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In Pain Thou Shalt Bring Forth Children: The Peak-and-End Rule in Recall of Labor Pain

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Abstract

Childbirth is usually the most painful event of a mother's life, and resonates in individual and collective memory for years. The current study examined the relationship between the experience of labor pain and its recollection 2 days and 2 months after delivery. We found that despite the exceptional physical and emotional experiences of childbirth, the memory of the pain involved in labor was biased toward the average of the peak pain and the end pain, whereas the duration of the delivery had a relatively negligible effect on the recollected intensity of pain. A comparison of mothers whose labor ended with or without epidural analgesia corroborated previous findings that the level of pain toward the end of an experience greatly influences the way the overall experience is remembered. Although both short- and long-term retention of memories of labor exhibited the peak-and-end effect, having given birth before weakened the effect 2 months after delivery.

Keywords

memory, judgment, pain

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Life experiences and memories of them largely define who we are and what we do. Among these experiences and memories, those of childbirth and labor pains may very well be the most remarkable of all. In addition to having collective value, the experience of childbirth becomes a precious memory that mothers cherish and share with other people. Childbirth is both physically and emotionally intense, and for many women, it is the most painful life event. Like other experiences, childbirth has a place in two temporal domains: in real time as the actual experience unfolds and in memory that resonates long after the experience itself ends. In the study reported here, we explored whether the recalled level of the pain of childbirth reflects the actual experienced pain.

Research conducted following the seminal work of Kahneman and his colleagues (Fredrickson & Kahneman, 1993; Redelmeier & Kahneman, 1996) has shown that people do not remember all parts of events equally (Ariely, 1998; Ariely, Kahneman, & Loewenstein, 2000; Ariely & Loewenstein, 2000; Fredrickson, 2000; Fredrickson & Kahneman, 1993; Redelmeier & Kahneman, 1996; Redelmeier, Katz, & Kahneman, 2003). Instead, they form an overall memory of an event on the basis of the most intense state (peak) and the final state (end); duration plays only a minor role (Kahneman, 2011), a phenomenon known as duration neglect.

Although duration neglect has been replicated in many studies, most studied experiences have been relatively short and have involved only discomfort or moderate pain.[1] Ariely and Carmon (2003) noted that it is not completely clear whether duration neglect also characterizes experiences that involve a mix of pleasant and unpleasant feelings. Therefore, we decided to investigate memory for childbirth, which involves relatively long acute pain, mixed emotions (reviewed in Lowe, 2002),

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Table 1. Descriptive Statistics and Confidence Intervals for the Indices of Actual Pain and Recollected Pain

Measure	Mean	*SD*	*SEM*	95% confidence interval
Actual pain				
Peak	89.16	14.86	0.87	[87.38, 90.87]
End	54.23	40.32	2.25	[50.01, 58.99]
Overall average	37.61	24.49	1.33	[35.05, 40.34]
Peak-and-end average	71.70	23.85	1.34	[69.05, 74.46]
Recollected pain				
Two days later	72.72	23.41	1.35	[69.95, 75.39]
Two months later	68.86	24.55	1.35	[66.29, 71.67]

and a life-changing outcome. Many attempts have been made to understand how mothers recall labor pain. Some studies have focused on labor pains during labor (Algom & Lubel, 1994; Lowe & Roberts, 1988; Norvell, Gaston-Johansson, & Fridh, 1987) or just after childbirth (Bennett, 1985; Cogan, Perkowski, & Anderson, 1988; J. O. Robinson et al., 1980; Rofé & Algom, 1985). However, given the methodological differences among these studies, the ways in which labor pains are experienced and remembered remain somewhat unclear (for a review, see Niven & Murphy-Black, 2000; Waldenström & Schytt, 2009).

The accessibility model (M. D. Robinson & Clore, 2002a, 2002b) suggests that immediate reports of emotion should primarily reflect experiential knowledge (episodic information) and therefore be biased toward peak and end states. In contrast, reports provided after a long time might be reconstructed and influenced by previous knowledge, beliefs, and other individual differences (Kemp, Burt, & Furneaux, 2008; M. D. Robinson & Barrett, 2010). According to Geng, Chen, Lam, and Zheng (2013), the watershed between short and long retention intervals (i.e., between memory reflecting experiential knowledge and more reconstructed memory) should be found between 3 and 7 weeks after an experience.

Following Kahneman and his colleagues (Kahneman, Fredrickson, Schreiber, & Redelmeier, 1993; Redelmeier & Kahneman, 1996), we directly contrasted the pain experienced during labor with its remembered intensity, to look for evidence of the peak-and-end rule and duration neglect in mothers' memories 2 days and 2 months after giving birth. Our sample included both first-time mothers (primipara) and women who had given birth before (multipara). The two groups differ in their previous knowledge regarding childbirth and labor pain, as well as in many other factors, including whether they have experienced the overwhelming feeling associated with becoming a mother. A comparison of these groups offers an ecologically valid means by which to test predictions of the accessibility model.

