysis and suggests that organisms will respond to the stimulus that provides the highest rates of reinforcement, a behavioral phenomenon termed the matching law (Cooper, Heron, & Heward, 2007). Many studies have demonstrated that within a concurrent choice paradigm, individuals engage in behavior with respect to higher choice options (e.g., Tiger, Hanley, & Hernandez, 2006). In other words, people prefer having options and are more likely to engage in certain tasks, even more difficult tasks, if they are given a choice. With regard to a labor situation, there are very few choices that the woman is presented with in the medical model wherein her labor is managed. These restricted choices do not help the woman engage in the challenging tasks of maintaining appropriate labor behaviors. In fact, more often than not, the only choice a woman is presented with is what type of pain medication she would like to use during her labor.

Summary and Specific Aims

To summarize, the Cesarean Epidemic in the has resulted in 1 in 3 women giving birth via major surgery with serious risk of complications. As a result, the U.S. has some of the highest rates of infant and maternal mortality of any developed nation. This societal problem is largely identified as a systemic issue wherein a cascade of interventions is provided to a laboring woman while having her birth managed within a medical model. While epidural analgesia use during labor has serious known side effects

for mother and baby, over 90% of women in the U.S. still request and consent to their use. Moreover, as many as 50% of women that did not plan on using epidurals accept one during labor. Variables that increase the likelihood of pharmacological pain management include lying in bed in one position, having an unsupportive partner, and having no behavioral coping strategies. Alternatively, movement, relaxation, and partner support promote a natural progression of labor with a much lower risk of cesarean section (Caton et al., 2002). While such coping strategies may be taught during childbirth education classes, skill generalization is not commonly observed following the instruction (Slade, Escott, Spiby, Henderson, & Fraser, 2000) and research has demonstrated a need for better methods of prompting such behavior (Escott, Slade, & Spiby, 2009).

In order to address the previously mentioned barriers to a natural progression of labor, a behavioral software program called StorkAssist was created for this study incorporating labor support strategies to provide empirically based labor support options for maternal movement, position and relaxation as well as partner support options for physical and emotional comfort. The specific behavioral interventions utilized in this labor support software include prompting and video modeling. Prompting is an intervention commonly used in disabilities research and practice, wherein reinforcement is signaled through the use of a salient stimulus indicating the correct behavior to engage in (Cooper, Heron, & Heward, 2007). Video modeling, or a video demonstration of the task to be completed, is an intervention extensively researched behavior analytic literature, and has many implications for skills training and aquisition (Cooper, Heron, & Heward, 2007). Use of video modeling during labor will provide impromptu teaching of labor support strategies for both the woman and her partner.

While antecedent interventions or manipulations may be less commonly used in behavior analysis without the addition of contrived reinforcers, in this scenario a restructuring of the environment through the introduction of software may prove to be quite reinforcing. The ongoing labor support strategies provided by the software fosters increased opportunity to automatically reinforce labor behaviors if the prompted behaviors are engaged in and pain reduction serves as a reinforcer. Additionally, the increase in social support is likely to function as a reinforcer as demonstrated in numerous studies on labor (e.g., Brasted & Callahan, 1984).

By harnessing the stimulus control of the specific labor behaviors for both the woman and her partner, it is predicted that the dyad will be more likely to engage in non-pharmaceutical pain management strategies resulting in a higher likelihood of the natural progression of labor. The aim of this research was to examine how a behavioral software treatment package incorporating in-vivo behavioral techniques such as momentary prompting, choice, modeling and conditioned reinforcers effect labor behaviors of both a woman and her partner during unmedicated labor.

STUDY 1

Purpose

The purpose of study 1 was to examine the frequency of labor behaviors and variability of labor behaviors across and between participants during early and active labor. Additionally the experience of sensory pain, perception of personal control and perception of partner support, widely referenced in the medical literature, was monitored.

Methods

Participants and Setting

Six dyads, including a laboring woman and her labor support partner, participated in this study. Women of all ages and backgrounds were eligible to participate. No particular knowledge or experience with childbirth was required for participation however women that were considered to be a high-risk pregnancy and/or could not labor at home for a period of time were excluded. Additionally, women that hired a professional doula (a trained and experienced labor support person) were excluded, as the work of the doula would interfere with the research variables. The experimental portion of the study took place in the participants' homes, prior to the time in which their care provider would require that they be admitted to the hospital.

Materials

This study was conducted using a software program called StorkAssist (see Appendix A), a behavioral application specifically designed by the researchers for this study. Each woman and her partner were provided with an iPad with the StorkAssist program on it. The StorkAssist program is designed to support laboring women and their partners through labor by incorporating evidence-based labor support and comfort measures such as movement, relaxation, breathing, massage, and labor positions. The software is programmed to recognize the momentary and unique needs of the laboring woman and provide prompts for 1-6 behaviors for the woman to engage in followed by 1-6 behaviors for her partner to engage in, based upon information input. StorkAssist uses evidence-based prompting and video modeling strategies to quickly demonstrate effective behavioral coping techniques for a variety of challenges experienced during labor. Below is a description of each feature of the software:

Tutorial. When the participants open the software, they are taken through a brief tutorial on how to use the program. Screen shots of the most important pages are used to highlight certain features with explanations of how to use each feature. The tutorial is 8-pages in length and the participants must click through each page before the program will begin. The participants can navigate back to the tutorial at any time by pressing the tutorial button on the homepage.

Set-Up. Immediately following the tutorial, the participants will be prompted to input as much information as they currently have regarding: 1) the three medically measurable areas of labor progress (station, dilation, effacement); 2) amenities and resources available to them during labor (birth ball, massage tools, shower, bathtub, heat and cold packs); and 3) special conditions (fetal monitors, epidural or confined to bed). These special conditions would only apply to the participants if they choose to continue using the software package following the experimental condition and upon entering the hospital. The participants can navigate back to the set-up menu at any time by pressing the set-up button on the homepage. Based on the conditions entered into this set-up screen, the program will begin to filter out coping strategy options that are irrelevant or would not be beneficial or allowed and generate only the strategies that are applicable to the participants.

Home Screen. The home screen is where the participants will be directed after completing the set-up menu. The home screen consists of 3 buttons and 8 tabs (the 8th tab generates two additional tabs). The 8 tabs are on every screen of the software for navigation purposes. The *Set-Up* button directs the user back to the set-up screen so that at anytime during their labor, the participants can make changes to the amenities and

special conditions that they have available to them. They also have the option to update

labor progress in the set-up menu or to turn reminders on/off. The *Researcher Page*

button is a password-protected button that allows the researcher to make changes to the

backend of the system from the mobile device. The researcher can: 1) set the time

intervals for the reminder pop-ups that can be turned on/off by the participant; 2) change

the contraction intervals in which the user is asked to update their labor progress; and 3)

turn on/off the questions to the user following each contraction. The *Tutorial* button

takes the user back to the first screen of the tutorial so they can review it at anytime.

Each one of the tabs at the bottom of the home screen takes the user to a different feature

of the program, all of which are explained below. The first tab is the *Home* tab that

allows the user to navigate back to the home screen at any moment.

    Select Challenge. The *select challenge* tab (tab 2) is the main feature of the program.

In this tab, the user can select a common labor challenge that they are momentarily facing

(e.g., fear/stress/panic, exhaustion, baby in bad position, pain, progressing too quickly,

not progressing). The pain selection is the only selection that will guide the user to an

additional menu screen in which they will select the location of the pain (stomach,

hip/thigh, back). After selecting the challenge, the user is presented with general position

options that correlate with the challenge selected and any special conditions established

in the set-up menu. The general position (sitting, standing, laying, kneeling, squatting) is

a choice the user can make based on what would be most comfortable or convenient for

them to be in at that moment. Based on their input from the setup screen and from the

challenges options, the program will determine between 2 to 6 specific labor options for

the user to select. Pictures and words appear on the selection screens to ensure the

specific labor support terminology is understood. After the laboring woman makes a selection for herself, the program will identify up to 6 partner support choices that will work well with the woman's selection. If there is no partner option or only one partner option based on the woman's selection, the videos will automatically begin to play. If there are partner options, once the participants make the respective choices, a video preview of the combination of selections will automatically appear. The participants can choose to move this video to the 'cue' to use with the next contraction, or they can go back to select different challenge support techniques.

Contractions. The participants are instructed to navigate to the *Contractions* tab (tab 3) at the onset of a labor contraction. The user should immediately press the *Start Contraction* button and the previously cued video will being to play. If the user has not yet cued up a video, a default 4-second deep breathing video will play. At the end of the contraction, the participant is instructed to press the *Contraction End* button. Immediately following the contraction, the software will display 3 questions that the participant will be forced to answer before navigating elsewhere. The questions are answered using a sliding scale of 1-10, with each scale explained per question. The questions address: (1) discomfort; (2) personal control; and (3) partner support.

Labor Progress. The *Labor Progress* tab (tab 4) can also be navigated to at any time and shows the participants a visual depiction of their labor progress based on 3 medical measurements (dilation, effacement and station). A growing red bar or circle is used to highlight the progress in each of the three areas on a visual picture. This real time visual graphic will both show the participants what is occurring in the mother's body. When the entire line or circle has turned red, the laboring woman is now ready to deliver her baby.

The participants can update their labor progress at anytime by navigating back to the set-up menu in addition to being prompted to update labor progress after a predetermined number of contractions.

   Extra Feature Tabs. The extra feature tabs (tabs 5, 6, 7, 8) allow the participant to access pages that are non-interactive but serve as a shortcut to more general labor behaviors. These tabs can be navigated to at any time. Tabs 5, 6 and 7 are labeled *Supportive Words*, *Affirmations*, and *Breathing* respectively, whereas tab 8 is labeled *More*. Upon pressing the *More* tab, the participants will be shown 2 additional options including *Massage* and *Rhythmic Movements*. Some of the options in the extra feature tabs are included in *Select Challenges*, however there are some that are additional and are found only in these tabs. The *Supportive Words* tab (tab 6) includes 10 statements that the laboring woman's partner can say and explanations of when to say them in order to positively reinforce her labor behaviors. The *Affirmations* tab (tab 7) provides brief motivational augmentals (Jackson, et al. 2016) for the laboring woman to say to help motivate herself. The *Breathing* tab (tab 8) displays 3 videos of deep breathing of differing length breaths (4-sec, 6-sec & 8-sec). The 4-sec breathing video is used as the default video for the contraction timer until another video is selected. The *Massage* tab (tab 9) displays 4 videos that include hand massage, foot massage, shoulder massage and a light touch massage. The *Rhythmic Movements* tab (tab 10) displays 5 videos that include pelvic rocking, swaying on birth ball, stand and sway, standing lunge, and sitting on birth ball with partner rocking birth ball.

Procedures

The researchers met with the participants one time prior to the onset of labor. This meeting took no more than 30-minutes with the primary goal of completing consent forms and answering research related questions. During this meeting, the participants were allowed to view the 8-slide software tutorial on the iPad. The time spent engaged with the iPad software prior to labor did not exceed 5-minutes. During this initial meeting, the participants also completed a brief survey of their prior labor experience and childbirth education.

Participants were instructed to call the researcher at the onset of early labor in which contractions are 10-min apart for at least 1-hr. At this time, the researcher arrived at the home of the participants and determined if they were in early or active labor at the time of arrival, based on the pattern of contractions. Contractions that were 5 minutes apart or less are defined to be active labor whereas contractions more than 5 minutes apart are considered to be early labor. The above definitions are consistent with the medical literature. All 6 dyads were monitored during one baseline and one intervention session during unmedicated labor.

Baseline was conducted across a predetermined number of contractions (5-15 contractions) for each participant. The baseline phase occured prior to receiving the software and participants were observed engaging in labor behaviors.

The intervention phase began immediately following the baseline session wherein the participant was handed the iPad with the StorkAssist software on it and instructed to, "Use it as much as you want." The participants were then left alone to labor and engage with the software program while the researcher observed for the remainder of the 2-hour session. At the onset of a contraction, the laboring woman and her partner would engage

in the behavior being modeled on the StorkAssist program. During this contraction interval, the researcher used partial interval recording to monitor the labor behaviors of both the woman and her partner. At the end of the contraction, the software asked the same 3 Likert-type scale questions from baseline regarding pain, support and control. When the experimental condition was complete, the participants were asked, "Would you like to keep the iPad with the software for the remainder of your labor?"

Following the birth, the researcher emailed the participants with a post-delivery survey. The survey included social validity questions and request information regarding their birth outcome (i.e., delivery method and use of pain medication).

Experimental Design

Data were examined using a multiple baseline across participants during early and active labor with the time interval being one contraction. There were 2 sets of 3 dyads each with one set of dyads monitored during early labor and one set monitored during active labor.

The independent variable is the StorkAssist software, a treatment package consisting of visual prompting, choices, and video modeling. The dependent variables include engagement in labor behaviors by both the mother and her partner, variability in labor behavior from the laboring woman and her partner, and indirect measures of experienced pain, perceived control and perceived partner support. Additional measurements include option to keep the iPad software for the remainder of labor, use of pain medication, and labor outcome.

Response Measurement, Interobserver Agreement and Treatment Fidelity

A primary data collector observed all sessions and collected data on the laboring women's labor behaviors and the partners' labor behaviors (see Appendix B). A trained research assistant collected interobserver agreement (IOA) by reviewing and transcribing video recordings of each participant.

Labor behaviors were defined before beginning the study. Data were collected on adaptive and maladaptive labor behaviors for the woman, although only appropriate labor behaviors were presented in the data, as inappropriate labor behaviors were rarely observed. As an example, a maladaptive behavior during labor might be considered something that would interfere with the process of relaxation such as screaming or flailing. Women's labor behaviors included the position of the woman, her movement and her vocalizations. Positions for the woman included sit, stand, kneel, lay, squat, and submersion in water. Movements identified included rhythmic sway, lean forward, rock on a ball or chair, flail, or no movement. Mother vocals included deep breath, hum, yell or none at all. Partner labor behaviors included partner behaviors and partner vocalizations. Partner behaviors were identified as counter pressure (defined as partner hands or object held by partner pressed firmly against the woman's lower back), double hip squeeze (defined as two hands or the partner with pressure/force applied to the woman's hips), application of heat or cold packs, position support (defined as holding, steadying or supporting a woman in the chosen labor position), massage/touch, or none at all. Partner vocals included supportive words or encouragement, explanation of the position or support strategy, or none at all.

During each session, the total numbers of labor behaviors were recorded for the woman and her partner during each contraction interval. A contraction interval was

defined as the onset of the tightening of the uterus throughout the duration of the muscle contraction, and ending upon the full release of the tightening. As the study was conducted in the home environment without access to medical equipment, researchers relied upon the verbal report of the contraction start and end from the woman. Contraction duration for women during early labor was recorded and observed for 45-sec during early labor and 60-sec during active labor, consistent with the medical literature. Women also reported on their perception of pain, personal control and partner support following each contraction interval using a paper data sheet (see Appendix C) or a brief questionnaire generated on the iPad.

A secondary dependent variable of behavioral variability was calculated using a definition of novel behaviors, or behaviors that were different from the previous interval. For example, if sitting and rocking occur in interval 1 and again in interval 2, there are 2 novel behaviors in interval 1 and 0 novel behaviors in interval 2. Alternatively, if in interval 3, standing occurs, there is 1 novel behavior scored in interval 3. A behavior that was engaged in during interval 2 and then not observed again until interval 7 would be coded as a novel behavior, thereby indicating behavioral variability.

Interobserver agreement was calculated using total interval agreement methodology in which all behaviors coded within an interval either agreed or did not. Agreement was defined as a point-to-point correspondence between the primary observer and the secondary observer. Agreements were divided by the total number of contraction intervals per participant and multiplied by 100%. Interobserver agreement was collected for all participants with 71.4% to 100% of contraction intervals coded for agreement. Mean agreement for all 6 dyads was 91.8% (range, 80% to 98.5%). Mean agreement was

94.8% for the women's positions (range, 80% to 100%), 77.8% for the women's

movements (range 20% to 100%), and 93.6% for the women's vocalizations (range,

76.6% to 100%). Mean agreement was 96.7% for partner behavior (range, 80% to 100%)

and 96.1% for partner vocalizations (range, 85% to 100%).

Treatment fidelity was controlled for as the intervention was a software program

that was either available or not available to the participant. Coding the videos for

appearance or non-appearance of the iPad provided for an additional measure of

treatment fidelity. Treatment fidelity was collected for all participants with 100% fidelity

of implementation across baseline and intervention conditions.

Results

The first group of participants consisted of three primipara, or women who

are giving birth for the first time, and their partners. The women in this first group

were all in early labor at the time of the study being conducted. Overall, the

women's frequency of labor behavior increased during the intervention condition

(see *Figure 1*). Woman #201 consistently engaged in 1 labor behavior during all

baseline sessions, whereas following the intervention she had a range of 1-2 labor

behaviors with a mean of 1.5 labor behaviors per contraction interval in the

intervention condition. Woman #202 engaged in one labor behavior consistently

across contractions during baseline, and following intervention she engaged in one

to three labor behaviors per interval with a mean of 1.9 labor behaviors. Woman

#203 engaged in one to two labor behaviors per interval during the baseline

condition with a mean of 1.2 labor behaviors per interval, and following

intervention, engaged consistently in three labor behaviors per interval.

The partners in the first group showed similar results in that the frequency of labor behaviors during the intervention condition was higher than that of the baseline condition for two of the three participants (see *Figure 2*). Partner #201 engaged in zero labor behaviors during baseline whereas during intervention conditions, he engaged in zero to two labor behaviors with a mean of 0.88 labor behaviors per contraction interval. Partner #202 did not engage in any labor behaviors during the baseline or intervention conditions. Partner #203 engaged consistently in one labor behavior throughout the baseline condition and engaged in a range of one to three labor behaviors during intervention, with a mean of two labor behaviors per interval.

