Innovator's Strategy and Commercial Success of Radical Innovations

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ABSTRACT

This paper examines the impact of innovating firms' conscious action to persuade potential consumers on the commercial success of radical innovations in the tennis racket industry. Based on the literature in information processing, behavioral marketing, and evolutionary economics, we hypothesize that innovators' action through professional endorsement increases the sales of radical innovations when it is difficult for consumers to assess the validity of technical superiority. With previous studies in the field, the study suggests that it is critical for innovators to eliminate initial uncertainty and ambiguity in the market through various measures and, once it's properly done, consumers as well as competitors begin to appreciate the value of the radical innovation.

1. INTRODUCTION

The market is defined by the interaction between producers and consumers (White, 1981). Despite its importance and complex nature, the interface has not drawn much attention in strategic management. Previous studies mostly focus on only one side of the market with the other side assumed given and fixed (Frenzen, Hirsch, and Zerrillo, 1994): the relationship typically portrayed is arms-length at best based on clear signals such as price-to-performance ratio. The separation between producers and consumers, however, raises serious concerns when we are interested in explaining the success of innovation, particularly of radical nature, because the interface lies at the heart of the phenomenon. Several studies note that the extent to which producers and consumers are separated is affected by such factors as the nature of innovation and the stage of its life cycle (Amendola and Bruno, 1990; Tushman and Rosenkopf, 1992; Afuah and Bahram 1995; Santos and Eisenhardt, 2009). In fact, Schumpeter (1934, 1939) noticed this point earlier: he stated that the success of innovation critically depends on the successful management of consumer preferences. This study is an attempt to pursue this idea further by examining how the firm affects technological evolution by influencing consumer preferences and then this is manifested in the sales figure.

Interaction between producers and consumers is clearly visible when a radical innovation is introduced to the market. Innovation creates uncertainty and ambiguity because it is difficult to predict *ex ante* whether market exists for the new product (Tushman and Anderson, 1986). In previous studies, reduction of such vagueness and emergence of successful innovation are mainly attributed to the socio-political factors in the institutional environment (e.g., Garud and Rappa, 1994). In contrast, we attempt to open up the black box of the market selection environment, of which the essential element is consumers. Due to its newness, consumers do not have well-developed preferences for the product (March, 1978). Therefore, it is critical to understand the process by which consumers construct their preferences for the innovation and how firms intervene the process (Babutsidze, 2011). This opens up the possibility for the firm to intervene the process of consumer preference formation for the new product because prior expectation of consumers can be influenced by the firm's behavior (Hoch and Ha, 1986; van den Belt and Rip, 1987). In other words, the success of innovation results from the firm's effective management of the producer–consumer interface.

Along this line, this study is an extension of Kim and Pennings (2009), which demonstrated the role played by the firm in influencing the consumer choice under uncertainty and ambiguity and, in turn, shaping the direction of technological evolution in the tennis racket industry. In particular, after controlling the impact of radically new innovation's technical quality, they showed that the endorsement by top professional players and advertising efforts significantly influenced the innovation's acceptance, measured by replication of the racket design by competitors in the industry. However, it is not clear whether such efforts by innovative firms translate into the acceptance by consumers. By analyzing the sales data, this study examines the final link from innovative ideas to consumer acceptance, namely the effect of the innovating firm's action to change consumers' purchasing choice on the innovation's commercial results.

2. THEORETICAL DEVELOPMENT

In the field of strategy and technology management, it is widely accepted that industries evolve through a long period of incremental improvement followed by a relatively brief period of breakthrough technologies, some of which from time to time change the direction of the industries' technological progress (Tushman and Anderson, 1986). While these studies well document the cyclical nature of industry evolution in many different settings, they usually focus on the dynamic interaction among supply-side actors such as firms, government, and industry association while the role played by demand-side actors like customers and consumers is not highlighted (e.g., Tushman and Rosenkopf, 1992).