Method

Participants

Our data were collected at the delivery department at Rabin Medical Center in Israel.[2] Data collection was discontinued whenever the decision was made to perform a cesarean section. Thus, our final sample consisted of 320 women (average age = 30.4, *SD* = 4.5) who gave birth vaginally.

Procedure

Ethical approval was obtained from the Rabin Medical Center's institutional review board. As soon as each woman and her spouse entered the delivery department, a research assistant approached them and asked if they were willing to participate in the study. All participants signed a written informed-consent form that described the nature and purpose of the research. Every assenting woman was accompanied into the delivery room by the research assistant, who asked the woman to indicate her degree of pain every 20 min until the child was born. Ratings were provided on a numeric rating scale that ranged from 0 (*no pain*) to 100 (*the worst pain imaginable*). Two days and again 2 months after the delivery, the research assistant called the new mother and asked her to use the same scale to provide an overall evaluation of the pain during the entire experience from the moment that she entered the delivery room up until the birth itself.

Results

On average, births lasted 6 hr and 37 min (*SD* = 3 hr and 44 min). To test for evidence of the peak-and-end rule, we employed two complementary analyses. First, we compared ratings at different time points. Second, we examined how well the average of the peak and end ratings predicted the ratings 2 days and 2 months after delivery. Table 1 summarizes the ratings of peak pain and

Table 2. Correlations of Ratings of Actual Pain and Delivery Duration With Recollected Pain

Measure	Recollected pain 2 days after delivery	Recollected pain 2 months after delivery
Peak pain	.537*	.523*
End pain	.498*	.410*
Overall average pain	.469*	.366*
Average of peak and end pain	.588*	.509*
Delivery duration	−.008	.012

*$p < .001$.

end pain, the average of these ratings, the overall average of reported pain at all time points excluding the peak and the end points, and the ratings of recalled pain 2 days and 2 months after delivery. To detect similarities and differences among these indices, we used a bootstrap approach that defined a 95% confidence interval (CI) for each index. As the table shows, the CIs for recollections of pain 2 days and 2 months after delivery almost completely overlapped the CI for the average of peak and end ratings. The CIs for all other indices fell outside the CIs for recollected pain.

Next, we examined the advantage of the peak-and-end average as a predictor of pain recollection. Table 2 presents the correlations of recollected pain with peak rating, end rating, peak-and-end average rating, overall average rating, and delivery duration. Except for delivery duration, all indices correlated with later recollections of pain. To test whether the correlations of recollected pain with the average of peak and end ratings differed significantly from the other correlations, we used Fisher's *r*-to-*z* transformation and followed Steiger's (1980) method of comparing correlated correlations. The analyses revealed that the correlation between the peak-and-end average and the 2-days-later ratings was higher than the correlation between the end ratings and the 2-days-later ratings ($z = 6.681$, $p < .001$). Similarly, the correlation between the peak-and-end average and the 2-days-later ratings was higher than the correlation between the overall average and the 2-days-later ratings ($z = 2.704$, $p < .01$). The correlation between the peak-and-end average and the 2-days-later ratings did not differ significantly from the correlation between the peak ratings and the 2-days-later ratings ($z = 1.312$, $p = .19$). The 2-months-later ratings had higher correlations with the peak ratings and with the peak-and-end average than with the end ratings ($z = 2.112$, $p < .05$, and $z = 6.907$, $p < .001$, respectively) or with the overall average ratings ($z = 3.004$, $p < .005$, and $z = 3.011$, $p < .005$, respectively). The correlation between the peak ratings and 2-months-later ratings did not differ from the correlation between the peak-and-end average and 2-months-later ratings ($z = 0.343$, n.s.).

Next, we examined the peak-and-end bias using stepwise regressions in which the pain ratings provided 2 days and 2 months after delivery were predicted by the peak ratings, the end ratings, the overall average ratings, and delivery duration (see Table 3). These analyses revealed that the peak ratings and the end ratings were the best predictors of ratings provided 2 days later. Together, they accounted for 39.6% of the variance. Adding the overall average ratings to the model accounted for only an additional 2.6% of the variance. The peak ratings and the end ratings accounted for 33.1% of the variance in ratings provided 2 months after delivery, and the overall average ratings accounted for no significant additional variance. Delivery duration contributed nothing to the prediction of recalled pain on either occasion.