The results for the combined behaviors for both the woman and her partner in the early labor group show an increase in labor behaviors for all dyads (see *Figure 3*). Dyad #201 engaged in one labor behavior consistently throughout the baseline session whereas they had a range of one to four labor behaviors following intervention with a mean of 2.38 labor behaviors per interval. Dyad #202 also engaged in one labor behavior consistently during the baseline condition, and following intervention engaged in one to three labor behaviors per interval with a mean of 1.9 labor behaviors. Dyad #203 engaged in two to three labor behaviors per interval during baseline, with a mean of 2.2 behaviors, and during intervention engaged in four to six labor behaviors with a mean of five behaviors per contraction interval.

The second group of participants consisted of one primipara and two multipara, or women who have previously had one or more live births, in active labor. The women in this group also all demonstrated an increase in overall frequency of labor behavior following the baseline condition (see *Figure 4*). Woman #101 engaged in one to four labor behaviors during baseline with a mean of 1.8 behaviors per interval and following intervention engaged in two to four labor behaviors with a mean of three labor behaviors. This participant's intervention condition was ended prior to the completion of the two-hour time interval as a result of the labor progressing too quickly to complete the entire session. Woman #102 engaged in two to three labor behaviors per interval during baseline with a mean of 2.1 behaviors, whereas she engaged in one to four labor behaviors per interval during intervention with a mean of 2.31 behaviors per contraction interval. Woman #103 engaged in one to three labor behaviors per interval during baseline with a mean of two behaviors and engaged in two to four labor behaviors per interval during intervention with a mean of 2.47 behaviors.

The partners' frequency of labor behaviors increased for two of three participants and remained the same for one participant (see *Figure 5*). Partner #101 engaged in zero labor behaviors consistently during the baseline session and engaged in four labor behaviors consistently during intervention intervals. Partner #102 engaged in zero to one labor behaviors during baseline with a mean of 0.1 behaviors per interval and engaged in zero to two labor behaviors per interval during intervention with a mean of 0.77 behaviors per interval. Partner #103

engaged in zero to one labor behaviors during both baseline and intervention

conditions with a mean of 0.07 behaviors per interval in both conditions.

The results for the combined behaviors for both the woman and their

partners in the active labor group show an increase in frequency of labor behaviors

for all dyads (see *Figure 6*). Dyad #101 engaged in one to four labor behaviors

during baseline and six to eight labor behaviors during intervention, with means of

1.8 and 7, respectively. Dyad #102 engaged in two to three labor behaviors per

interval during baseline with a mean of 2.2 labor behaviors and engaged in one to

five labor behaviors during intervention with a mean of 3.08 behaviors per interval.

Dyad #103 engaged in one to three labor behaviors per interval during baseline

with a mean of 2.07 and engaged in a range of two to four labor behaviors per

interval during intervention with a mean frequency of 2.5 per interval.

In addition to frequency of labor behaviors, variability of labor behaviors was

calculated and analyzed by determining the frequency of novel behaviors per

interval. Novel behaviors were defined as any labor behavior that is different from

the interval immediately preceding it. As the first interval cannot technically

contain any novel behaviors per this definition, the number of behaviors during

interval 1 is denoted by an open triangle (see *Figure 7*). In the early labor group,

woman #201 did not have any variability in behavior during baseline whereas

during intervention, she engaged in 0-2 novel behaviors per interval, with a mean of

0.88 novel behaviors per contraction interval. Woman #202 also engaged in zero

variability during baseline but engaged in 0-2 novel behaviors per interval during

intervention, with a mean frequency of 0.9 novel behaviors per interval. Woman #203 engaged in only 1 novel behavior during baseline, with mean frequency of novel behaviors being 0.07, whereas during intervention she engaged in 0-2 novel behaviors per interval with a mean variability of 0.75 per interval.

The partners' variability in responding during early labor is displayed in the same manner as mentioned above and 2 of 3 participants increased in the frequency of novel behavior following the baseline condition (see *Figure 8*). Partner #201 engaged in zero novel behaviors during baseline and between 0-1 novel behaviors during the intervention condition, with a mean frequency of novel behaviors of 0.5. Partner #202 did not engage in novel behaviors during baseline or intervention. Participant #203 engaged in 1 novel behavior during baseline with a mean frequency of novel behavior at 0.07 and between 0-2 novel behaviors per interval during intervention with a mean frequency of 1 per interval.

The combined frequencies of novel behaviors for the dyads also demonstrate higher frequencies of novel behavior in the intervention condition (see *Figure 9*). Dyad #201 had zero novel behaviors during baseline and 0-3 novel behaviors per interval during intervention with a mean of 1.36. Dyad #202 also had zero novel behaviors during baseline and 0-2 novel behaviors per interval during intervention with a mean of 0.9. Dyad #203 engaged in 0-1 novel behaviors during baseline with a mean of 0.14 and 1-2 novel behaviors during intervention with a mean of 1.75 novel behaviors per interval.

The variability for the women in active labor shows increases in frequency of novel behaviors for 2 of the 3 participants (see *Figure 10*). Woman #101 engaged in 0-3 novel behaviors during baseline with a mean of 0.75, whereas she engaged in 0-1 novel behaviors during intervention with a mean of 0.5. Woman #102 engaged in 0-2 novel behaviors during baseline with a mean of 1.11 per interval and she engaged in 0-4 novel behaviors with a mean frequency of 1.46 novel behaviors per interval during intervention. Woman #103 engaged in 0-1 novel behaviors per interval during baseline with a mean of 0.29 and 0-2 novel behaviors with a mean of 0.4 during intervention.

The variability for the partners during active labor also increased for 2 of 3 participants (see *Figure 11*). Partner #101 did not demonstrate any variability in responding during baseline, however he engaged in 0-4 novel responses per interval during intervention, with a mean frequency of 2. Partner #102 engaged in 0-1 novel behaviors during baseline with a mean of 0.11, whereas he engaged in 0-2 novel behaviors per interval during intervention with a mean frequency of 0.46. Partner #103 engaged in 0-1 novel behaviors during both baseline and intervention with a mean of 0.07 in each condition.

While the variability of labor behaviors did not increase for every participant, when variability is combined and calculated by dyad, all 3 dyads showed an increase in frequency of novel labor behaviors during active labor following intervention (see *Figure 12*). Dyad #101 engaged in 0-3 novel behaviors during baseline with a mean of 0.75 while they engaged in 1-4 novel responses during intervention with a mean

of 2.5 per interval. Dyad #102 engaged in 0-3 novel behaviors during baseline with

a mean of 1.22 and 0-5 novel behaviors per interval during intervention with a

mean frequency of 1.92. Dyad #103 engaged in 0-1 novel behaviors per contraction

interval during baseline with a mean frequency of 0.36, whereas they engaged in 0-2

novel behaviors per interval during intervention with a mean frequency of 0.47.

Data are also displayed within participant by examining the percentage of

intervals with precise labor behaviors for each dyad. During baseline, woman #101

engaged in standing during the entire observation period with lower levels of

walking, swaying, leaning forward and deep breathing, each occurring during 20%

of intervals (see *Figure 13*). Following intervention, standing still occurred during

100% of contraction intervals, walking, swaying and leaning forward increased to

40% of intervals and squatting also appeared during 40% of intervals. Deep

breathing dropped off after baseline. Partner #101 did not engage in any pre-

defined labor behaviors during baseline but engaged in position help, massage,

supporting words and explanation during 100% of intervals in the intervention

condition.

Woman #102 engaged in sitting during 30% of intervals, standing during

70% of intervals, swaying during 50% of intervals, leaning during 20% of intervals

and rocking during 40% of intervals in the baseline condition (see *Figure 14*).

Following intervention, she demonstrated an increase in the percent of intervals

with sitting up to 30.8% and began engaging in the new behaviors of kneeling

during 7.7% of intervals, laying during 23.1% of intervals, and deep breathing

during 38.5% of intervals. Some behaviors lessened following intervention which is seen in standing behavior decreasing to 38.5%, swaying decreasing to 38.5%, leaning to 15.4%, and rocking to 38.5%. Partner #102 engaged in massage only in baseline during 10% of intervals. Following intervention, he engaged in position help and explanation during 7.7% of intervals each and increased the intervals with massage to 61.5%.

Woman #103 engaged in sitting during 100% of intervals in both the baseline and intervention conditions (see *Figure 15*). During baseline, she also engaged in rocking 86.7% of the time and deep breathing 13.3% of the time. Following intervention, her behaviors of rocking and deep breathing increased to 100% and 33.3% respectively. New behaviors of squatting and leaning began during intervention, both during 6.7% of intervals. Partner #103 engaged in massage during 6.7% of intervals during baseline and intervention conditions.

In the early labor group, woman #201 engaged in sitting only during 100% of intervals in baseline (see *Figure 16*). During the intervention condition, her sitting decreased to 25% of intervals while standing and occurred during 12.5% of intervals, kneeling during 37.5%, squatting during 12.5%, swaying during 25%, leaning during 25%, and rocking on a ball occurred during 25% of intervals. Partner #201 did not engage in any labor behaviors during baseline but during intervention engaged in hip squeezes during and position help during 12.5% of intervals each as well as massage during 37.5% of intervals.

Woman #202 showed similar results to #201 in that she too engaged in sitting only during 100% of intervals in baseline (see *Figure 17*). During intervention, her sitting behavior decreased to 30% of intervals while standing, squatting, walking, rocking and deep breathing began to occur at 30%, 40%, 40%, 10% and 50% of intervals, respectively. Partner #202 did not engage in any labor behaviors during the baseline or intervention conditions.

Similarly, woman #203 engaged in sitting during 100% of intervals in baseline (see *Figure 18*) and also rocked on the ball during 20% of intervals. During the intervention condition, sitting decreased to 20% of intervals, kneeling and leaning began at 80% and 100% of intervals, respectively, and rocking increased to 100%. Partner #203 engaged in counter pressure during 100% of intervals during baseline as well as supportive words during 7% of intervals. In the intervention condition, the partner's counter pressure behavior decreased to 80% of intervals, while supportive words increased to 20% of intervals. New behaviors of hip squeeze, massage and explanation began during intervention at 20%, 40% and 40% of intervals, respectively.

Discussion

The women and their partners in the early labor group significantly increased the frequency of labor behavior during intervention. It was interesting to observe that during the early labor baseline condition, the partners were largely uninvolved, meaning that that did not engage in any labor specific behaviors. It is also important to consider that during baseline, the women in early labor mostly sat still without much other movement. Following the intervention conditions, all three women began to engage in higher

frequencies of labor behaviors, and two of three partners also began to engage with the woman in labor. Partner #202 is the only one for which behavior did not increase, however it should be noted that he was asleep during both the baseline and experimental sessions, therefore did not engage in any labor behaviors during the observation period. The multiple baseline design across participants shows that the intervention was effective in increasing frequency of cumulative labor behaviors in all 3 dyads during early labor.

While there is a less noticeable effect in the active labor group via visual inspection, the range of and mean frequencies of labor behaviors did increase during the intervention condition. The three women engaged in some labor behavior during baseline but engaged in higher frequencies following intervention. The three men engaged in very little labor behavior during baseline, if any, but following intervention, two of three men engaged in higher frequencies of labor behavior. Partner #103 was actually asked to, "not touch," as requested by the woman through the StorkAssist program, so while the frequency of labor behavior did not increase, he was actually engaged in high fidelity of implementation with regard to software usage. Upon inspection of the dyads' frequency of labor behaviors, all three dyads engaged in more labor behavior during the intervention condition as compared to the baseline condition.

In a comparison between early and active labor groups, the women in the active labor group engaged in higher frequencies of labor behavior during baseline as compared to the women in the early labor group. While it is apparent that the intervention was successful at increasing frequency of labor behavior during early labor, it is less apparent in the active labor group as a higher frequency of labor behavior was already occurring, likely due to a natural response to pain. Additionally, at the point in which painful

stimulation is at its peak during labor, it may be too late in the labor process to focus on engaging with external stimuli.

The partners, however, demonstrated similar increases in frequency of labor behaviors during both early and active labor. In both the early and active labor groups there was one partner who did not engage in increased frequency of labor behavior, due to sleeping and request to not be touched, respectively. The other 4 partner participants engaged in zero or very low frequency of labor behavior during baseline and increased participation in labor behaviors during intervention. Partner participation in labor is very helpful to the laboring woman as it provides a source of comfort, physically and emotionally. Research shows that partner support is a vital component in perception of birth outcome, therefore this intervention's ability to increase partner support in both early and active labor can be considered quite beneficial.

Variability in labor behavior is extremely important as positional changes by the mother during labor help the baby settle into the pelvis in optimal fetal positioning, allowing for ease of birth. Additionally, as labor becomes progressively harder, both physically and emotionally, different coping strategies are needed for both the laboring woman and her partner to overcome the various triumphs of childbirth. Variability of labor behaviors was calculated and analyzed by determining the frequency of novel behaviors per interval. Novel behaviors were defined as any labor behavior that is different from the interval immediately preceding it. For example, if the woman engaged in sitting and rocking during the first contraction interval and engaged in standing and swaying during the second contraction interval, there would be two novel behaviors scored during the second interval. If then during interval three the

woman engaged in standing, swaying and deep breathing, there would be one novel behavior coded in interval 3.

Both the women and their birth partners engaged in little to no variability of labor behaviors during baseline conditions in early labor. With the exception of partner #202 who was sleeping, all 5 participants in the early labor condition increased the frequency of novel behaviors during the intervention condition. As such, the dyads variability in responding during early labor increased significantly for all three dyads.

All three women in the active labor group engaged in novel responses during the baseline condition, whereas two of these three laboring women increased their frequency of novel labor behaviors during intervention. The partners engaged in little to no variability in responding during baseline and two of three partners increased their frequency of novel responding during intervention. When novel behaviors were combined for the dyads, all three dyads in the active labor group increased their frequency of variability in labor behaviors during the intervention phase. Even though variability seems to increase in response to pain, the multiple baseline design suggests that the intervention is likely to increase variability for women and most certainly increases variability in responding for the partners.

The precise labor behaviors engaged in by each dyad are interesting to examine in order to get a better understanding of how labor behaviors changed between the baseline and intervention conditions. In examining the precise labor behaviors of the active labor group, one will notice that in all three dyads, there was a shift in the behaviors that were engaged in. Not only were new behaviors attempted, but also new behaviors sustained throughout intervention, indicating that the women and their partners discovered new

behaviors that were helpful to them by engaging with the software treatment package. In the early labor group, sitting was the primary labor behavior engaged in by all three women until they were introduced to the software in which they were able to find new ways of coping through labor. Two of three partners did not engage in any labor behaviors during baseline in the early labor group but all three partners found new ways to help their partners during the intervention condition.

The results from study 1 suggest that the intervention is successful in increasing both labor behaviors and variability in behaviors for women and their partners in early and active labor, more significantly in early labor though. In addition to the quantitative data demonstrating the effectiveness of the StorkAssist program, anecdotal comments by the participants collected in an exit survey indicate the same results. One participants writes, "We just wanted to say thank you for having us participate in your study, the app we super helpful - especially when we started running on fumes! The reminders and different positions really helped when something stopped working and we needed to change things up. Once we got past a certain point we didn't use the app anymore, but the things we were able to glean from using it in the beginning came back to us while we were in the major throws of things."

STUDY 2

Purpose

The purpose of study 2 was to engage in a closer examination of the intervention in a group design to see if labor behaviors and variability increased while using the StorkAssist software treatment package. Given that the dyads in early labor showed the

most effect sizes in Study 1, it was decided to include participants during early labor only and only those women that were primipara, to further control for variables.

Methods

Participants and Setting

Four dyads were recruited for this study. Women of all ages and backgrounds were able to participate however all women had to be primipara and low risk with no professional labor support person hired. Additionally, they had to have permission from the care provider had to be granted to labor at home for a period of time. The sessions took place in the participants' homes, prior to their admission to the hospital.

Materials

The StorkAssist program (explained in detail in Study 1) was used for the experimental sessions. Participants were also given a data sheet to collect perceptual data (see Appendix C).

Procedures

The methods for the control group were identical to that of the baseline condition in study 1 and the methods for the experimental group were identical to the intervention condition in study 1. To summarize, participants went about labor as usual in the control group and the experimental group had access to StorkAssist the entire time. All participants were instructed to contact the researcher when the contraction intervals were 10-minutes apart and the researcher arrived within an hour to make sure to collect data during early labor. Study sessions were not time based, but rather interval based, with a total of 20 contractions observed during the session. Sessions lasted between 1.5-3 hours, depending on the frequency of contractions.

Experimental Design

A group comparison design was used wherein participants were randomly assigned to the control group or the experimental group. Two dyads were assigned to each group. The independent and dependent variables were identical to Study 1.

Response Measurement, Interobserver Agreement and Treatment Fidelity

A primary data collector observed all sessions and collected data on the laboring women's labor behaviors and the partners' labor behaviors (see Appendix B). A trained research assistant collected interobserver agreement (IOA) by reviewing and transcribing video recordings of each participant.

Labor behaviors were defined before beginning the study and were identical to the definitions of Study 1. During each session, the total numbers of labor behaviors were recorded for the woman and her partner during each contraction interval. A contraction interval was defined as the onset of the tightening of the uterus throughout the duration of the muscle contraction, and ending upon the full release of the tightening. As the study was conducted in the home environment without access to medical equipment, researchers relied upon the verbal report of the contraction start and end from the woman. Contraction duration for women during early labor was recorded and observed for 45-sec, consistent with the medical literature. Women also reported on their perception of pain, personal control and partner support following each contraction interval using a paper data sheet (see Appendix C) or a brief questionnaire generated on the iPad.

A secondary dependent variable of behavioral variability was calculated using a definition of novel behaviors, or behaviors that were different from the previous interval. For example, if sitting and rocking occur in interval 1 and again in interval 2, there are 2

novel behaviors in interval 1 and 0 novel behaviors in interval 2. Alternatively, if in interval 3, standing occurs, there is 1 novel behavior scored in interval 3. A behavior that was engaged in during interval 2 and then not observed again until interval 7 would be coded as a novel behavior, thereby indicating behavioral variability.