Another stream of research focuses on uncertainty and ambiguity prevalent in the emerging stage of technological change and the process by which the nascent state of the industry gets settled down. Contrary to the typical "best technology wins the market" argument, it is well documented that factors other than technology play a significant role in the market's choice of a winning technology. For example, Arthur (1989) and David (1985) show that 'small historical events' can significantly change the pattern of technology adoption when the relative advantage of competing technologies is hard to distinguish from one another. Furthermore, Cusumano, Mylonadis, and Rosenbloom (1992) argue that strategic maneuvering by JVC made it possible for the VHS format to capture a lead in the video cassette format war against Sony's Betamax format even though the latter was widely regarded as an option with better picture quality than the former. Unlike the strategy and technology management literature, the process by which uncertainty and ambiguity in the emerging stage of the technological change is elaborated in this line of research. However, the thick description often comes at a cost in that the studies are usually narrative and could be complemented with data-driven empirical studies.

Kim and Pennings (2009) is an attempt to fill this gap in the literature in that an analysis with historical data including the successful and failed radical innovations complements the thick description of what happened in the tennis racket industry. They argue that radical innovations introduce a condition where established preferences no longer hold because information on novel product attributes is neither valid nor reliable and consumers often do not have information processing capacity for them (Kahneman, Slovic and Tversky, 1982; Simon 1955). Therefore, consumer experience with radical innovations is conceptually closer to learning than calculation-based rational choice (Payne, Bettman, and Johnson, 1992).

Research on information processing elaborates on this learning process. Learning is conceptualized as the process by which individuals test the validity of new information against some intuitive hypotheses or cognitive schemata, rather than through assimilating information regardless of prior beliefs (Bower and Hilgard, 1981; Hoch and Ha, 1986). Depending on the clarity of information, individuals assume one of two information processing strategies (Bobrow and Norman, 1975). When the stimulus provides clear signals, they tend towards data-driven processing and prior expectations play hardly any role. Since people accept information at its "face" value, they confirm their prior beliefs accordingly. In contrast, when perceptual cues are vague and ambiguous, concept-driven processing conduct occurs. Because novelty accommodates multiple interpretations, prior beliefs induce choice and sense making: people lean towards information consistent with their beliefs and discount disconfirming. Radical innovation is shrouded by a good deal of ambiguity – much uncertainty prevails regarding its usefulness to the adopter. The implication is that any radical innovation invokes concept-driven processing in which prior beliefs or some provisional hypotheses play a critical role.

Therefore, the progenitor of a radical innovation, whether an established firm or an entrepreneur, stands to gain from intervening into consumer learning. Schumpeter in particular stressed this management of consumer preferences. He wrote, "all change in consumers' tastes is incident to, and brought about by, producers' action" (Schumpeter, 1939: 73). He also identified advertising as an instrument for molding consumer preferences: they "have had to be educated up by elaborate psychotechnics of advertising" (Schumpeter, 1939: 73). Hoch and Ha (1986) likewise argue that consumers view advertising as a source of intuitive hypotheses rather than treating it as source of value-free information (e.g., Nelson, 1970): due to the lack of source credibility, advertising is taken as a source of information with reservations regarding its validity. Temporary or "tentative" hypotheses emerge in consumer's minds and they either believe or discard them until they have had a chance to test the product themselves.

Once tentative hypotheses have been formed, the next step, therefore, is to test them with direct experience. Behavioral decision research stands in sharp contrast to neoclassical economics which assumes away cognitive bias and experiential learning. Innovations that enter the market are simply cleared by the collective conduct of consumers who are postulated to be utility maximizers. Studies in information processing, however, show them to resort to decision heuristics resulting in behaviors that are far removed from the dictum of rational choice models (Valente, 2012; Kahneman, Slovic, and Tversky, 1982; Hoch and Ha, 1986). Since consumers are concerned with making good decisions rather than the best (Simon, 1955), they discontinue their search as soon as new evidence supports their hypothesis. This confirmation bias under a high level of uncertainty and ambiguity augments adoption of an innovation once the innovator successfully instills belief-supporting data through advertising. Within broad limits, such hypothesis relevant data might supersede more or less ambivalent product quality, or customer value information, but as argued such information is hard to come by, and if present, prone to being tenuous. Based on the above argument, we propose the following proposition:

When the benefit of innovations is tenuous, uncertain and ambiguous, the innovators' conduct aimed at changing consumer perceptions is likely to increase its likelihood of success, measured by the sales of the products adopting the same technology.

