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A Novel Scheme to Relieve Parking Pressure at Tourist Attractions on Holidays

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Abstract: Parking is a key component of urban transportation managements and has become a severe problem at many tourist attractions during holidays in China. This paper presents a novel scheme to relieve the holiday parking pressure. Based on the perspectives of the activity-based travel characteristics, we propose an effort to develop parking alternatives by utilizing existing traffic facilities. A conceptual model is employed to explore the influence of additional leisure activity of parking and various options of transportation modes. The results indicate that compared to commuters, the scenery is the major factor affecting tourists' parking preference, besides parking time and cost. Based on the finding, a tourist-centered strategy is designed to satisfy the peak hours parking demands in order to relieve the parking pressure at tourist attractions during holidays.

Keywords: holiday; tourist attractions; parking preference; tourist-centered strategy

1. Introduction

Tourist attractions are popular destinations for leisure activities. Along with the holiday system reforming and the economy blooming, people are expected to have more time and money for holiday travel in China. The arrival of large number of tourists would stimulate the local consumption and lead to better development of tourism and related industries. However, many tourists prefer to travel by private vehicles currently, the severity of traffic congestion at tourist attractions and surrounding areas is increasing. In addition, as the large number of vehicles arriving at the attractions at the same time, the drivers could hardly find parking spaces. Motorists must spend considerable hours to cruise for parking spaces. Consequently, holiday parking has become one of the thorniest issues of the traffic managements in China.

Parking may directly impact urban mobility characteristics, such as traffic congestion, accessibility, safety and environment [1]. Many researchers have concentrated on parking polices. The initial parking policy attempted to supply enough parking spaces to satisfy parking demand [2–4]. For example, in 1923 the first residential parking requirement originated in Ohio, USA, and in 1939 the first non-residential parking requirement was laid down in California, USA, which set the minimum provision of parking to provide adequate parking spaces for cars [5]. These unconstrained provisions of parking increased the use of car and aggravate traffic congestion, soon parking policy moved away from satisfying demand to regulating vehicle usage [6]. Many cities limited the amount of parking spaces, which tried to induce the excess demand to other transportation modes, such as walk, bike and public transit [7–14]. For example, the downtown of Amsterdam has limited parking spaces to encourage the development of green travel and public transit [15].

Many researches also try to deal with parking demands from the economic view, which expect to control parking demand by manipulating the relationship of parking price and parking provision [16–20]. For example, Shoup optimized parking prices to reduce cruising time for parking space [21–23]. Arnott *et al.* adjusted parking prices to increase parking capacity [24–28]. Zhang *et al.* utilized parking permits distribution and trading to manage limited parking spaces [29].

Most proposed parking policies are specific to commuter parking. Event parking, especially during holidays, suffers from a dearth of research evidence [30]. In this paper, we study a specific domestic tourism parking problem, and focus our investigation on the tourists' parking preference during holidays. A novel scheme is advised to relieve parking pressure at tourist attractions from the perspectives of activity-based travel characteristics and parking choice behaviors. This scheme comes up with alternative parking choices, and takes consideration of the tourists' characteristics and the combination of the alternative transportation modes. The following Section 2 presents the conceptual framework of the parking preference scheme. Section 3 introduces the stated preference survey. Section 4 utilizes multinomial logit model to analyze the survey data. Section 5 concludes the policy application of the results.

2. The Conceptual Framework for Parking Preference Scheme

Parking preference is heavily affected by the purpose of the trips. Commuters travelling between work and home care about whether they can arrive at the destination on time. Their parking choices relied on travel time and parking cost [3]. However, tourists are different users of the transportation system. They are seeking a variety of scenic, natural, cultural, recreational qualities of the destinations. Compared with commuters, tourists' visiting and scheduling are much more flexible. Their travel behavior is affected by the historical characteristics of the intended destinations, shopping facilities, restaurants and the nature of the cities [31]. In this case, the historic attractions combined with other scenic spots and leisure activities, would form more attractive and sustainable tourism environments. For tourists, travelling comfort, service quality, accessibility and other additional features are main factors affecting their mode choice [32]. So they would spend more time and money on the routes and transportation modes with scenic roadways [33]. The relationship of visiting areas, travelers' behavior and transportation modes indicate that a feasible tourism planning needs the cooperative work of tourism and transport planner [34–36].