Interobserver agreement was calculated using total interval agreement methodology in which all behaviors coded within an interval either agreed or did not. Agreement was defined as a point-to-point correspondence between the primary observer and the secondary observer. Agreements were divided by the total number of contraction intervals per participant and multiplied by 100%. Interobserver agreement was collected for all participants with 80% to 100% of contraction intervals coded for agreement. Mean agreement for all 4 dyads was 92.45% (range, 80% to 100%). Mean agreement was 100% for the women's positions, 93.8% for the women's movements (range 90% to 100%), and 98.3% for the women's vocalizations (range, 90% to 100%). Mean agreement was 86.3% for partner behavior (range, 70% to 100%) and 88.8% for partner vocalizations (range, 55% to 100%).

Treatment fidelity was controlled for, as the intervention was a software program that was either available or not available to the participant. Coding the videos for appearance or non-appearance of the iPad provided for an additional measure of treatment fidelity. Treatment fidelity was collected for all participants with 100% fidelity of implementation across baseline and intervention conditions.

Results

The results of study 2 are graphed as a comparison between participants, looking at both the behaviors of the experimental group (participants with numbers

in the 300's) and the control group (participants with numbers in the 400's). The women's frequencies of labor behaviors are higher for the experimental group than for the control group, however the range is 1-3 for both groups (see *Figure 19*). Experimental woman #303 has a range of 1-3 labor behaviors per contraction interval with a mean of 1.85 whereas experimental woman #305 has a range of 1-2 labor behaviors per contraction interval with a mean frequency of 1.5. The total range for the women's frequency of labor behaviors in the experimental group is 1-3 and the mean is 1.68. The control group has a total range of 1-3 labor behaviors per interval with a combined mean of 1.28. Control woman #401 has a range of 1-3 labor behaviors per contraction interval with a mean of 1.55 whereas control woman #407 has a range of 1 labor behavior per contraction interval with a mean frequency of 1.

The partners' frequencies of labor behaviors are also higher for the experimental group than for the control group (see *Figure 20*). The overall range for the experimental group is 0-3 labor behaviors per contraction interval with a combined mean of 1.35 whereas the range for the control group is 1 with a mean of 1. Experimental partner #303 had a range of 0-3 labor behaviors per contraction interval with a mean of 1.5 and experimental partner #305 had a range of 1-2 labor behaviors per interval with a mean of 1.2. Control partners #401 and #407 both had a range of 1 and a mean of 1 labor behavior per contraction interval.

Given that both the women and the partners' frequencies of labor behaviors are higher in the experimental group, naturally the dyad's frequencies of labor

behavior are higher for the experimental group (see *Figure 21*). The overall range for the experimental group is 1-5 labor behaviors per contraction interval with a combined mean frequency of 3.03 whereas the range for the control group is 2-4 labor behaviors with a mean frequency of 2.23. Experimental dyad #303 had a range of 1-5 labor behaviors per contraction interval with a mean of 3.35 and experimental dyad #305 had a range of 2-4 labor behaviors per interval with a mean of 2.7. Control dyad #401 had a range of 2-4 labor behaviors per interval with a mean of 2.55 while control dyad #407 had a range of 2 and a mean frequency of 2 labor behaviors per contraction interval.

Variability of labor behaviors was calculated and analyzed by determining the frequency of novel behaviors per interval. Novel behaviors were defined as any labor behavior that is different from the interval immediately preceding it. As the first interval cannot contain any novel behaviors per this definition, the frequency of behaviors during interval 1 is excluded in the data. The women's variability is higher for the experimental group than for the control group (see *Figure 21*). Experimental woman #303 has a range of 0-3 novel behaviors per contraction interval with a mean of 0.85 whereas experimental woman #305 has a range of 0-2 novel behaviors per contraction interval with a mean frequency of 0.75. The total range for the women's frequency of novel behaviors in the experimental group is 0-2 and the mean is 0.8. The control group has a total range of 0-3 novel behaviors per interval with a combined mean of 0.2. Control woman #401 has a range of 0-3 novel behaviors per contraction interval with a mean of 0.25 whereas control

woman #407 has a range of 0-1 novel behaviors per contraction interval with a mean frequency of 0.15.

The partners' frequencies of novel behaviors are also higher for the experimental group than for the control group (see *Figure 22*). The overall range of variability for the experimental group is 0-3 novel behaviors per contraction interval with a combined mean of 0.73 whereas the range for the control group is 0-1 with a mean of 0.18. Experimental partner #303 had a range of 0-3 novel behaviors per contraction interval with mean variability of 0.8 and experimental partner #305 had a range of 0-2 novel behaviors per interval with a mean of 0.65. Control partners #401 had a range of 0-1 novel behaviors and a mean of 0.05 novel behaviors per contraction interval. Control partners #407 had a range of 0-1 novel behaviors with a mean of 0.3 novel behaviors per contraction interval.

Again, since both the women and the partners' variability in behaviors are higher in the experimental group, the dyad's variability in behavior are higher for the experimental group (see *Figure 23*). The overall range for the experimental group is 0-4 novel behaviors per contraction interval with a combined mean frequency of 1.53 whereas the range for the control group is 0-3 novel behaviors with a mean frequency of 0.38. Experimental dyad #303 had a range of 0-4 novel behaviors per contraction interval with a mean of 1.65 and experimental dyad #305 also had a range of 0-3 labor behaviors per interval with a mean of 1.4. Control dyad #401 had a range of 0-3 novel behaviors per interval with a mean of 0.3 while

control dyad #407 had a range of 0-2 and a mean frequency of 0.45 novel behaviors per contraction interval.

Rate of labor behavior and rate of behavioral variability were also calculated for each dyad by dividing the total number of behaviors by the total number of contractions. Except in one instance, the rate of labor behaviors was higher in the experimental participants than in the control (see *Figure 24*). The rate of labor behaviors for the two control women was 1.55 for woman #401 and 1 for woman #407 and for the two experimental women was 1.85 for woman #303 and 1.5 for woman #305. The rate of labor behaviors for the two control partners was 1 for both partners #401 and #407 and for the two experimental partners was 1.5 for partner #303 and 1.2 for partner #305. The rate of labor behaviors for the dyads was 2.55 for control dyad #401 and 2 for control dyad #407, while rate of labor behavior for the two experimental dyads was 3.35 for dyad #303 and 2.7 for dyad #305.

For all participants, the rate of variability of labor behaviors was higher in the experimental group than in the control (see *Figure 25*). The rate of variability for the two control women was 0.21 for woman #401 and 0.1 for woman #407 and for the two experimental women was 0.74 for woman #303 and 0.75 for woman #305. The rate of variability for the two control partners was 0 for partner #401 and 0.3 for partner #407 whereas for the two experimental partners was 0.79 for partner #303 and 0.65 for partner #305. The rate of variability for the dyads was

0.21 for control dyad #401 and 0.4 for control dyad #407, while rate of variability

for the two experimental dyads was 1.53 for dyad #303 and 1.4 for dyad #305.

Discussion

The frequencies of partners' labor behaviors were higher for in the experimental

group and the overall frequencies of the dyads labor behaviors were higher in the

experimental group. The women however engaged in similar frequencies of labor

behaviors in both the control and the experimental group suggesting that the intervention

did not increase frequency of labor behavior for the women alone during early labor but

did so for the partners. With such low rates of behaviors, approximately 1-2 labor

behaviors per interval for both the women and their partners, it may be difficult to

discriminate differences in frequency of labor behaviors per contraction interval within

this very small population.

Perhaps the most interesting conclusion drawn from study 2 is that the variability

of labor behaviors increased significantly for both the laboring women and their partners.

The variability of behaviors engaged in by the women in the experimental group was

more than triple that of the variability engaged in by the women in the control group.

Similarly, the variability of behaviors engaged in by the partners in the experimental

group more than doubled that of the variability engaged in by the partners in the control

group. Of course, the variability for the dyads combined also showed an increase of

more than three times for the behaviors of the experimental group when compared to the

control group.

Whereas the frequency of labor behaviors remains relatively low during early

labor for both the laboring women and their partners, the variability of labor behaviors, or

frequency of novel behaviors, is greatly increased for the experimental group. Again, this behavioral variability is quite important during labor to increase the optimal fetal positioning. Additionally, the increase in frequency of labor behaviors seen for the partner is important to keep the partners engaged with and supportive of the laboring women's needs.

Conclusions

The interdisciplinary field of behavioral medicine was created to address societal challenges from the medical or health perspective using a behavioral approach (Schwartz & Weisberg, 1978). A primary illustration of a societal problem in the medical arena is that the applications of modern medicine to normal physiological processes have become commonplace. People prefer to be treated rather than to feel any discomfort or distress. For example, the common cold may be treated with antibiotics as a precautionary step; feelings of sadness and grief are often masked by antidepressants; and heavy narcotics are administered during normal childbirth.

The commonly used "cascade of interventions" contributing to the Cesarean Epidemic has resulted in the U.S. having some of the poorest birth outcomes of any developed nation (Goer & Romano, 2012). In a report summarizing the World Health Organization's principles of perinatal care, appropriate methods for pain relief are suggested to all be behavioral: "Avoid the use of medications in labor. Preferably pain management should use nonpharmacological methods, such as ambulation, changing positions, massage, relaxation, breathing, acupuncture, and others. Avoid epidural analgesia as a routine method of pain management," (Chalmers, Mangiaterra, & Porter, 2001, p. 206). Additionally, a large meta-analysis of non-pharmacological approaches for

pain management concluded that when compared to routine medical interventions, non-pharmacological approaches were found to have better birth outcomes for mothers and babies (Chaillet et al., 2014). Even with said findings, over 80% of women in the U.S. use an epidural during labor and almost 50% of women who do not want epidurals end up receiving them (Goer & Romano, 2012).

The lack of fluency with labor coping strategies and partner support skills is a major contributing factor to the over-reliance upon heavy narcotics during childbirth. In fact, decades of research have specifically mentioned the need for more effective prompting methodologies of non-pharmacological coping strategies in childbirth (e.g., Escott, Slade, & Spiby, 2009; Slade, Escott, Spiby, Henderson, & Fraser, 2000; Spiby et al., 1999). Additionally, just this year, the World Health Organization released a paper specifying the importance of a laboring woman having a good birth support partner (World Health Organization, 2015). The scope of this research addressed the common practices within childbirth; outcomes associated with such practices were discussed and a behavior analytic perspective of the barriers and a behavior analytic solution within the current system was proposed and evaluated.

The authors conclude that the introduction of a behavioral software using in-vivo prompting and video modeling increases the frequency of labor behaviors and the variability of labor behaviors during unmedicated labor for both women and their labor support partners. Using single subject research methodology across 6 dyads in Study 1, we are able to conclude that the introduction of the StorkAssist iPad software is the variable responsible for increasing appropriate labor behaviors. In the very small subject group design of Study 2, something that would be more relevant and applicable to a

medical community, we see similar effects and also conclude that the dyads in the intervention group engaged in higher frequencies of labor behavior and behavioral variability while using the StorkAssist program (see *Table 1*). While labor behaviors do occur in the absence of the software, the program does gain stimulus control over certain labor behaviors, as seen in the increase in frequency and variability of behaviors following the intervention.

Appropriate labor behaviors that are widely taught and accepted in childbirth education courses include various positions, relaxation strategies and comfort measures (Chaillet et al., 2014). Women are taught how to breathe through contractions and relax their body in certain positions whereas partners are taught how to support women in these positions and offer additional comfort measures such as use of heat/cold therapy, massage techniques and supportive words of encouragement. Childbirth education classes and/or self-study programs do not have one governing board that oversees said childbirth education, therefore the instructor of record is at the whim of their own experiences in disseminating information. Depending on what city you live in, what state you reside in, what hospital you are delivering at, what instructor you have, what author you choose to subscribe to, you will be taught different skills in coping with childbirth. In addition to these differences in education of coping strategies, the amount of time engaged in learning the strategies varies widely. Some people may spend 12 weeks in childbirth education courses whereas many expecting parents attend just one week or not at all.

When considering childbirth education from a science of behavior or learning perspective, it is difficult to imagine that this variability in training produces any

consistency in outcomes. Couple those differences in training with brand new and highly stressful environments, and as behavior scientists, we expect nothing less than a lack of generalization and a major skill deficit of coping strategies for both the woman and her partner during labor, also demonstrated in the literature (Spiby et al., 1999). In an extensive survey on labor support, 91% of women found immersion in water, heat/cold packs or use of a birth ball to be somewhat or very helpful in managing labor pain, however only 7% of women used these strategies (Declercq, Sakala, Corry & Applebaum, 2007). It is no wonder that while these strategies are empirically based and widely taught, the likelihood of actually engaging in them during labor is quite low.

Participants were surveyed at the completion of their birth and asked to comment on what features of StorkAssist they found most helpful. Almost all of the participants remarked that they would not have remembered what they had learned in childbirth education classes if not for the immediate prompts of this intervention. One participant commented, "When I am laboring, I forget what could be effective. I was much more open to trying different positions this birth. I think the program helped because I was able to get ideas instantly." Another remarked, "It's so helpful to have all of the position options available. After learning them in a class or reading about them, it would have been difficult to recall them all on our own, not to mention which would be right to use when." A third said, "It suggested positions that we had not thought of. Even though I had read about all the positions before, at the time of labor I wasn't thinking of them. It helped remind me and get me into different positions to see what was working." Another commented that it aligned well with what she had learned in her childbirth education classes and that for women that did not attend 12 weeks of Bradley Method childbirth

education like she had, she would have imagined it even more helpful: "…the suggestion to change positions and other options to try really helped when we were tired. It reminded us of what we learned in our birthing class. This software is a great partner to the Bradley Method classes and even offered ideas that we had not already learned. If it was helpful to us, I can't imagine how valuable it would be to someone who had not taken an extensive birthing class."

Engaging in labor behaviors is important during labor for a host or reasons outlined in the introduction. To recap, the movement and positioning of the woman during labor helps with optimal fetal positioning, allowing the baby to settle into the woman's unique pelvis in the ideal position for her body and impending birth (Shilling, 2009; Storton, 2007). If the baby is in an optimal position in the pelvis, the birth process will be quicker and cesarean section or other major interventions to assist with delivery will be less likely to be necessary (Chaillet et al., 2014). In addition to helping the baby settle into the pelvis, movement and positioning help the mother cope with the pain and other challenges associated with labor (Shilling, 2009). We also know that having an epidural restricts a woman to lying on her back throughout her labor and as a result, doubles the woman's chance of needing a cesarean section due to dystocia, or failure to progress (Thorp, Meyer & Cohen, 1994), often resulting from a poorly positioned fetus.

As an example of movement aiding the progression of labor, imagine a woman that is experiencing back pain during labor. This pain may likely be due to a baby whose head is pressing on her sacrum in an occiput posterior position, or the back of the head facing her back. This is not an ideal situation for the other or baby as the baby will struggle to descend through the pelvis in this position and the mother will report higher

levels of pain. If the woman gets onto the floor on her hands and knees, gravity will help

the pressure on mom's back subside and the baby will be better able to rotate given that

the back of the head is the heaviest part of the baby and again, gravity will assist with this

movement. If the women were unaware of this position or had perhaps forgotten what

was learned in childbirth education, she might reside in a sitting or prone position,

thereby not helping herself cope or her baby rotate. Partners can also help in this

situation by applying counter pressure on the mother's back, but again, they have to know

to use the skill at the precise moment that it will be helpful; something that may or may

not have been learned and generalized from childbirth education.

     Partners also have a responsibility during labor to provide support and comfort

measures, and over 20 years of research supports that women labor better and have better

birth outcomes with good partner support (Green & Hotelling, 2014). In a study of over

400 women, the presence of a supportive labor companion, or doula, reduced the rate of

cesarean delivery by 10% and reduced the use of epidurals by over 50% (Kennell, Klaus,

McGrath, Robertson, & Hinkley, 1991). Research also shows that appropriate and

adequate labor support reduces birth trauma and likelihood of post partum depression

(Hodnett, Gates, Hofmeyr, Sakala, & Weston, 2012). A recent review of the literature on

factors influencing women's coping with pain during childbirth concluded that

continuous and individualized support was a contributing factor, regardless of cultural

differences (Van der Gucht & Lewis, 2015). Women reported that they needed effective

support during childbirth and that there were implications in their birth outcomes in the

absence of such support.

In addition to engaging in appropriate and adequate labor behaviors, variability within these labor behaviors is also important. Consider that at any time during labor, the laboring woman is largely unaware of the exact position of her baby in her body. She may have information from her care provider of the baby being head down, low in the pelvis, facing posterior or anterior, but the exact position remains unknown to everyone present. It is with respect to this unknown element that frequent changes in positions during childbirth are also helpful to promote optimal fetal positioning. The various positions that a woman finds herself in throughout her labor will allow her pelvis to open and give the baby different and changing opportunities to settle into an ideal position for birth. As we know from the wide use of epidurals, laying flat on one's back throughout the labor actually inhibits the natural progression of labor and typically results in a less than optimal position for the fetus, thereby requiring use of assisted delivery, including forceps, vacuum extraction or cesarean section (Goer & Romano, 2012).

Variability in behavior is also useful in coping mechanisms and support strategies. As labor progresses, the challenges and barriers to overcome are also ever changing. A woman in early labor is typically alert and excited whereas once active labor sets in, the woman is often more withdrawn and focused. In early labor, the laboring woman is able to easily communicate her needs to her partner but as active labor sets in, this communication gets much more difficult as the woman uses all of her energy to focus on the task at hand. Throughout early labor, the ability to try a variety of appropriate labor behaviors helps the woman and her partner decide what works best for their unique labor. Additionally, as the woman loses the ability to communicate clearly with her partner

during active labor, the prompting for the partner to try different support strategies becomes essential.

With regard to communication, the laboring couples bring with them to the birth scenario a history of communication with each other. Consider that the woman, in this scenario, the speaker, has a history of engaging in mands with her partner, the listener in this case. If the speaker engages in mands that have been extinguished by the listener, her likelihood of manding, or requesting assistance, during labor may be diminished. Likewise, the partner may be in a position of not engaging in listener behavior with respect to the speaker's mands. With this verbal behavior history, it may be unlikely that a woman would request partner support, and even if she did, the partner may not comply as the listener. Given this scenario, the StorkAssist program offers the dyad an indirect means of communicating as speaker and listener, thereby alleviating the prominence of the history of verbal behavior with which the dyad typically behaves.