3. EMPIRICAL SETTING AND HYPOTHESES

The empirical setting for this study is the tennis racket industry, which provides an interesting opportunity to study technological innovation (Kim and Pennings, 2009; Dahlin and Behrens, 2008). The tennis racket is a relatively simple product with a rather uncomplicated architecture. It is typically depicted that the tennis racket has evolved through five different stages since the 1960s: the wood racket, the metal and graphite racket, the oversized racket, the widebody racket, and the longbody racket. In particular, it is the latter three innovations that are regarded as the catalyst that significantly changed the direction of technological progress as they broke free the conventional mindset about the parameters of racket design.

However, the racket design innovations are not limited to the above mentioned three innovations (Kim and Pennings, 2009). In fact, the industry is full of interesting innovations, some of which had the potential to leave a mark on the industry. As an example, let's take a look at Ergonom, an ergonomically designed racket with its head attached to the throat of the racket 42 degrees tilted, introduced by Snauwaert, a Belgian firm in 1983. The manufacturer claimed that the tilted head rotated the sweet spot of the racket perpendicular to the ground on groundstrokes so that the racket enabled the players to generate more stable and powerful shots while reducing the burden on the player's wrist. While the racket's unusual shape attracted negative comments and sometimes even ridicule, testimony from an industry expert suggested that they were unfounded suspicion. An industry expert said:

> "Although Snauwaert recommends that the racquet be used with its head in the "up" position, the frame is symmetrically balanced and handles equally well when the head is angled down. As a matter of fact, if you close your eyes and spin the Ergonom in your hand, it's impossible to tell which way the head is angled. Therefore, the radical looking frame does not require much stroke adjustment on the player's part." (from Leonard, 1983: 54)

A group of test panels, after a couple of hours playing with Ergonom on the court, also noted:

> "The panel lauded the Ergonom, giving it fine marks in every category… This is radical step and fine new concept that, if given a chance, may well succeed." (from racket review on Ergonom in World Tennis, October 1984)

Given the uncertainty, ambiguity, and even controversy about racket innovations illustrated with the Ergonom example, an interesting question to ask is why some innovations managed to leave significant impacts on technological progress while the others failed to do so. Kim and Pennings (2009) showed that when radical new technologies were introduced in tennis, it was not the quality of the technology but the professional endorsement that increased the likelihood of the technology replication by competitors in the industry. Just like the Ergonom example, some of the radical, but eventually not well accepted technologies were at least as good technically as the radical and successful ones. What was critical to a technology's success was how well the innovator eliminated the uncertainty and ambiguity about the new technology. One of the most effective measures to be used in tennis was the professional endorsement because top ranked professional players were the experts in utilizing the device and were highly visible to the public.

Kim and Pennings (2009) empirically showed that active engagement by the innovator in persuading the consumers about the benefit of the innovation cleared out commercial as well as technological uncertainties and, therefore, competitors joined the bandwagon by launching their version of the innovation. Professional endorsement acted as what Arthur (1988) and David (1985) called a "small historical event," but in fact it was not a random event but a conscious, intentional action.

One limitation of Kim and Pennings (2009) is, however, that they measured the success of radical technologies by the number of rackets employing the same technology by competitors. While it is in itself an interesting way to frame radical technologies' success, an ultimate measure of innovation is the sales, a measure reflect the acceptance by consumers. Therefore, using the sales as a dependent variable, we first suggest the following hypotheses as a baseline:

> *Hypothesis 1:* Racket quality of the racket embodying a radical innovation is positively associated with the sales of the rackets adopting the same innovation.

While technical performance is no doubt an important factor in determining the success and/or failure of an innovation, it may not be the sole factor especially when relevant actors in the market suffer from uncertainty and ambiguity about technical performance of the innovation. Under such circumstances, the innovator's action to persuade consumers by not just conveying the technical information but also increasing the level of consumers' confidence about the innovation becomes quite critical. As we described above, professional endorsement is regarded as the best measure available for the innovator due to the professionals' status as an expert as well as their high visibility to the public. Therefore, as a competing hypothesis, we propose the following:

> *Hypothesis 2:* Professional endorsement of the racket embodying a radical innovation is positively associated with the sales of the rackets adopting the same innovation.