In modern medicine, the availability of analgesia has increased substantially. In this study, 79.7% of births involved an epidural procedure (and 4.4% involved administration of pethidine). Epidural analgesia clearly divides the childbirth experience into two phases (pre- and postepidural), which differ significantly in the severity of pain. To investigate the possibility that women recalled the duration of the preepidural phase but neglected the duration of the postepidural phase, we attempted to predict ratings of recollected pain using the duration of the preepidural phase alone. Results indicated that duration of the preepidural phase accounted for no variance in recollected pain (2-days-later ratings: $R^2 = .008$; 2-months-later ratings: $R^2 = .013$).

Duration neglect implies that pain assessment would be similar in women who gave birth relatively quickly and did not receive an epidural and in women who had a prolonged labor and received an epidural (i.e., both groups experience a period of intense pain, and the milder pain subsequently experienced by the latter group would not have a large effect on pain ratings because of duration neglect). However, the peak-and-end effect implies that women whose end experience was not modulated by analgesia would recall more pain than would women who received an epidural. We therefore compared the recollected pain of women who experienced a given duration of pain and then delivered a baby without analgesia with the recollected pain of women who experienced the same duration of pain before receiving an epidural. For this analysis, we matched mothers who gave birth without analgesia to mothers with similar labor duration prior to administration of an epidural (maximum difference of 10 min). In addition, within each pair, the average pain reported by the mother who received no analgesia matched the average pain reported by the mother who received analgesia up to the point at which the epidural was administered (maximum difference of 5 points). Using

Table 3. Results of Stepwise Regressions: Predicting Pain Ratings 2 Days and 2 Months After Delivery

Step and predictor	β
Recollected pain 2 days after delivery	
Step 1 (R^2 = .289, adjusted R^2 = .286, ΔR^2 = .289*)	
Peak pain	0.54*
Step 2 (R^2 = .396, adjusted R^2 = .392, ΔR^2 = .096*)	
Peak pain	0.41*
End pain	0.35*
Step 3 (R^2 = .422, adjusted R^2 = .416, ΔR^2 = .026*)	
Peak pain	0.36*
End pain	0.28*
Overall average pain	0.19*
Recollected pain 2 months after delivery	
Step 1 (R^2 = .274, adjusted R^2 = .272, ΔR^2 = .274*)	
Peak pain	0.52*
Step 2 (R^2 = .331, adjusted R^2 = .326, ΔR^2 = .057*)	
Peak pain	0.43*
End pain	0.26*

Note: Only predictors with significant coefficients are listed in this table.
*p < .001.

these two criteria for matching, we identified 38 pairs of women with similar amounts of pain in the matched period of labor duration (M = 72.04, SD = 24.60, for the epidural group before the epidural and M = 73.39, SD = 23.29, for the nonepidural group until delivery). However, it is important to note that for the nonepidural group, the pain ended after an average of 2 hr and 59 min (SD = 1 hr and 43 min), whereas for the epidural group, this was duration of the first stage, the stage with the severe pain, and the second stage, which was characterized by less acute pain, lasted on average for an additional 5 hr and 8 min (SD = 3 hr and 28 min).

The average pain recalled 2 days after delivery was significantly higher for the nonepidural group (M = 87.46, SD = 19.87) than for the epidural group (M = 69.50, SD = 27.65), $t(74) = 3.25$, $p < .005$; mean difference = 17.96, 95% CI = [6.95, 28.97], Cohen's d = 0.75. The same pattern was seen after 2 months, with the nonepidural group providing significantly higher pain ratings (M = 80.79, SD = 21.06) than the epidural group (M = 64.72, SD = 29.98), $t(74) = 2.70$, $p < .005$; mean difference = 16.07, 95% CI = [4.23, 27.91], Cohen's d = 0.61. Despite the fact that mothers in the epidural group, compared with those in the nonepidural group, endured the same amount of pain in the beginning of labor and then experienced more (although less acute) pain for another duration, they recalled the total pain experienced as lower. These results indicate that more pain can be preferred to less pain when a better end is added to the experience.

According to the accessibility model (M. D. Robinson & Clore, 2002a, 2002b), prior experience, beliefs, and other individual differences may change the predictive power of peak and end ratings, especially after a long time (between 3 and 7 weeks after the experience; Geng et al., 2013). To test this hypothesis, we compared ratings provided by primiparous (n = 115) and multiparous (n = 205) women. None of the indices of experienced pain differed significantly between these groups (see Table 4, which also reports the obvious difference in age and delivery duration between the groups). We then calculated the correlations between the average of peak and end ratings and ratings of recollected pain separately for the primiparous and multiparous women (see Table 5). The differences between the correlations for these two groups were not statistically significant, $z = 0.481$, $p = .63$, for ratings 2 days after birth and $z = 1.526$, $p = .12$, for ratings 2 months after birth. However, for primiparous women, the correlations at the two time points did not differ significantly, $z = 0.75$, $p = .45$, whereas for multiparous women, the correlation between the average of peak and end ratings and ratings provided 2 days after delivery was significantly higher than the correlation between peak and end ratings and ratings provided 2 months after delivery, $z = 3.20$, $p < .001$.