Childbirth is a unique phenomenon in which the ultimate reinforcer of childbirth, the birth of the child, is quite delayed relative to the behavioral process of coping with labor. Labor involves many behaviors that a woman must engage in, some of which are negatively reinforced through the lessening of painful stimulation. Many behaviors, however, go without reinforcement and the painful stimulation increases, regardless of the behaviors engaged in, as labor by nature intensifies as birth nears. It is no wonder that women rely upon support from partners to provide additional reinforcement throughout the process in the form of touch, massage, and words of encouragement. Decades of research show that good partner support is predictive of positive birth outcomes for the baby and increased satisfaction by the mother (e.g., Green & Hotelling,

2014). The construct of delay discounting well describes the desire for use of pain medication during labor, even if the woman is aware of the side effects. The idea of reinforcement now in the removal of painful stimulation as compared to better outcome hours (or days) later for the mother and baby can often result in impulsivity. This impulsivity seems to be curbed by adequate partner support, yet that is a big responsibility for a partner, especially since the average number of births per woman in the USA is 1.9 (Thacker, Stroup & Chang, 2003), meaning there are few opportunities to practice these specific birth support skills.

The need for more adequate ways of prompting labor support strategies has been discussed for decades in the medical literature with little change in research or practice (e.g., Slade, Escott, Spiby, Henderson, & Fraser, 2000). The use of a professional labor support person, known as a doula, is slowly becoming a more common practice yet only 3% of the population in the USA report using doulas (Declercq, Sakala, Corry, & Applebaum, 2007) and doulas are cost prohibitive and location restrictive to many families. As recently as this year, the World Health Organization disseminated a Safe Childbirth Checklist that included specific mention of the presence of a birth companion (World Health Organization, 2015). However, even with the most helpful and compassionate partner, a woman and her partner will often find themselves in a position of lack of skills and/or adequate generalization of skills from books they have read or classes they have attended.

Enhancing coping strategies and partner support strategies during labor is crucial, especially given the cesarean epidemic that is sweeping the country as well as other nations. If use of heavy narcotics during labor is directly correlated to significant

increased risks of assisted delivery and surgical delivery (Goer & Romano, 2012), then the use of such narcotics should not be considered an effective coping strategy for labor and should be reserved for medical necessity. In the absence of escaping pain through analgesia, women and their birth partners need easy access to affordable ways to prompt labor behaviors at the moment in which they require that level of support. In an age of behavior science and technology, it is logical that harnessing the contingencies of the science of behavior into a quick-to-learn and easy-to-use software treatment package would be most beneficial in this scenario. While additional research is needed to draw widely accepted conclusions, the outcomes of this pilot study suggest that utilizing software such as StorkAssist is successful at prompting and increasing the frequency and variability of labor behaviors for women and their partners.

Perceptual data in line with the medical literature were collected for all women in this study following each contraction during both the experimental and control phases/conditions. The women in active labor in Study 1 (participants #101, #102, and #103) all reported increased levels of pain during the experimental condition as compared to the baseline condition (see *Figure 26*). While these effects may appear unpredicted, it is assumed that this would actually be the case as labor contractions increase in intensity as time goes on, often resulting in higher experiences of pain. As the sessions were not counterbalanced and all participants received the intervention following a baseline session, it is not surprising to see this pattern of reported experience. Of the three participants in early labor (participants #201, #202, and #203), two actually reported a decrease in pain during the intervention condition. It may be that the different positions and strategies prompted by the software were helpful in reducing the experience of pain

during early labor, before contractions became more intense. In a comparison of the

control participants and the experimental participants from Study 2, the two experimental

participants actually reported higher ratings of pain than did the control participants. As

pain perception varies widely between people, it is difficult to draw conclusions from this

data. We see similar results in the data on the ratings of personal control, assuming

control to have an inverse relationship to pain (see *Figure 27*).

Perception of partner support was also monitored for all women following each

contraction in the baseline and intervention conditions (see *Figure 28*). Of the

participants in Study 1 who were in active labor, 2 of 3 participants reported higher

ratings of partner support in the intervention condition and one reported the same level of

support. Of the participants in early labor, 1 reported an increase in perceptual rating of

partner support whereas 2 reported the same levels during baseline and intervention.

There are likely observer effects occurring with these ratings, as partners were able to see

the scoring take place. Additionally, there are ceiling effects seen in 2 of 4 participants in

Study 1 where they consistently rated the partner support a 10 out of 10 for contractions

in baseline and intervention. Perceptual ratings in Study 2 are challenging to compare

across participants as each participant has their own rating subjectivity, but the ratings of

partner support are cumulatively higher in the experimental group. Overall, ratings of

partner support increased for half of the participants and remained unchanged for the

other half, indicating that this intervention may increase perception of partner support for

some women.

Social validity was measured in several ways. The first measurement was the

request to keep the software program following the observation window in which 9 of 10

participants opted to keep the software program. Additionally, social validity questions were asked on an exit survey (see *Table 2*). Nine of 10 participants responded to the online exit survey and of the women that responded, 100% reported satisfaction with their birth experience, found StorkAssist to be helpful during their labor, and would recommend StorkAssist to a friend. Additionally, six midwives, two labor and delivery nurses, and one obstetrician looked at the program and responded that it would be useful to their patients. Participants were also given the opportunity to comment on their experience using the program and their responses included these statements: "We are really glad we participated in the study. The app helped keep us busy and give us something to do during the contractions as opposed to just stare at each other waiting. I think it helped make the time go by faster and gave us different options. Even things like the affirmations (which aren't really our kind of thing) helped lift the mood and put a smile on our face. I would definitely recommend it to pregnant women. Could also be great for women with less supportive or active partners to give them guidance." "Great for early labor to establish a rhythm and confidence for later." "Thank you for designing this software, it was one of the components that made our labor effective!"

Data on birth outcomes were also collected as a part of this study (see *Table 3* and *Table 4*). Given the very small sample size, we cannot draw formal conclusions from this data set. The preliminary data from Study 1 and Study 2 both suggest that analgesia use and cesarean section is less than that of the national average and less than the control group participants. There are too many other variables and too small of a population size to conclude that these outcomes were a direct result of this intervention, however preliminary data are promising and it warrants further investigation.

There are several limitations to this study. There are variables that could not be controlled for, including care provider delivering the baby, nursing staff responsible for patient care, preferences and desires of the participants, and number of childbirth education hours/self-study that participants engaged in (see *Table 4*). Another limitation is that the nature of the research attracted participants that were hoping for a natural childbirth, a variable that may have impacted the motivation to engage in labor behaviors. Additionally, the nature of a multiple baseline across participants in labor also poses its own barriers as labor progress and experience is quite different for each person. One of the challenges in gathering pain and control perceptual ratings within subject during labor is that labor pain increases in intensity over time, thereby making it difficult to determine the effectiveness of the intervention on perceptual measures. Observer effects may also play a role in this study, as it is possible that the participant was engaging with the software in order to please the researcher, and additionally, indirect measurement of self-report data may be inaccurate. Finally, data on birth outcome cannot be directly attributed to this intervention, as the participant pool was too small and there are many competing variables that contribute to birth outcome once the participants are finished with the experimental session and admitted to the hospital.

The purpose of the this study was to examine how a software treatment package incorporating prompting, choice, and modeling of labor behaviors affected the frequency and variability of labor behaviors engaged in by women and their partners. The package treatment intervention proved to be easy to engage with and was easily incorporated into the labor experience of 10 dyads. The authors conclude that the StorkAssist program was successful in increasing the frequency and variability of labor behaviors for both women

and their partners during unmedicated labor. Participants reported favorable outcomes and satisfaction with their experience using the software and found it to be helpful to them during their labors, so much so that they would recommend it to others.

If further research is conducted and the data continue to demonstrate usefulness at increasing frequency and variability of labor behaviors for women and their partners and better birth outcomes, this behavioral intervention may have implications for childbirth practices across the U.S. and in other countries. Given the alarming rates of cesarean sections in the U.S. and the fact that many of these surgical deliveries could be prevented through adequate use of labor movements and coping mechanisms, this intervention may be quite useful when used in a hospital environment. Whether a woman is planning a natural birth or not, there are benefits to delaying medication use, and the sooner a woman receives medication, the sooner she is restricted to the bed and the longer time the drugs are affecting her and her baby (Goer & Romano, 2012), both of which contribute to higher risk of cesarean delivery.

B.F. Skinner, the foremost-recognized pioneer of the science of behavior, proposed that behavior analysis would be the solution to many common societal problems (Skinner, 1974). His enthusiasm for and explanation of consequences in the analysis of behavior resulted in a vast body of research from supporters around the world. While behavior analysts are often recognized for major contributions to the research and clinical treatment in developmental disabilities and autism, the principles of the science of behavior stretch far beyond "the chair." To continue growth within the discipline and build upon the early findings within behavior science, behavior analysts must be

concerned with societal issues and attempt to address and resolve them from a behavioral perspective.

Through the application of behavior analytic technology to childbirth, immediate prompting and modeling of labor support strategies during labor could facilitate a change in childbirth practices across the country. While research has demonstrated a robust need for more effective prompting methodologies for coping strategies during childbirth, very limited attention has specifically been paid to this necessity. Results of this study suggest that a behavior analytic technology applied directly to the childbirth scenario, with no previous training required, provides successful outcomes in addressing the gaps and needs identified within the childbirth literature. Behavior analysis may be the most appropriate discipline to adequately provide the technology to meet this current gap in service delivery in an effective and cost efficient manner. Decades of research have provided the empirically based coping strategies for appropriate labor behaviors contributing to a healthy progression of childbirth, whereas behavior analysis has the potential to harness the contingencies with which these behaviors are most likely to occur.

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Table 1. Data summary table of ranges and means of the labor behaviors and variability of behaviors observed in women, partners and dyads in Study 1 and Study 2

	Labor Bx				Variability			
	Range - BL	Range - I	Mean - BL	Mean - I	Range - BL	Range - I	Mean - BL	Mean - I
WOMAN								
201	1	1-2	1	1.5	0	0-2	0	0.88
202	1	1-3	1	1.9	0	0-2	0	0.9
203	1-2	3	1.2	3	0-1	0-2	0.07	0.75
101	1-4	2-4	1.8	3	0-3	0-1	0.75	0.5
102	2-3	1-4	2.1	2.31	0-2	0-4	1.11	1.46
103	1-3	2-4	2	2.47	0-1	0-2	0.29	0.4
PARTNER								
201	0	0-2	0	0.8	0	0-1	0	0.5
202	0	0	0	0	0	0	0	0
203	1	1-3	1	2	0-1	0-2	0.07	1
101	0	4	0	4	0	0-4	0	2
102	0-1	0-2	0.1	0.77	0-1	0-2	0.11	0.46
103	0-1	0-1	.07	.07	0-1	0-1	0.07	0.07
DYAD								
201	1	1-4	1	2.38	0	0-3	0	1.36
202	1	1-3	1	1.9	0	0-2	0	0.9
203	2-3	4-6	2.2	5	0-1	1-2	0.14	1.75
101	1-4	6-8	1.8	7	0-3	1-4	0.75	2.5
102	2-3	1-5	2.2	3.08	0-3	0-5	1.22	1.92
103	1-3	2-4	2.07	2.5	0-1	0-2	0.36	0.47
WOMAN								
303	x	1-3	x	1.85	x	0-3	x	0.85
305	x	1-2	x	1.5	x	0-2	x	0.75
401	1-3	x	1.55	x	0-3	x	0.25	x
407	1	x	1	x	0-1	x	0.15	x
PARTNER								
303	x	0-3	x	1.5	x	0-3	x	0.8
305	x	1-2	x	1.2	x	0-2	x	0.65
401	1	x	1	x	0-1	x	0.05	x
407	1	x	1	x	0-1	x	0.3	x
DYAD								
303	x	1-5	x	3.35	x	0-4	x	1.65
305	x	2-4	x	2.7	x	0-3	x	1.4
401	2-4	x	2.55	x	0-3	x	0.3	x
407	2	x	2	x	0-2	x	0.45	x

Table 2. Social validity survey outcome data from the 9 of 10 responding participants

Social Validity Survey Data

Question	Responses	Total Respondents	Percent
Satisfied with birth experience	9	9	100
StorkAssist helpful during labor	9	9	100
Would recommend StorkAssist to a friend	9	9	100

Table 3. Birth outcome data from the participating dyads in Study 1 compared to the

national averages as reported by the Center for Disease Control report in 2011

Birth Outcome Survey Data – Study 1

	Responses	Total Respondents (N=6)	Percent	National Averages (according to CDC report, 2011)
Unmedicated Childbirth	3	5	60	
Analgesia use overall (epidural)	2	5	40	excluded data
Analgesia use without c-section	1	4	25	61.0
C-section	1	6	16.7	32.9
Vaginal Birth	5	6	83.3	67.1

Table 4. Birth outcome data from the participating control and experimental dyads in

Study 2 compared to the national averages as reported by the Center for Disease Control

report in 2011

Birth Outcome Survey Data – Study 2

	Experimental Group Percentage (N=2)	Control Group Percentage (N=2)	National Averages (according to CDC report, 2011)
Unmedicated Childbirth	100	0	
Analgesia use overall (epidural)	0	100	excluded data
Analgesia use without c-section	0	100	61.0
C-section	0	50	32.9
Vaginal Birth	100	50	67.1

Table 5. Approximate number of hours engaged in childbirth education and/or self-study by each participating dyad

Childbirth Experience Survey Data

Participant #	# of previous births	# formal childbirth education hours
101 (active labor)	3	12
102 (active labor)	1	10
103 (active labor)	0	0
201 (early labor)	0	7
202 (early labor)	0	0
203 (early labor)	0	6
303 (experimental)	0	27
305 (experimental)	0	0
401 (control)	0	0
407 (control)	0	16
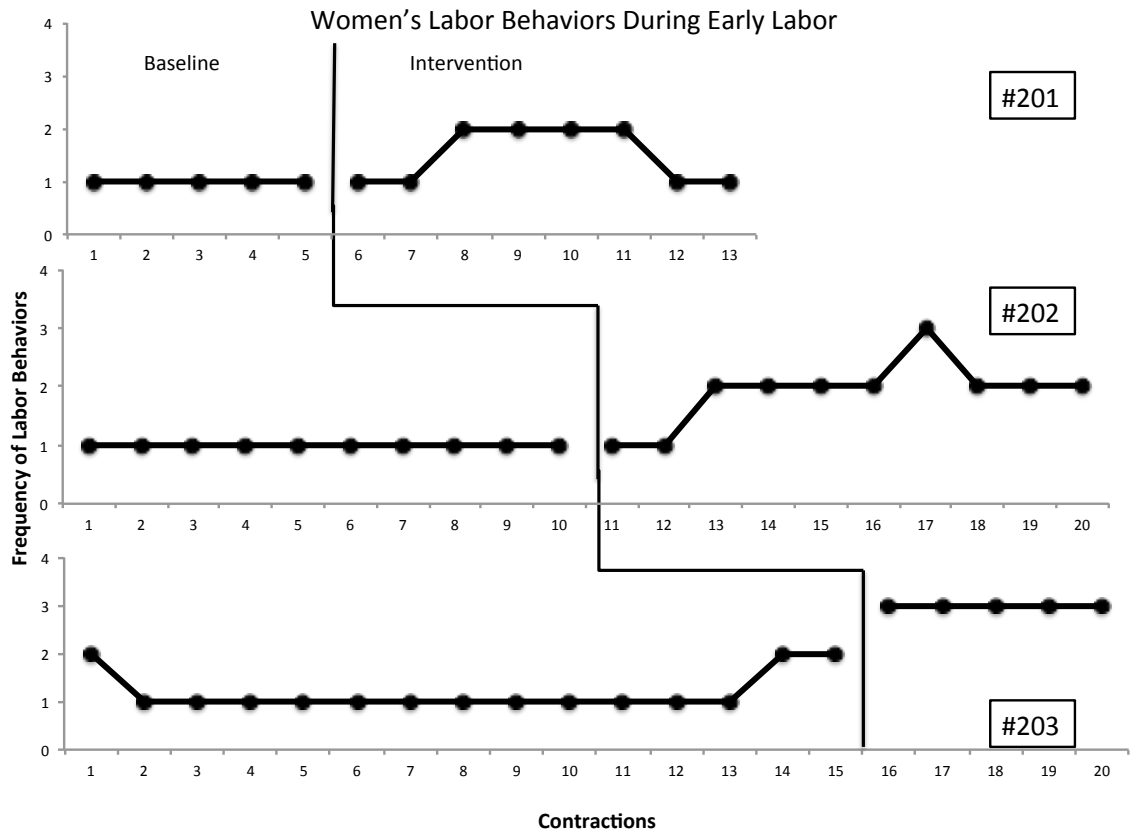
Figure 1. Frequency of labor behaviors of the laboring women in the early labor group.