4. DATA

Tennis rackets introduced to the U.S. market, 453 rackets, from 1990 to 1998 are the total sample of the study. The sales data was generously provided by Sports Research, Inc., in Princeton, New Jersey. The company is an independent market research company specializing in recreational products including tennis rackets. While the data contains the sales figure of the racket that is at least 0.1% of the total sales of the industry, quarterly reports by the company are widely regarded as the most reliable source of such data in the industry. The data set covers the years from 1990 to 1998 and, therefore, includes the total of 453 rackets.

We follow Kim and Penning's (2009) classification of radical innovation. In order to avoid the hindsight bias, they chose the racket technology innovations so different from the traditional rackets that were described with positive words like 'revolutionary,' 'breakthrough,' and 'radical' as well as negative ones like 'weird,' 'funny,' 'unusual,' and 'controversial.' They ended up using eight radical innovations described in Table 1.

Most of the data used in the analysis was collected from various issues of popular magazines in the sport, namely World Tennis and Tennis. These magazines are a rich source of information. When new rackets are launched, it is the manufacturers' interests in making the information public to attract attention to the rackets. Articles covering new rackets and paid advertising in the magazine contain a large amount

Table 1
Racket Designs Considered in Empirical Analysis

Design	Year	Innovator	Description
Oversize	1976	Prince	– Enlargement of the sweet spot – 110 square inches of the racket head (traditional rackets had the face of 70 square inches)
Adjustable	1976	Fischer	– Equipped with tension adjusting device
Longbody	1979	Head	– 1.5 inches longer than the traditional 27 inch racket
Ergonomic	1983	Sentra	– 13 degree bent grip for lessening stress on the muschles of the arm and wrist when players hit the ball with the racket
Convex Throat	1984	Chris	– Wide throat design for increased stability
Three String Pattern	1986	Mad Raq	– Strings woven in three directions for increased stiffness
Widebody	1987	Wilson	– Different frame width throughout the frame – Thin at the tip and bottom of the frame, thick in the middle for increased stiffness
Fan String Pattern	1988	SP.IN.	– Vertical strings are twice as long as those in the traditional racket

From Kim, H. and Pennings, J. 2009. Innovation and strategic renewal in mature markets: A study of the tennis racket industry. *Organization Science*, Vol. 20, No. 2, p. 375.

of information regarding new rackets; the number of advertising pages for a particular racket is a good proxy for promotional spending by the firm in the context where accurate information on advertising spending is hard to get. Also advertising and articles highlight the top professional players who are using the racket. Top professional players are experts in using tennis rackets, and, therefore, enhance credibility of the racket they use. In addition, they tend to appear in television broadcasting of major tennis events so that the rackets they use get the benefit of increased visibility.

We defined the top professional players in two ways. First, top 10 players of the year list by Association of Tennis Professionals (ATP) for male players and Women's Tennis Association (WTA) for female players were employed. Second, the players who reached semi-finals at four Grand Slam tournaments, namely Australian Open, French Open, Wimbledon, and U.S. Open because they attract a huge attention from the tennis community. For the variable of professional endorsement, we counted the number of these top professional players who were using a particular racket.

Quality of racket design data were also collected from a series of racket review sections published in the World Tennis magazine. When a new racket was launched, the magazine provided various information about the racket to help the magazine reader make a better purchasing decision. One of the information was the player test, in which a test panel consisting of at least six players at varying skill levels played with the racket at least one hour and gave their subjective judgment on the overall quality of the racket. Albeit imperfect, this information represented the best effort to capture the quality of the racket used in a real setting that a potential user would be in.

5. RESULTS

We employed the pooled time series regression analysis with a lagged dependent variable to test the hypotheses on the impact of professional endorsement on consumer response. First, descriptive statistics are reported in Table 2.