Table 4. Comparison of Primiparous and Multiparous Women

	Primipara		Multipara				Difference	
Measure	Mean	*SD*	Mean	*SD*	$t(318)$	Cohen's d	Mean	95% confidence interval
Peak pain	89.95	14.83	88.72	14.89	0.71	0.08	1.23	[–2.18, 4.63]
End pain	51.17	39.71	55.94	40.66	–1.02	0.12	–4.77	[–14.01, 4.47]
Overall average pain	36.21	22.87	38.40	25.37	–0.77	0.09	–2.19	[–7.81, 3.43]
Average of peak and end pain	70.56	23.25	72.33	24.22	–0.64	0.07	–1.77	[–7.24, 3.70]
Delivery duration (hours:minutes)	7:40	4:24	6:02	3:10	3.85*	0.45	1:38	[0:48, 2:29]
Age (years)	28.03	4.03	31.78	4.26	–6.38*	0.90	–3.75	[–4.91, –2.59]

Note: Epidural analgesia was received by 80.0% of primipara and 79.5% of multipara, $\chi^2(1, N = 320) = 0.14$.
*p < .001.

Table 5. Correlations Between the Average of Peak and End Pain Ratings and Recollected Pain

Time of recollection	Primipara	Multipara
Two days after delivery	.570	.607
Two months after delivery	.602	.475

Discussion

The current findings are consistent with Kahneman's findings (Kahneman et al., 1993; Redelmeier & Kahneman, 1996) that recollections of past experiences are biased and composed of only a few salient characteristics of the events. Specifically, recollections follow the peak-and-end rule, but the duration of experiences is largely neglected. In the current study, we tested these basic rules of human memory in one of the most central experiences of humankind. We measured labor pain systematically during childbirth and then contrasted mothers' on-line evaluations with their recollection of pain 2 days and 2 months after delivery.

Results indicate that the average of the most painful moment of labor (peak rating) and the pain experienced at the end of labor (end rating) is the best predictor of recollected labor pain—better than the average of all ratings provided during the entire experience. Furthermore, delivery duration has no effect on recollected pain intensity. This conclusion is supported by the comparison between mothers who gave birth with and without epidural analgesia who were matched on duration of pain as well as on ratings of on-line pain. We found that the average of peak and end pain ratings is the best predictor of pain recollected not only soon after labor but also 2 months later. Although the accessibility model (e.g., M. D. Robinson & Clore, 2002a, 2002b) suggests that the peak-and-end rule applies only in the short term, our findings show that the effect is maintained over time. Nevertheless, in multiparous mothers, the peak-and-end effect was decreased by 2 months after delivery, whereas in primiparous mothers, it remained unchanged after 2 months. Thus, as predicted by the accessibility model, previous knowledge (as well as other individual differences) and the reoccurrence of the experience apparently dilute the peak-and-end effect, even in the unique and rare (from the individual perspective) experience of childbirth.

The phenomenon of duration neglect in the case of modern childbirth is particularly interesting given the common use of epidural analgesia. This form of analgesia was developed mainly to counter labor pain, but its everlasting influence on the memory of childbirth is important as well. In our study, the natural memory of childbirth pain is represented by the pain ratings of the nonepidural group, which after 2 days averaged 87.46 on a scale from 0 to 100 (80.79 after 2 months). In contrast, mothers who received an epidural on average rated their pain as 69.50 after 2 days (and as 64.72 after 2 months). Thus, epidural analgesia may lead to a reduction of 15% to 20% in recollected pain intensity. We believe that the joint effects of pain reduction at the end of the experience together with duration neglect provide important input to a memory system that is inherently biased by the peak-and-end rule. In practical terms, these results suggest that epidural analgesia is not only beneficial during childbirth itself but also effective in modulating memory of it.

Author Contributions

All authors contributed to the study design and data collection. E. Chajut, A. Caspi, and D. Ariely analyzed and interpreted the data and wrote the manuscript.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Notes

1. A few exceptions have been studies on colonoscopy involving relatively high levels of pain. However, the patients received sedation, as well as pain-reducing and amnesia-inducing medications (Redelmeier & Kahneman, 1996).
2. In this article, we report only part of the data collected in this project. Data collection lasted 2 years, and the total sample included 658 women. However, not all women provided ratings at all time points. The analyses we report were conducted on all participants who completed the full protocol.

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