Figure 2. Frequency of labor behaviors of partners in the early labor group.
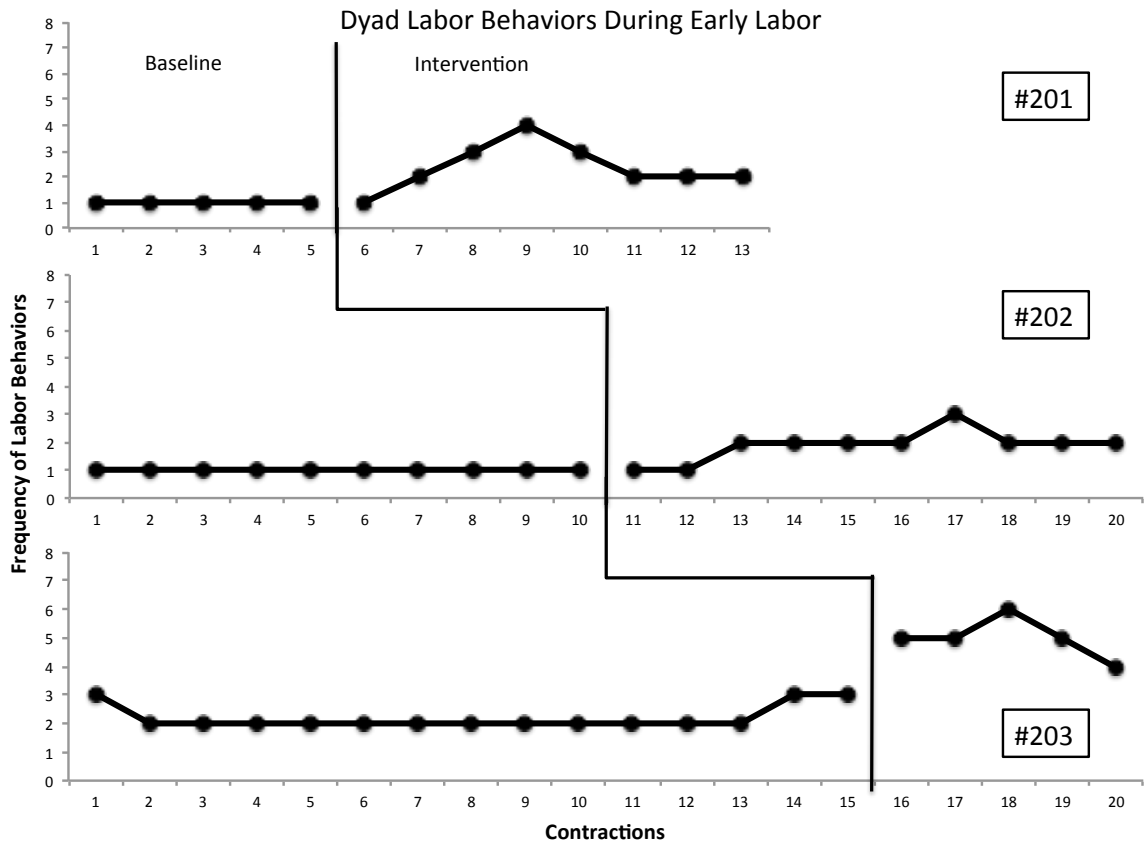
Figure 3. Combined frequency of labor behaviors of the dyads in the early labor group.
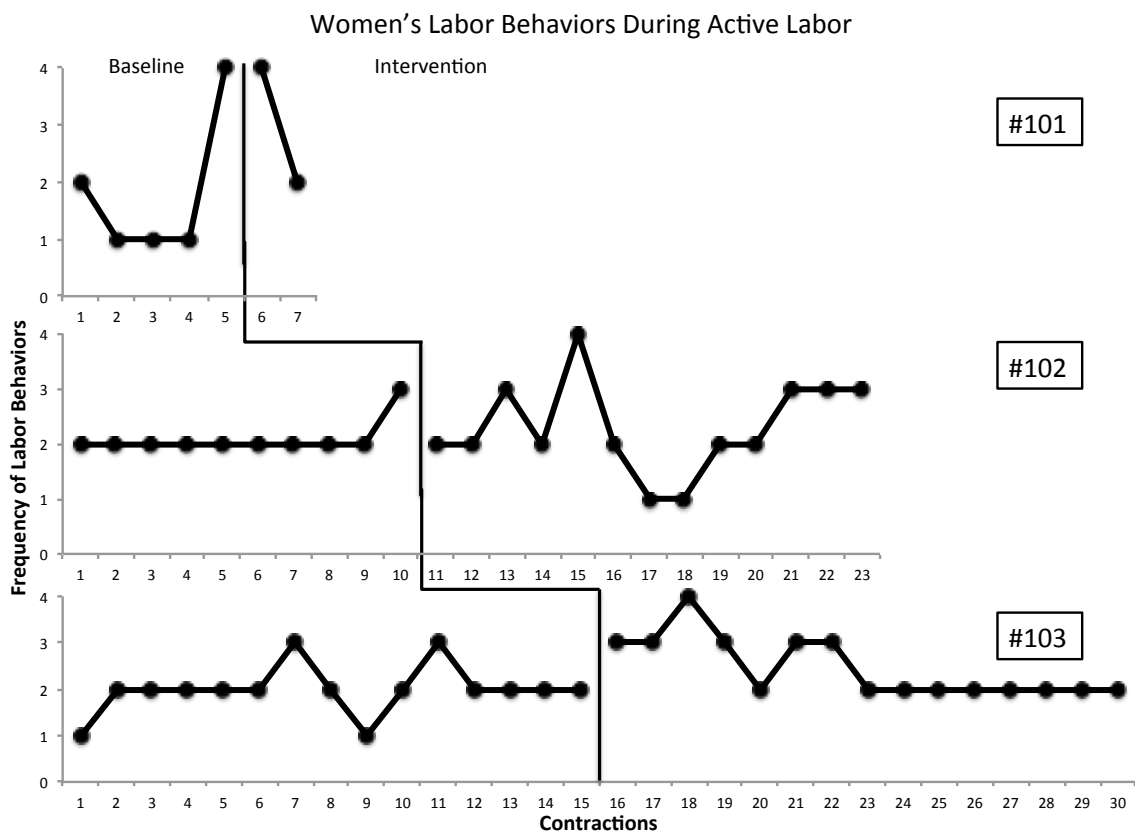
Figure 4. Frequency of labor behaviors of the laboring women in the active labor group.
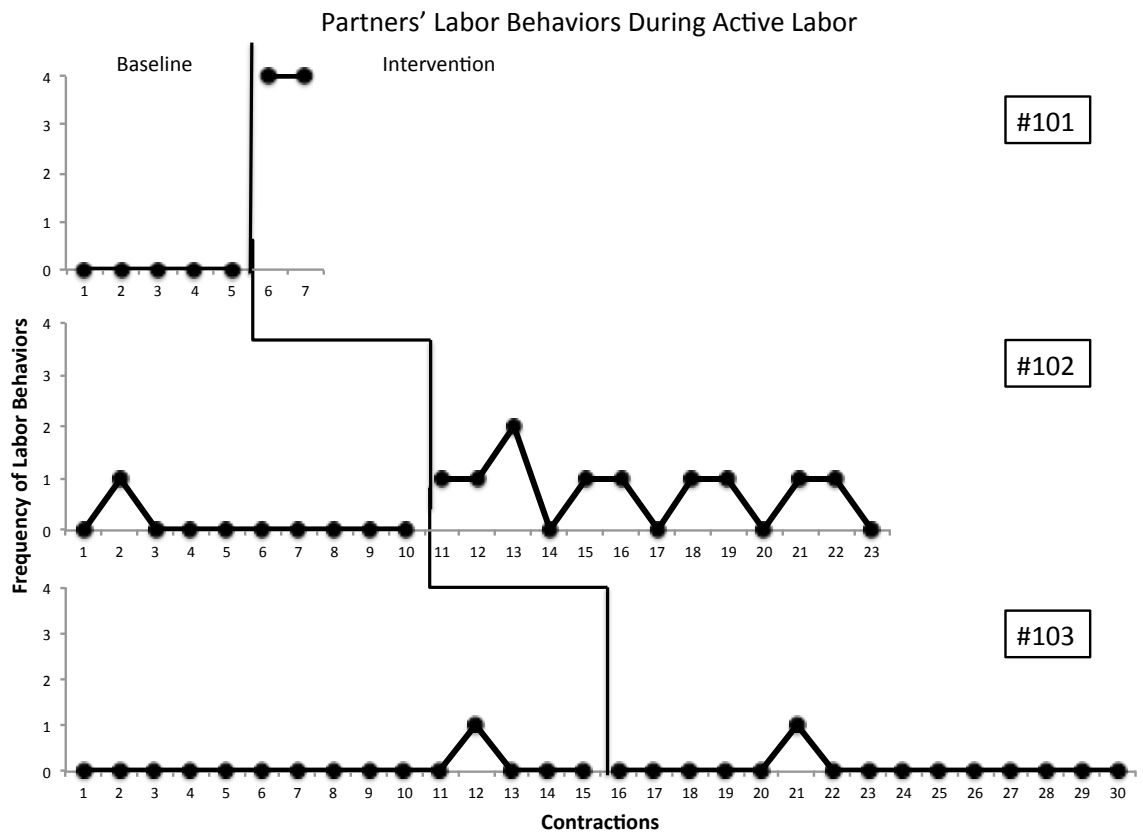
Figure 5. Frequency of labor behaviors of partners in the active labor group.
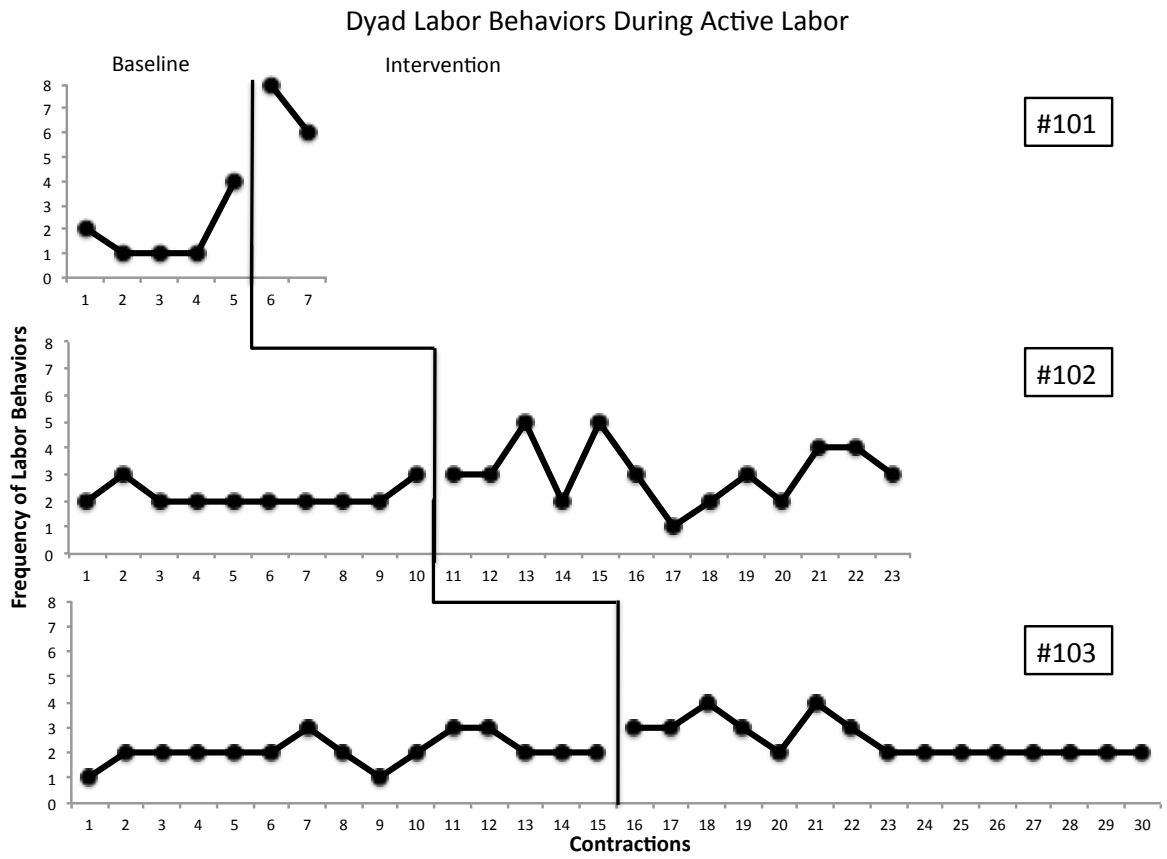
Figure 6. Combined frequency of labor behaviors of the dyads in the active labor group.
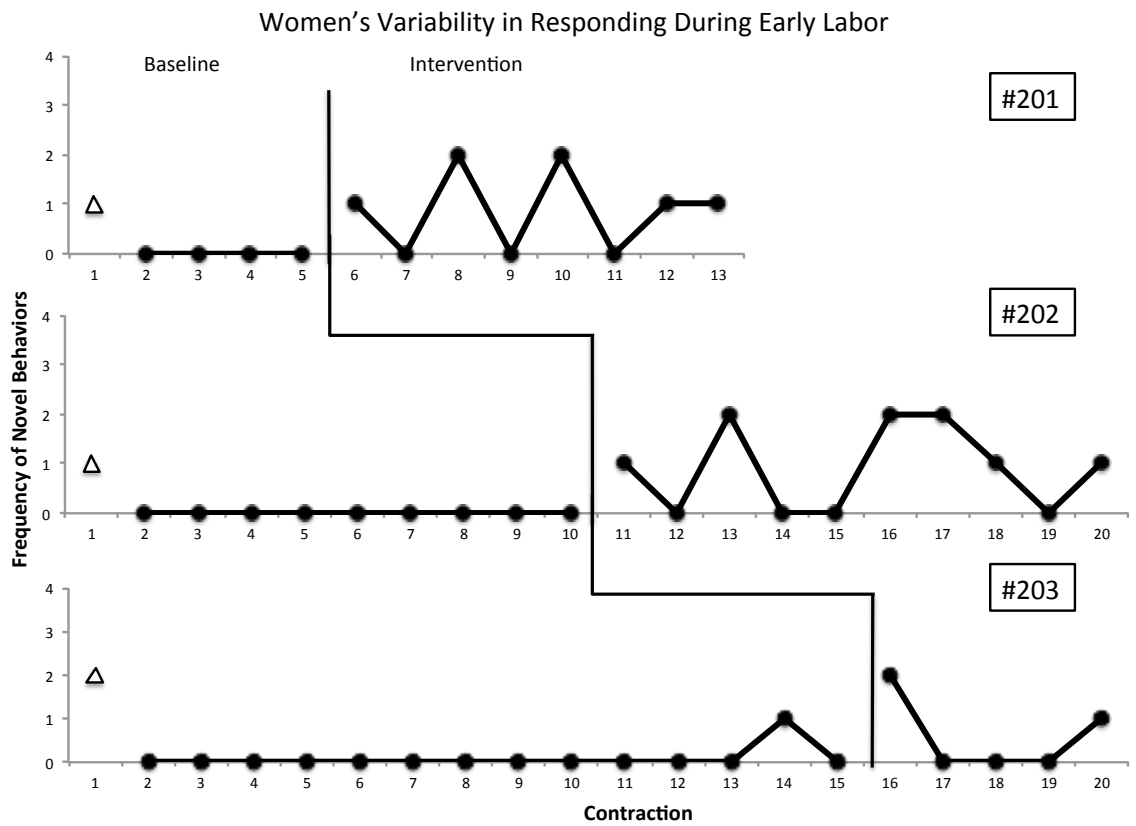
Figure 7. Variability of labor behaviors of the laboring women in the early labor group.
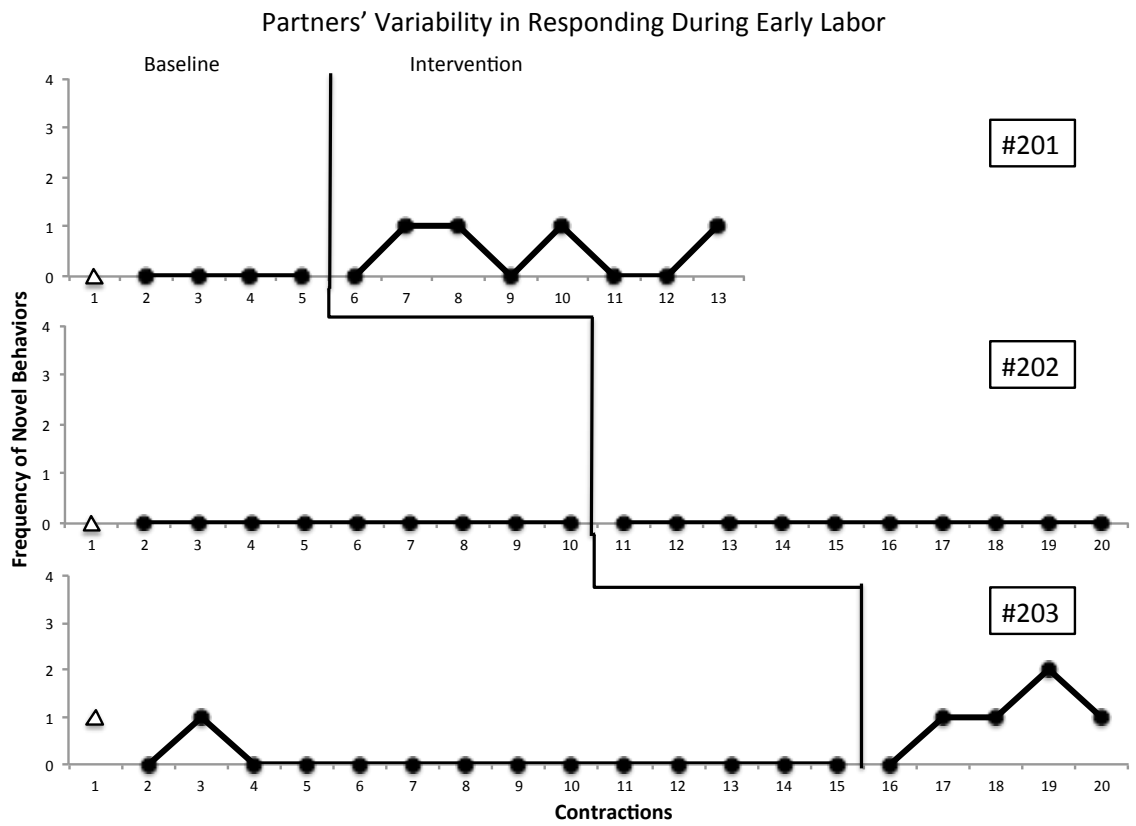
Figure 8. Variability of labor behaviors of the partners in the early labor group.
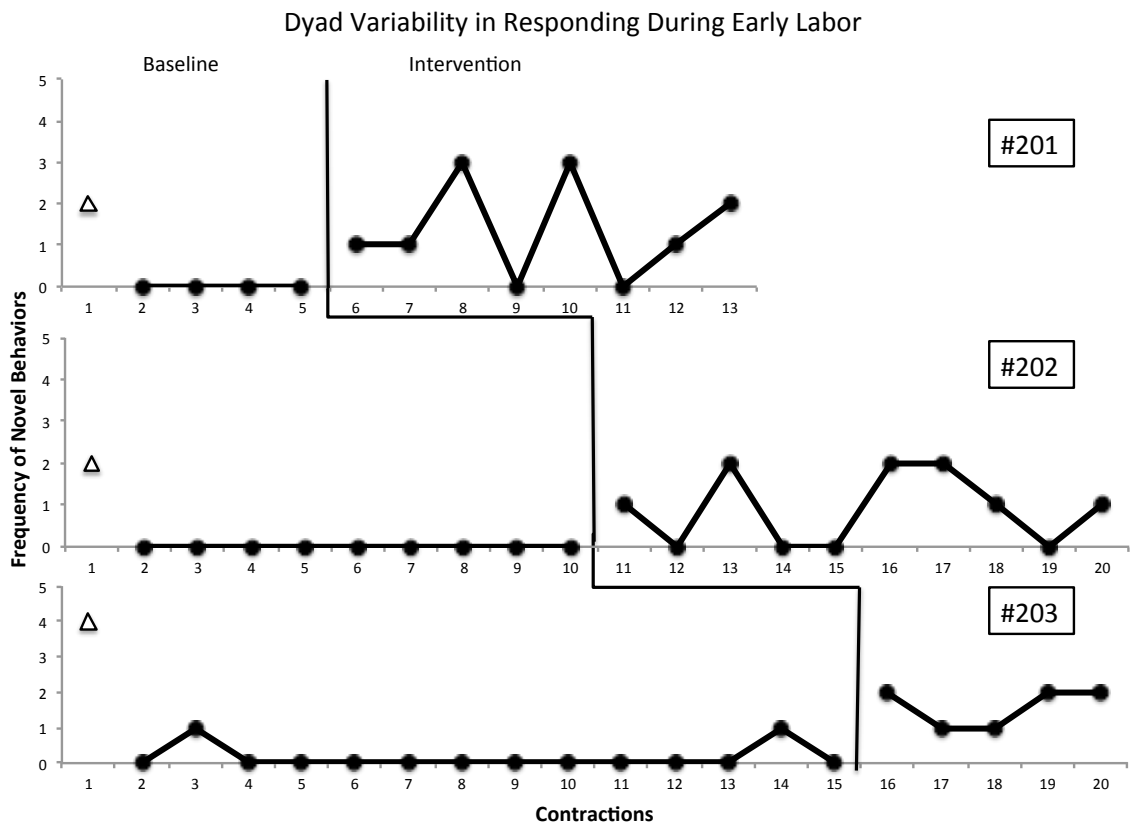
Figure 9. Combined variability of labor behaviors of the dyads in the early labor group.
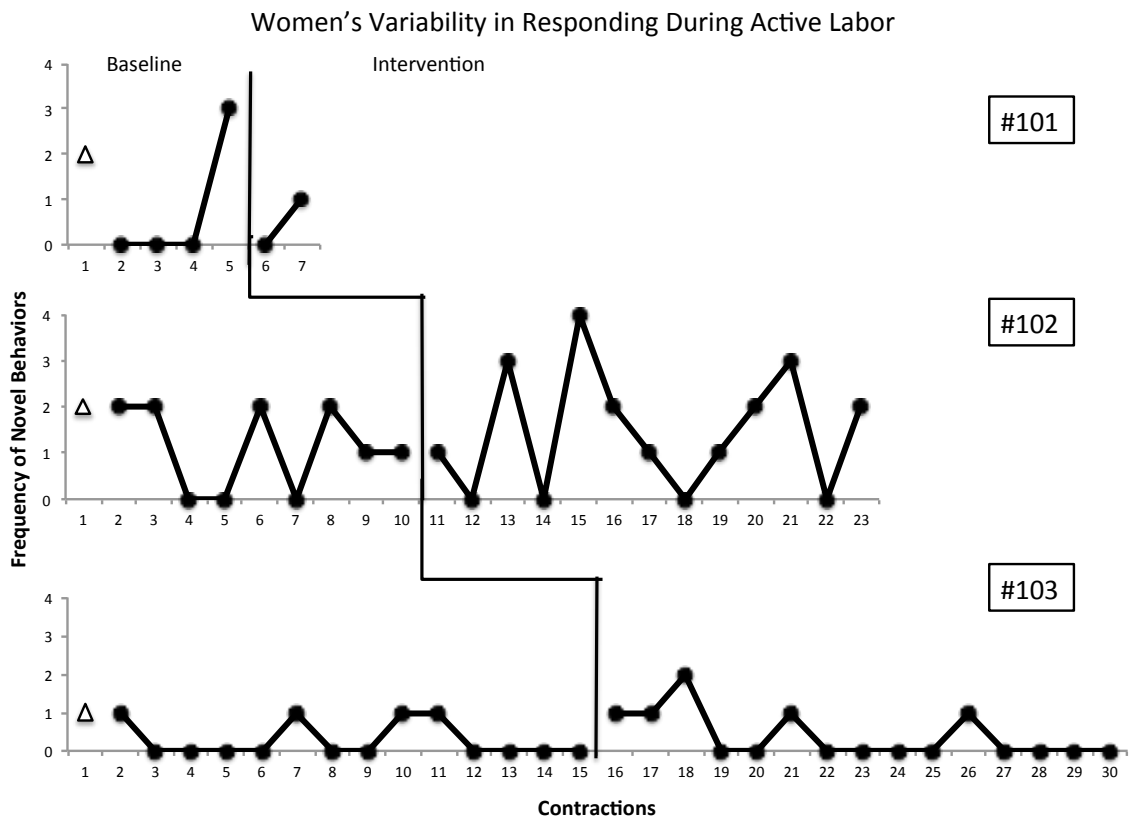
Figure 10. Variability of labor behaviors of the laboring women in the active labor group.