Table 2
Descriptive Statistics of and Correlations among Variables

Variable	N	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11
1. Log of Sales$_t$	453	10.56	3.06											
2. No. of Tennis Population (in million)	453	21.35	1.80	.34***										
3. No. of Racket Manufacturers	453	26.00	2.56	.43***	.54***									
4. No. of Rackets	453	247.59	83.99	-.43***	-.43***	-.83***								
5. No. of Rackets with Focal Design	453	31.10	12.80	-.14	.09	.09	-.08							
6. Diversified Firm	453	0.96	0.21	.03	-.09†	-.05	.05	-.38***						
7. Age of Firm	453	1.90	0.86	-.04	-.10*	-.08†	.08†	.53***	-.09†					
8. U.S. Firm	453	0.63	0.48	-.08	-.10*	-.15**	.15**	-.31**	.17	.06				
9. Age of Racket	453	4.14	2.75	-.58***	-.61***	-.56***	.54***	-.09	.12**	.16***	.31***			
10. Professional Endorsement	453	0.05	0.33	.01	-.00	-.05	.02	-.10	.03	.10*	.04	.16***		
11. Racket quality	453	7.43	0.69	.11*	.05	-.02	.02	-.09	.01	.07	-.07	-.16***	.10*	
12. Advertising	453	0.01	0.01	.14**	.09†	.09†	-.07	-.11	-.11	-.13**	-.00	-.06	.06	.02

†$p < 0.1$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Regression results are presented in Table 3. Some of the firm characteristics and racket characteristics are shown to be significant. The effects of domestic status of the firms on sales were consistently

Table 3
Regression Analyses of Racket Sales (from 1990 to 1998)

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	−17.583	−166.136	−70.971	−55.857
	(25.933)	(93.894)	(108.908)	(104.970)
Environment Characteristics				
Tennis Playing Population/1000	0.350***	−0.409	−0.083	−0.201
	(0.061)	(0.393)	(0.627)	(0.605)
Number of Racket Manufacturers	2.093	15.851*	3.588	2.782
	(2.334)	(8.597)	(11.915)	(11.470)
Number of Racket Manufacturers^2	−0.045	−0.326*	−0.066	−0.050
	(0.050)	(0.182)	(0.256)	(0.246)
Number of Rackets	−0.011	0.020	−0.006	−0.003
	(0.013)	(0.032)	(0.027)	(0.026)
Number of Rackets^2	−0.000	−0.000**	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Number of Rackets with Focal Design	−0.051***	−0.454	1.277*	1.071
	(0.011)	(0.534)	(0.731)	(0.708)
Number of Rackets with Focal Design^2	0.000***	0.006	−0.015*	−0.013
	(0.000)	(0.007)	(0.009)	(0.009)
Firm Characteristics				
Diversified (1 = Yes; 0 = No)	1.769***	5.030**	1.859	2.201
	(0.395)	(1.541)	(1.387)	(1.341)
Age (1 = − '67; 2 = '67 − '76; 3 = '76–)	0.042	0.273	−1.299***	−1.131**
	(0.083)	(0.490)	(0.482)	(0.469)
U.S. Firm (1 = Yes; 0 = No)	0.438***	2.780***	2.003***	2.185***
	(0.149)	(0.579)	(0.545)	(0.530)
Racket Characteristics				
Age of Racket	−	1.599**	2.569	2.360
		(0.776)	(1.882)	(1.813)
Age of Racket^2	−	−0.339***	−0.319**	−0.307***
		(0.121)	(0.120)	(0.116)
Professional Endorsement	−	2.546***	1.743**	1.220*
		(0.901)	(0.664)	(0.672)
Racket Quality	−	0.383	1.082***	1.060***
		(0.454)	(0.363)	(0.350)
Advertising	−	−	−	32.181**
				(12.763)
Log (Sales$_{t−1}$)	−	−	0.501***	0.514***
			(0.093)	(0.090)
R-Square	0.124	0.633	0.839	0.853

$^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

significant: sales by such firms were higher than those by foreign companies. However, the effects of firm's diversification and age were less consistent. The effects of firm's diversification changed from significant (Models 1 and 2) to nonsignificant (Models 3 and 4), while firm's age turned out significant when more racket characteristics variables were included: sales by firms established after 1976 were lower than those by firms having existed prior to 1976.

Model 2 indicates that the age of innovation has a curvilinear effect on sales in that sales increases in the early stage but tapers off as it gets matured. What is interesting in Model 2 is that professional endorsement is statistically significant on sales while racket quality is not. This seems to suggest that it is professional endorsement, not racket quality, that is a good predictor of commercial success in this industry (H1 supported, H2 not supported).

However, when log of sales at time $(t-1)$ is introduced, we get a different picture. As expected, log of sales at time $(t-1)$ is significant throughout models and its presence significantly increases adjusted R squares. Model 3 shows that both professional endorsement and racket quality are positively affect sales. This makes more sense than Model 2. When a racket with a radical innovation gets better review from the playtest panels, it provides potential consumers with higher confidence about the quality of radical innovation. With the endorsement by top professional players, radical innovation lessens the suspicion in the minds of potential consumers. As described above, when a racket with radical innovation gets a chance to be tried by potential consumers who already formed a positive tentative hypothesis, it is more likely for them to assess the innovation positively.

Model 4 adds the amount of advertising to Model 3. As expected, advertising is also significant and positive. While the correlation between advertising and professional endorsement is not significant in Table 2, a significant portion of advertising contains the picture and/or statement of top professional players using the racket, if there is any. Therefore, the positive effect of advertising on sales also can be interpreted to support H2.

Overall, professional endorsement, racket quality, and advertising had positive effects on sales of the rackets with radical innovation. Consistent with previous literature on innovation as well as conventional wisdom, the results suggested that radical innovations with better quality and with more advertising sell more. More importantly, professional endorsement, the variable of interest, significantly increased sales of the rackets with radical innovation after the effects of other variables were controlled. Its effect was quite consistently significant across models in which alternative quality measures were included. Although the analysis was limited to the 1990s due to the limits of the observation window, the analysis suggests that professional endorsement increases racket sales along with the positive effects of racket quality and advertising also affects sales positively.

6. CONCLUSION

Success and failure of innovation and its impact on industry evolution has been a central question in the field of strategic management. Producers and consumers, the two key players of the market, have traditionally been treated as separate, independent, and arms-length from one another. As documented in the literature of technological evolution, the dynamics between the two parties is quite different depending on the stage of evolutionary cycle. In the incremental period where a dominant standard technology has already emerged, the interaction between the two parties is rather loose because the parameters of technological

development and consumer preferences are well established. However, when an industry gets punctuated by radical innovations, the circumstances turn upside down: technical benefits of radical innovations are not clear and vested interests of existing players make the situation more complex. The boundary between producers and consumers becomes blurry and, as a result, this creates an opportunity for producers to work on and with consumers to change the competitive structure of the industry to their favor.

Researchers have provided explanations for how uncertainty, ambiguity, and controversy get settled down: for example, forming industry alliance (Tushman and Rosenkopf, 1992) and intervention by regulatory bodies (Garud and Rappa, 1994). More recent studies have highlighted the dynamic interaction between producers and consumers (Santos and Eisenhardt, 2009; Kim and Pennings, 2009; Durand and Khaire, 2016). While they elaborate how certain innovations get accepted in the market through the lens of producer-consumer interaction, few studies showed commercial impacts of successful innovations. This research is an attempt to fill the gap in the literature and empirically shows that professional endorsement as well as racket quality significantly increases sales of the innovation.

When combined with Kim and Pennings (2009), this study offers a full picture of industry change. Radical innovations are often misunderstood and undervalued. In the tennis racket industry, it took almost a decade for the tennis community to appreciate the true value of the most significant innovation of all time, the oversize racket by Prince in 1976. The concept of sweet spot was not clearly articulated until a paper by a physics professor published in 1981 showing that the bigger racket face could improve player performance by making sweet spot bigger (Brody, 1981). Under such uncertainty, both companies and consumers have little incentive to embrace the innovation. This gets changed when top professional players endorse the racket embodying the innovation. Professional endorsement makes the innovation visible and induces the potential consumers to come up with positive hypotheses about the innovation. It also attracts attention of the competing firms that have not fully grasped its benefit and implication. What is not clear in Kim and Pennings (2009) is whether professional endorsement has positive effects on commercial outcomes. This study demonstrates that professional endorsement as well as technical quality of innovation increases sales of the innovation, the final verdict of market acceptance.

Unfortunately, the data available for this study is limited to the 1990s. While this is an interesting time for the industry, the more longitudinal data could have made the study more interesting. Furthermore, when combined with recent developments in the dominant design literature (Suarez, Grodal, and Gotsopoulos, 2015), this line of research could contribute to the field by providing a full picture of technological evolution.

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