Partners' Variability in Responding During Active Labor
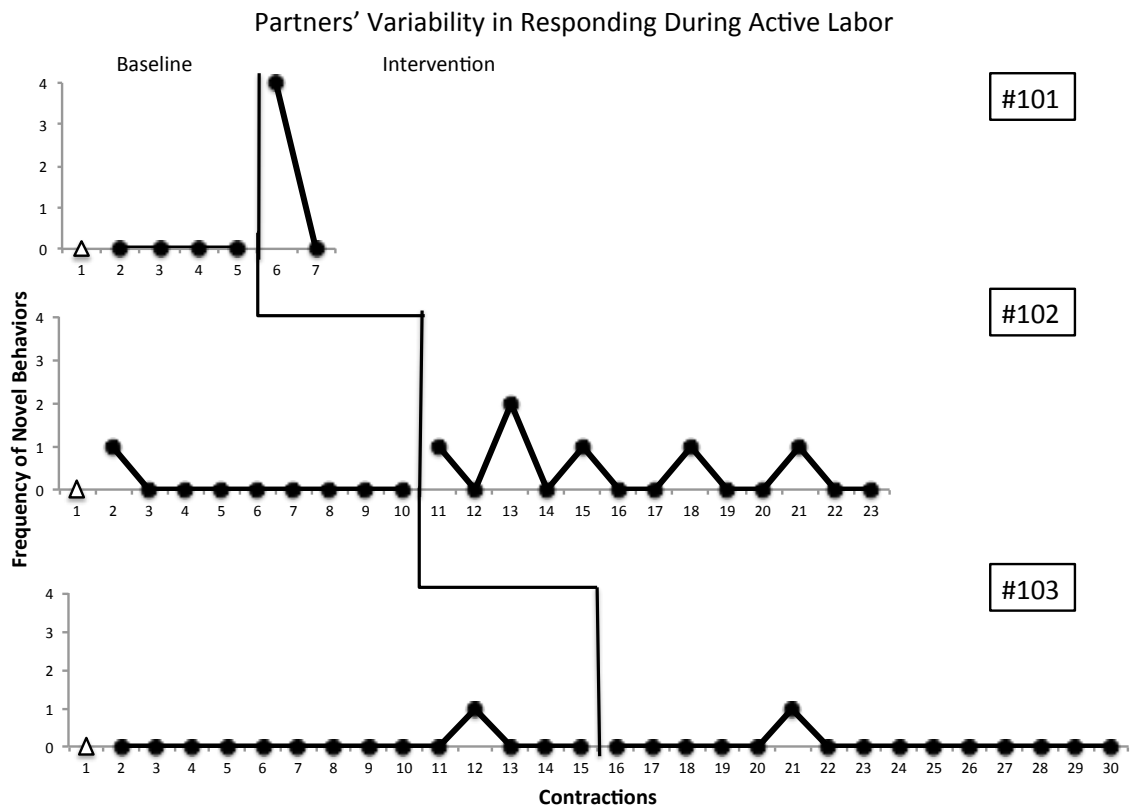
Figure 11. Variability of labor behaviors of the partners in the active labor group.
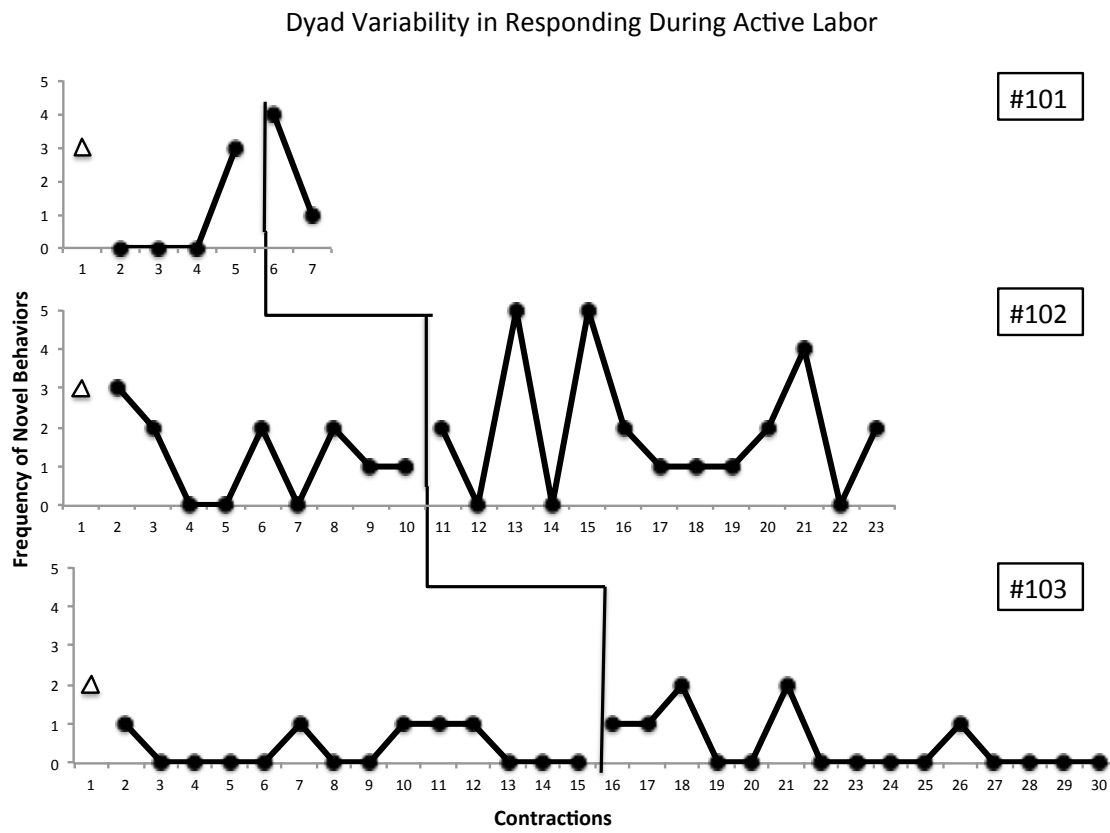
Figure 12. Combined variability of labor behaviors of the partners in the active labor

group.

Dyad #101 Precise Labor Behaviors

Figure 13. Percent of intervals with specific labor behaviors during baseline and intervention.

Dyad #102 Precise Labor Behaviors
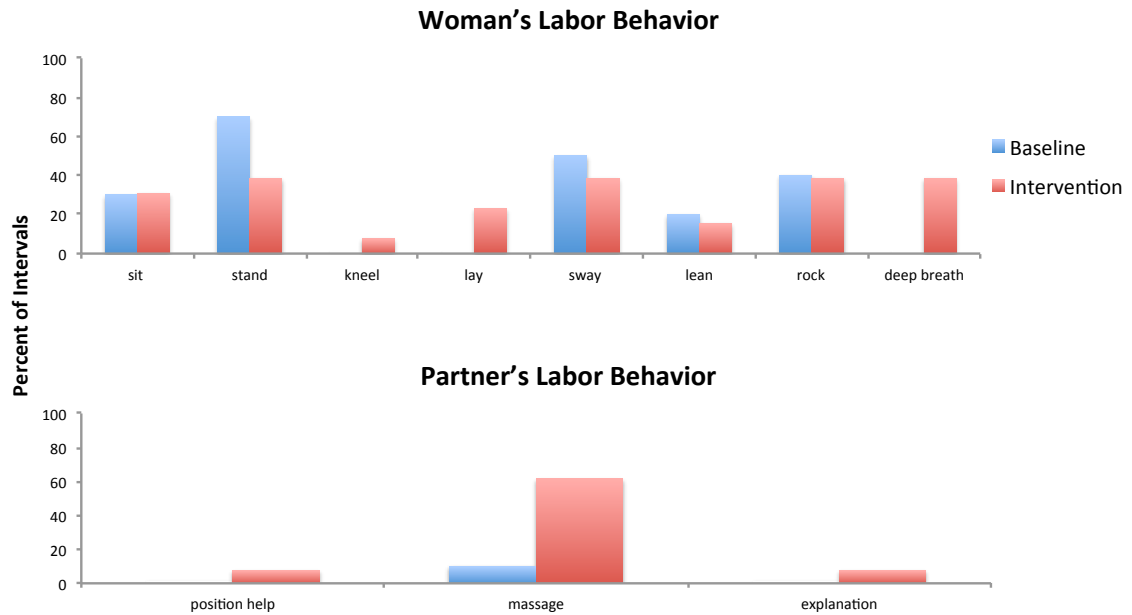
Figure 14. Percent of intervals with specific labor behaviors during baseline and intervention.

Dyad #103 Precise Labor Behaviors

Figure 15. Percent of intervals with specific labor behaviors during baseline and intervention.

Dyad #201 Precise Labor Behaviors

Figure 16. Percent of intervals with specific labor behaviors during baseline and intervention.

Dyad #202 Precise Labor Behaviors

Figure 17. Percent of intervals with specific labor behaviors during baseline and intervention.

Dyad #203 Precise Labor Behaviors

Figure 18. Percent of intervals with specific labor behaviors during baseline and intervention.

Women's Labor Behavior
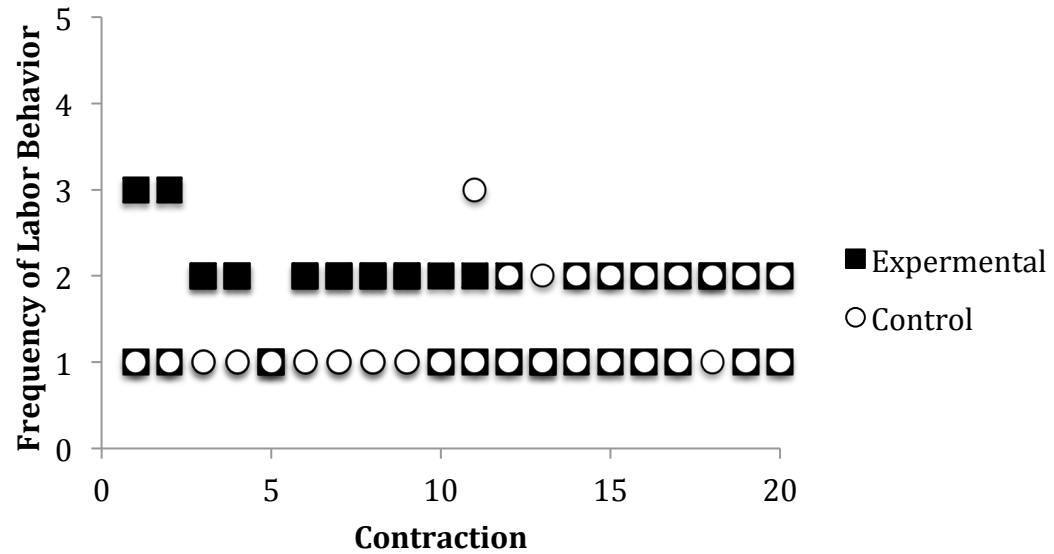
Figure 19. Frequency of labor behavior of 4 women, 2 control participants and 2 experimental participants
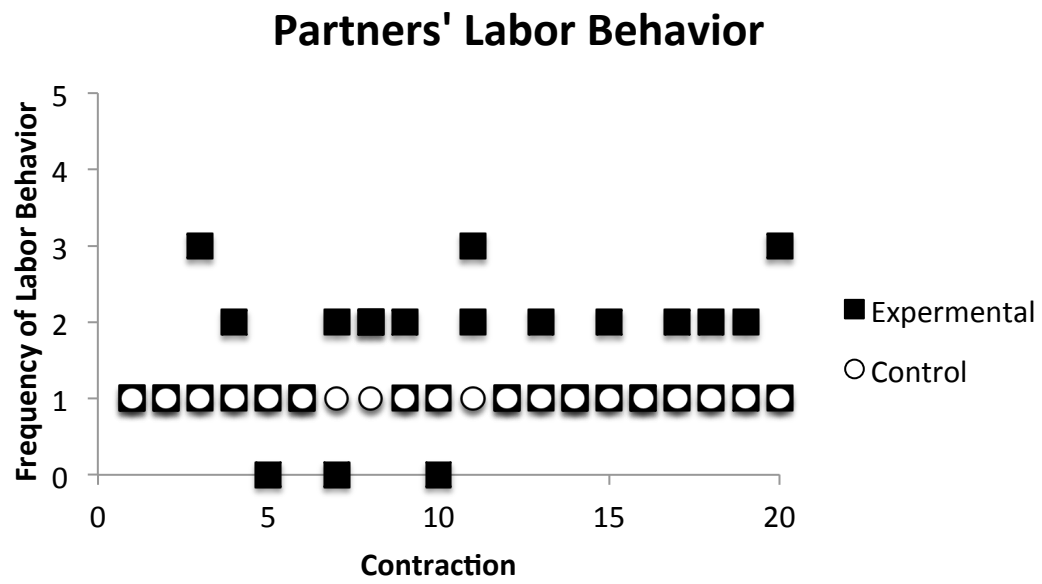
Figure 20. Frequency of labor behavior of 4 partners, 2 control participants and 2 experimental participants
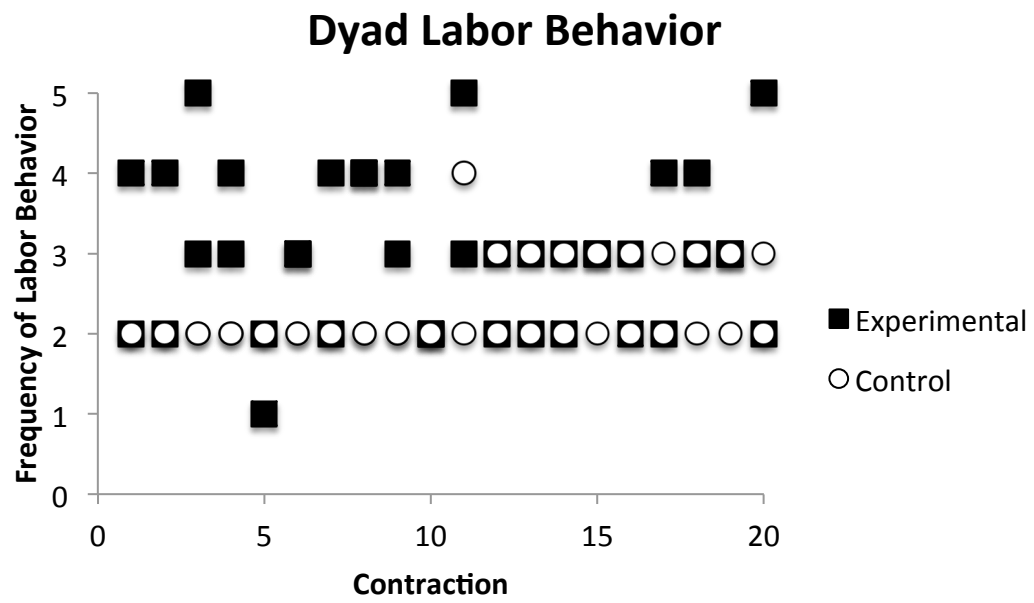
Figure 21. Frequency of labor behavior of 4 dyads, 2 control dyads and 2 experimental

dyads
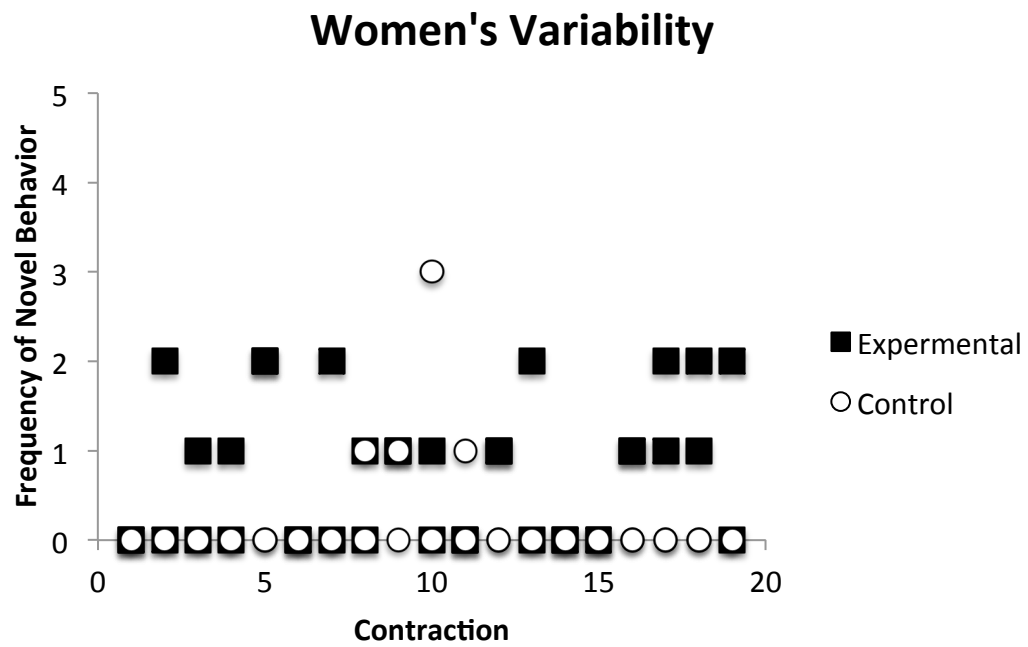
Figure 22. Frequency of novel behavior of 4 women, 2 control participants and 2

experimental participants

Partner's Variability
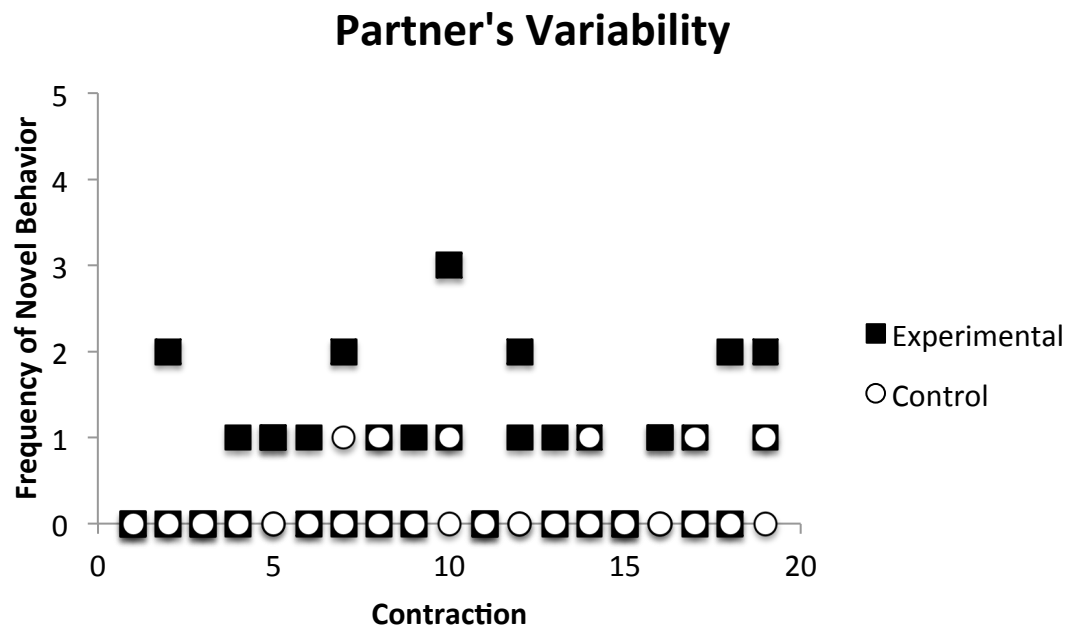
Figure 23. Frequency of novel behavior of 4 partners, 2 control participants and 2 experimental participants
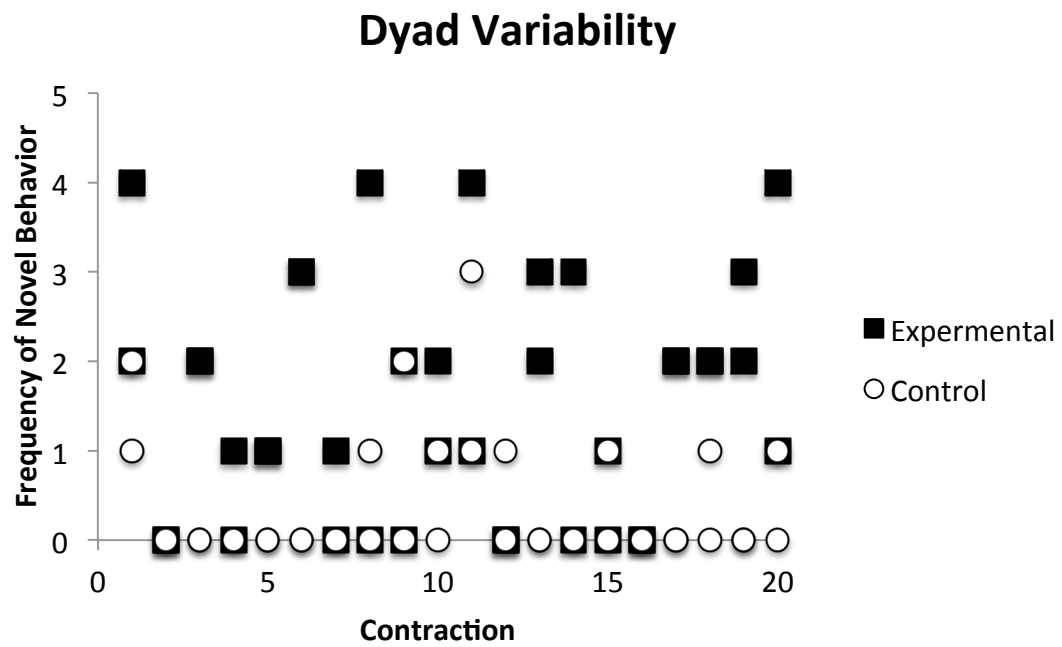
Figure 24. Frequency of novel behavior of 4 dyads, 2 control dyads and 2 experimental

dyads

Rate of Behavior – Control vs Experimental
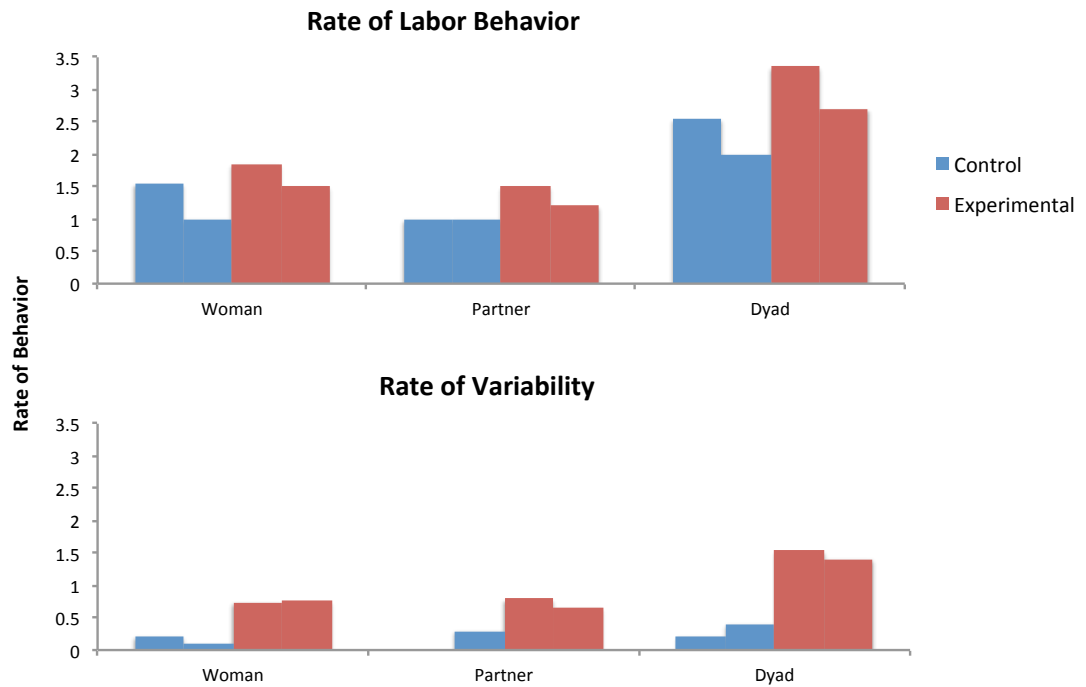
Figure 25. Rate of labor behavior and variability in the experimental and control

participants

Perceptual Rating of Pain
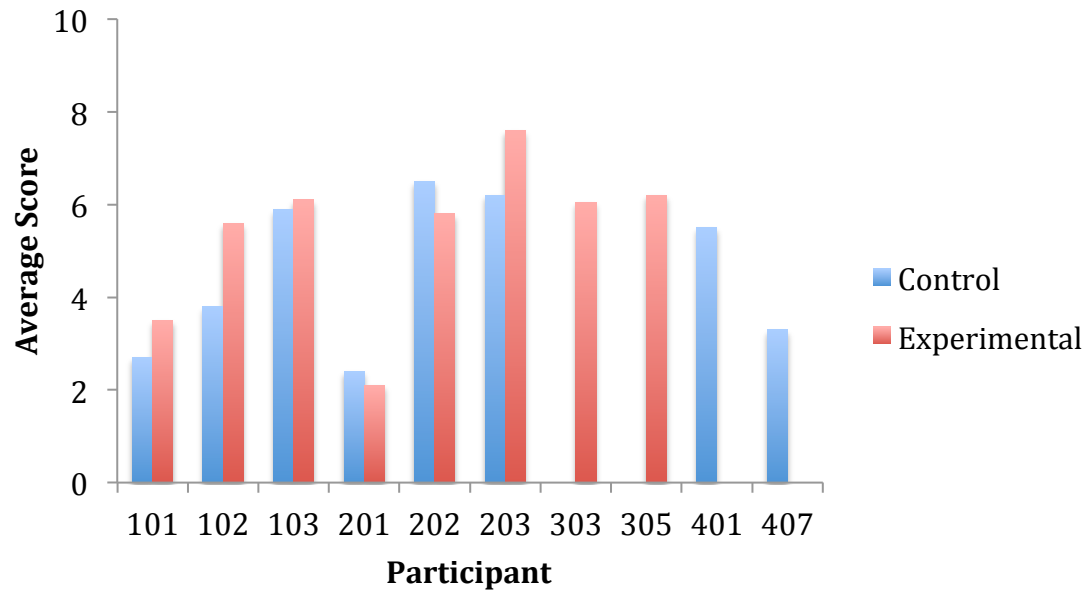
Figure 26. Women's average perception of pain ratings across experimental and control
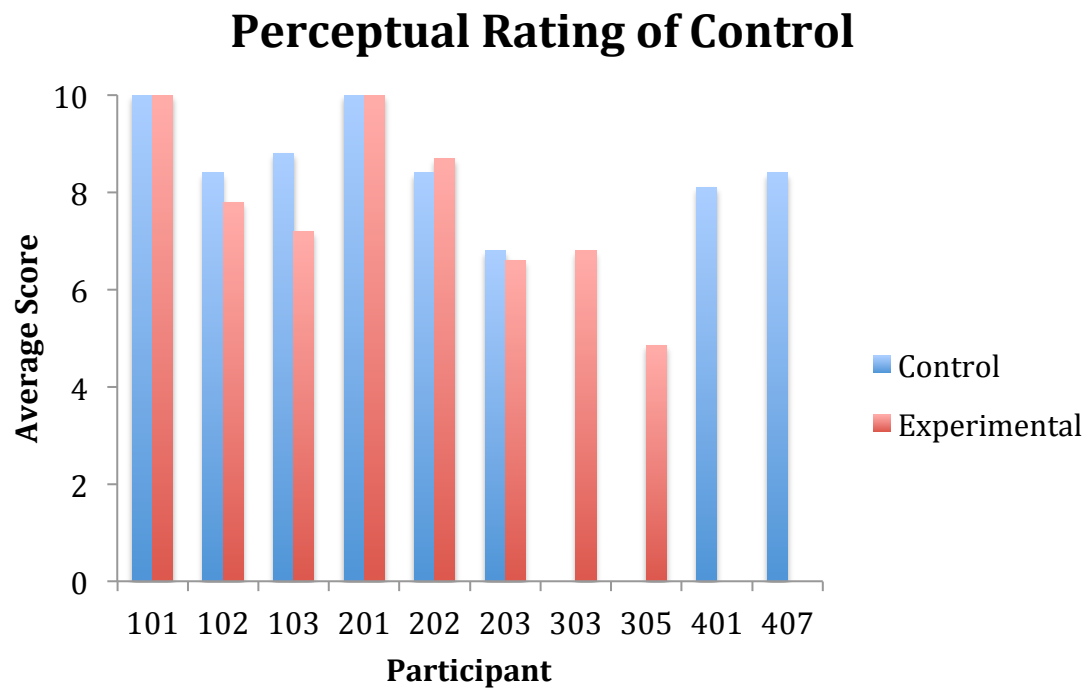
conditions

Figure 27. Women's average perception of personal control ratings across experimental

and control conditions
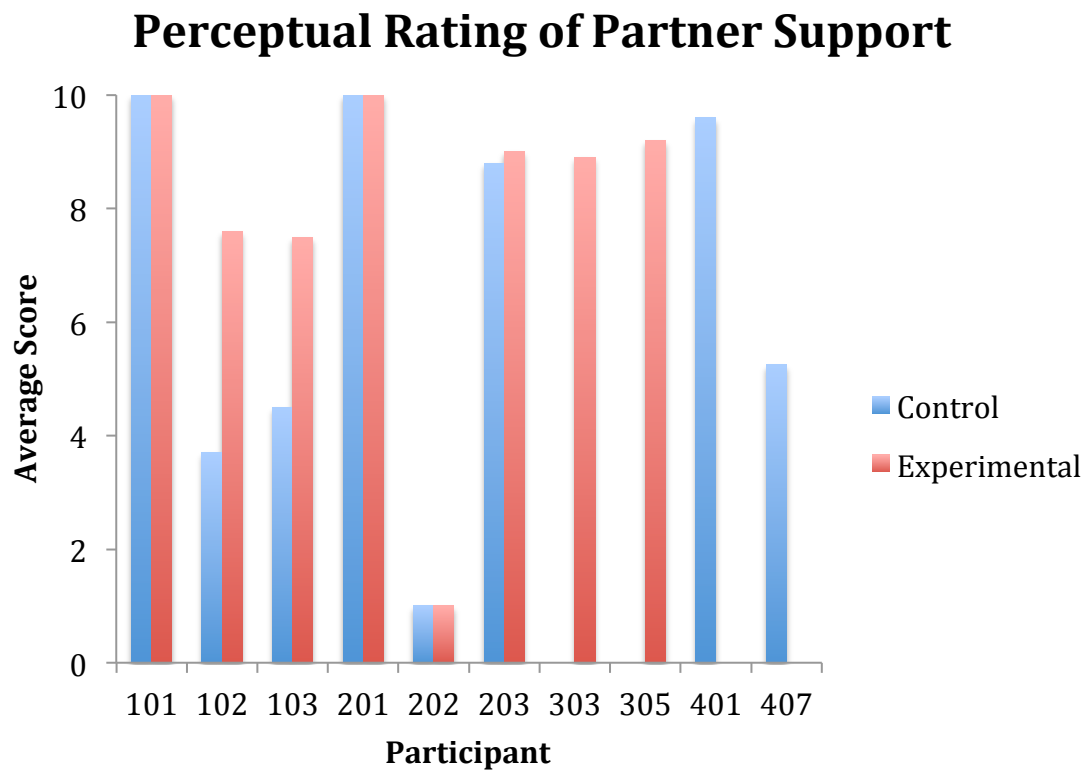
Figure 28. Women's average perception of partner support ratings across experimental and control conditions

APPENDIX A

Carrier 🛜   10:14 AM   100% 🔋

Tell me the challenge you are experiencing

Fear, stress, or panic	›
Exhaustion	›
Baby in bad position	›
Pain	›
Progressing too quickly	›
Not Progressing	›

🏠 Home   📈 Select Challenge   🕐 Contractions   ▶ Video Preview   🥧 Labor Progress   📢 Supportive Words   💬 Affirmations   ••• More

Carrier 📶   10:15 AM   100% 🔋

Challenges   What position are you in or would you like to be in?

Sit   >

Lay   >

Kneel   >

Stand   >

| Home | Select Challenge | Contractions | Video Preview | Labor Progress | Supportive Words | Affirmations | More |
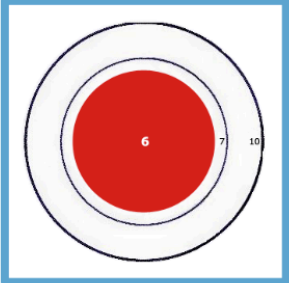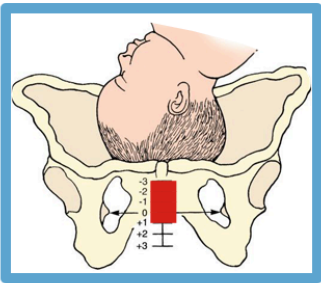
Supportive Words

Hang in there!
A note of support without a lot of pressure.

You're doing a great job.
She may not believe you even if it's true. Her experience of what is going on feels much differently than what you're seeing. Meaning she may feel out of control while she looks calm and collected.

I love you!
Need I say more?

Think of the baby...
For a mother who wants to be reminded of the baby in labor, which is easier than you think to forget about, this can be helpful. You might also use a similar phrase agreed upon in labor.

Awesome!
A nice quick word of encouragement to whisper in her ear when she's got very low concentration levels.

You will never have that contraction again.
It might be helpful to be reminded that once a contraction passes, that one is gone for good and with each contraction she is getting closer to birth.

Keep going...
A nod of approval during a long labor, as in "I know you're tired, but you're doing great, so keep going..."

I'm here for you.
You're not leaving her side, be sure she knows that.

Just a bit more...
Use this one only if you're reasonably sure that it's true. Otherwise you lose your credibility. Ask a nearby professional for some help here and know they are guessing too.

You are doing it!
This is a great thing to say if she says something like, "I can't do it." You can reply, "But you are doing it!"

Carrier 🛜   10:22 AM   100% 🔋

Affirmations

I accept my labor.

I trust my body.

My body knows how to give birth.

Birth is safe for me and my baby.

Contractions help to bring my baby.

Pain is just a sensation.

I am a strong woman.

I will make the right decisions for me and my baby.

I can do this.

My baby will find the perfect position for birth.

I accept the help of others.

I am surrounded by those who love and respect me.
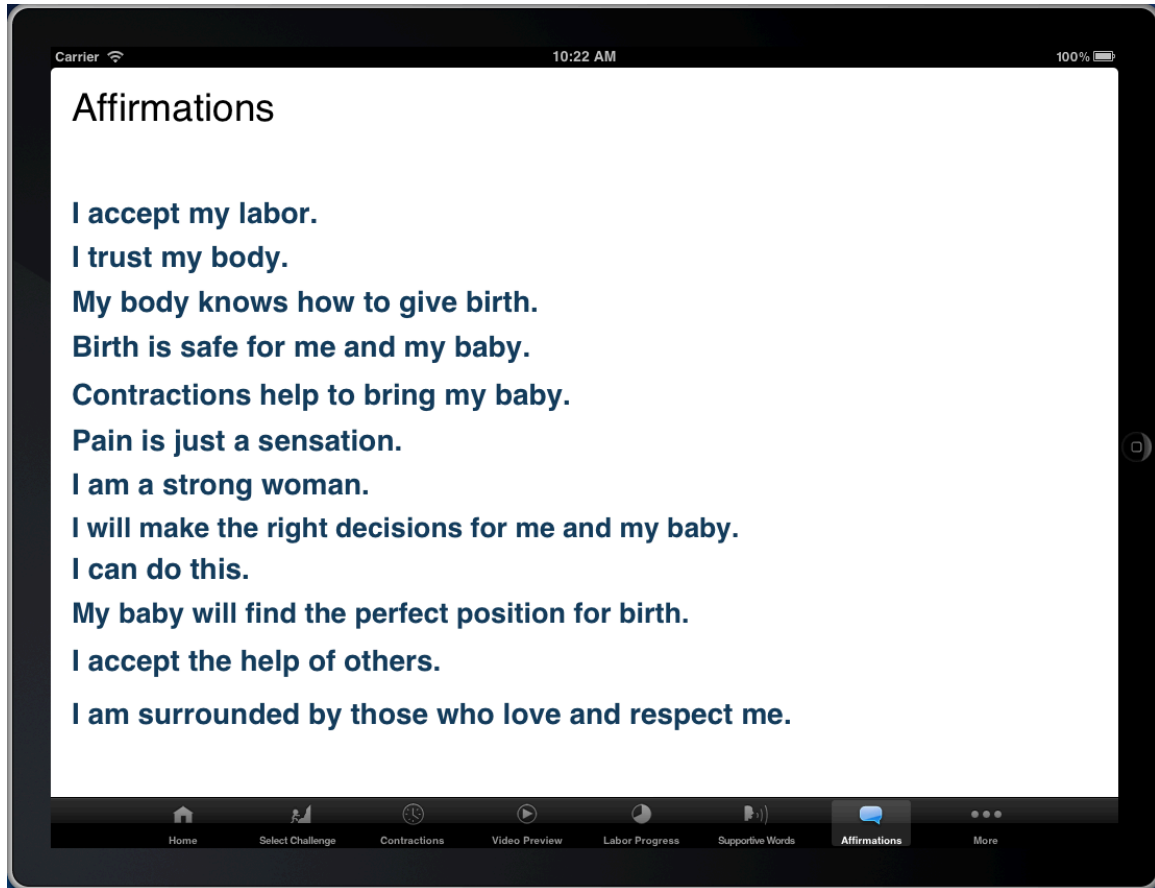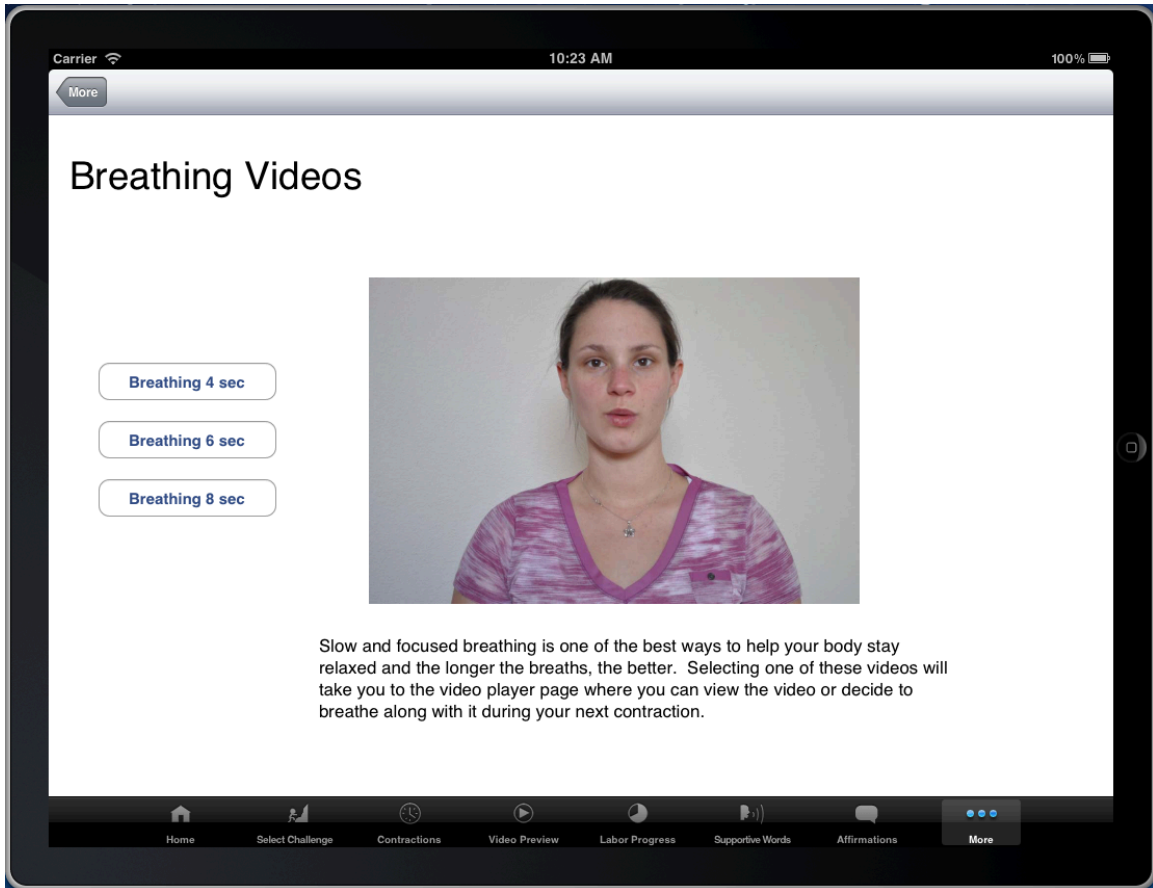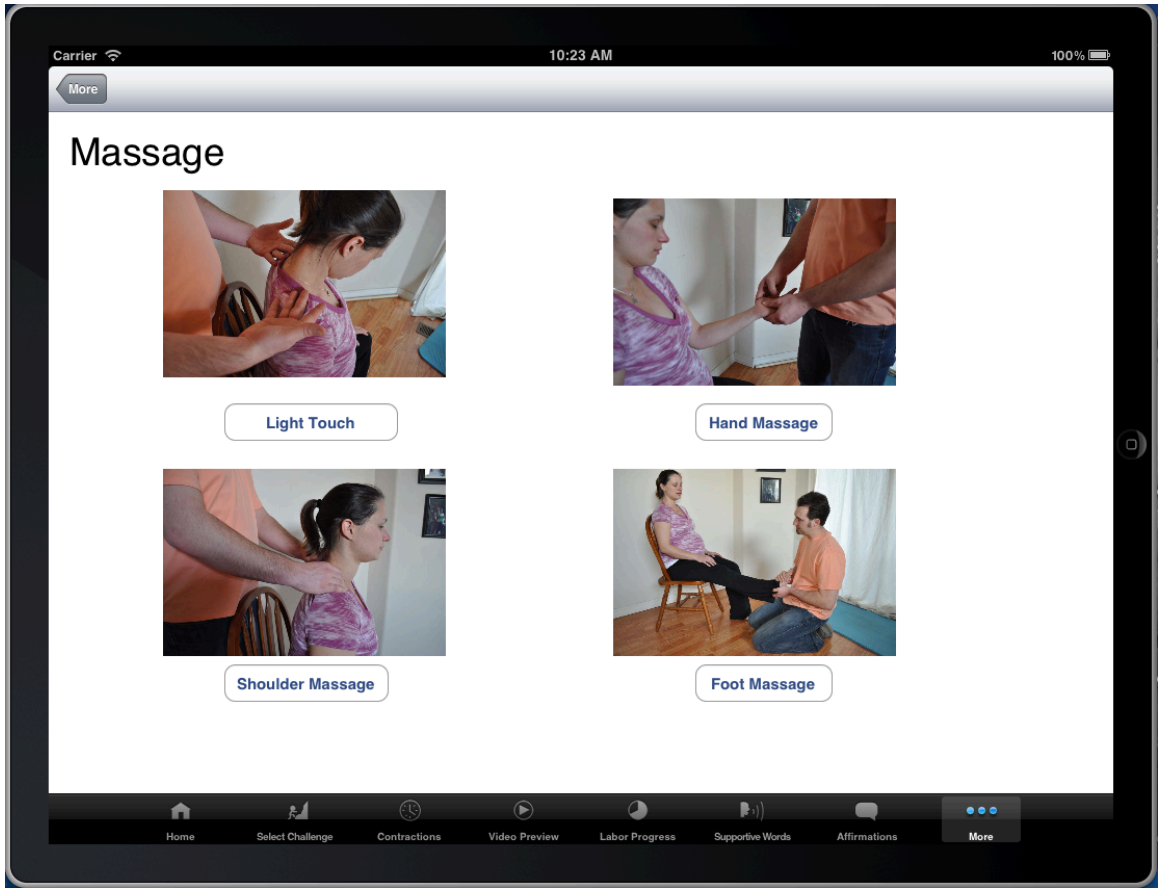
| Home | Select Challenge | Contractions | Video Preview | Labor Progress | Supportive Words | Affirmations | More |

APPENDIX B

BBB Labor Data Sheet Date:_____ Participant #:_____ Data Collector:_____																												
#	Time	Mother position						Mother movement					Mother vocals				Partner behavior						P. vocals			Questions		
		Sit	Stand	Kneel	Lay	(Semi) Squat	Water	Rhyth. Sway/walk	Lean forward	Rock (ball/chair)	Flail	None	Deep Breath (4s +)	Hum/Moan	Cry/Yell	None	C. Pressure	Hip Squeeze	Apply heat/cold	Position Help	Massage/Touch	None	Support Word	Explanation	None	Comfort	Control	Support
1																												
2																												
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APPENDIX C

Contraction #	Time (optional)	Discomfort (1-10) 1 = No Pain 10 = Worst Possible Pain	Control (1-10) 1 = Out of Control 10 = Totally in Control	Partner Support (1-10) 1 = Not at all supportive 10 = Extremely supportive
1				
2				
3				
4				
5				
6				
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APPENDIX D

1) For each birth, please complete the following information:				
Year of birth	**Medication Used** ❑ IV pain meds ❑ Epidural ❑ None	**Method of Delivery** ❑ Vaginal ❑ Vaginal assisted ❑ C-section	**Provider Type** ❑ Doctor ❑ Nurse midwife ❑ Midwife ❑ Doula	**Overall birth satisfaction** ❑ Dissatisfied ❑ Somewhat satisfied ❑ Satisfied ❑ Extremely satisfied
Year of birth	**Medication Used** ❑ IV pain meds ❑ Epidural ❑ None	**Method of Delivery** ❑ Vaginal ❑ Vaginal assisted ❑ C-section	**Provider Type** ❑ Doctor ❑ Nurse midwife ❑ Midwife ❑ Doula	**Overall birth satisfaction** ❑ Dissatisfied ❑ Somewhat satisfied ❑ Satisfied ❑ Extremely satisfied
Year of birth	**Medication Used** ❑ IV pain meds ❑ Epidural ❑ None	**Method of Delivery** ❑ Vaginal ❑ Vaginal assisted ❑ C-section	**Provider Type** ❑ Doctor ❑ Nurse midwife ❑ Midwife ❑ Doula	**Overall birth satisfaction** ❑ Dissatisfied ❑ Somewhat satisfied ❑ Satisfied ❑ Extremely satisfied

2) What type of childbirth education have you taken? Write the approximate total number of hours spent engaged in each activity, if applicable.

Hospital class	Prenatal centering	Bradley method	Hypnobirth	Lamaze	Other	Self-educated	None

3) Do/did you and your partner feel adequately prepared for your labor and delivery? Please explain.

4) What, if anything, would have helped you feel more prepared?

APPENDIX E

1) Please complete the following information regarding your labor and delivery:			
Medication Used ❑ IV pain meds ❑ Epidural ❑ None	**Method of Delivery** ❑ Vaginal ❑ Vaginal assisted ❑ C-section	**Provider Type** ❑ Doctor ❑ Nurse midwife ❑ Midwife ❑ Doula	**Overall birth satisfaction** ❑ Dissatisfied ❑ Somewhat satisfied ❑ Satisfied ❑ Extremely satisfied

2) Did you find the Stork Assist program helpful during your labor?	
❑ Yes	❑ No

3) Did you birth partner(s) find the Stork Assist program helpful during your labor?	
❑ Yes	❑ No

4) If you were to have another birth, would you use Stork Assist again?	
❑ Yes	❑ No

5) Would you recommend Stork Assist to a friend?	
❑ Yes	❑ No

6) What feature of Stork Assist did you find most helpful? Why?

7) What feature of Stork Assist did you find least helpful? Why?

8) What suggestions do you have to make Stork Assist beneficial for other women giving birth?

9) Please provide any other thoughts or comments here about your experience with Stork Assist.