In this study, we integrate tourism and transport planning, proposing a conceptual framework for parking preference scheme. This plan is based on a hypothesis that the tourists' parking choices are affected by the trip characters such as the scenery of routes. As shown in Figure 1, we assume a popular tourist attraction is congested during holidays, and the tourists have to spend considerable time to cruise for parking spaces. We also assume that some of tourists would go to these parking lots, and then, arrive at their destination by alternative transportation modes, such as walk, public transit, or water shuttle if other parking choices are provided. These parking choices can be located around the recreational, scenic or historical places, and distributed to the existing parking facilities. These locations may provide more services and entertainments to the tourists. In addition, the alternative transportation may use various scenic roadways and routs.

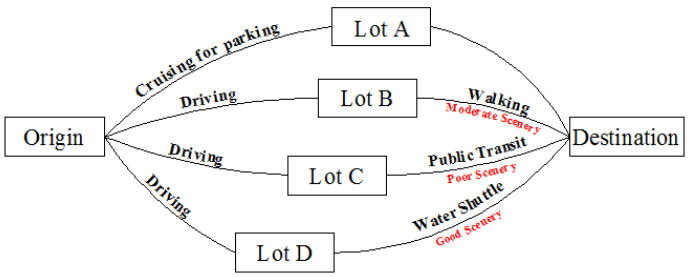

Figure 1. Three solutions to relieve parking pressure.

3. Survey Description

A survey was conducted for data collecting for holiday parking preference in the Summer Palace, a popular tourist attraction in Beijing, China. It is the largest royal park in China, and dominated by the Longevity Hill and Kunming Lake. Situated at 15 kilometers northwest to the center of Beijing. There are very convenient and accessible transportation during non-peak hours nearby the Summer Palace. Figure 2 shows a conceptual map for the major routes around the Summer Palace. Tourists can enter the palace at the North Palace Gate, the East Palace Gate, the New Palace Gate and the West Palace Gate. In terms of public transit, there are over 10 bus routes stopping at every gates and the subway line 4 stopping at the North Palace Gate. For private vehicles, tourists may use the 4th Ring Road from downtown or the 5th Ring Road from suburban. There are 22 parking lots with about 1300 parking spaces around the Summer Palace. The another most attractive route to the Summer Palace is the dedicated water shuttle from Huangdichuan Wharf to Kunming Lake of the Summer Palace.

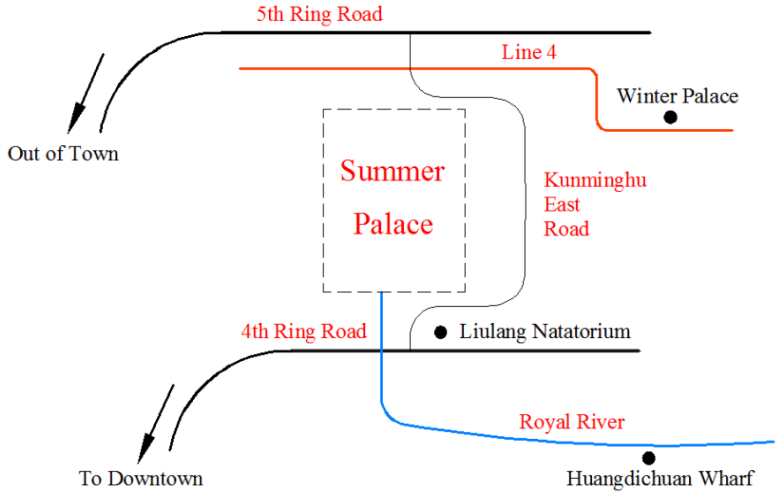

Figure 2. Conceptual map showing the major route for the Summer Palace.

As one of the most popular tourist destinations in Beijing, the Summer Palace attracts more than 10 million visitors each year. During the peak periods of holidays, it receives over 100 thousand tourists daily and about 16% of the tourists arrive by private cars [37].

Obviously, the demand of parking exceeds its supply. The average cruise time to find a parking space is about 45 min, which makes additional congestions in parking lots and around the attraction area.

Base on the hypothesis proposed in section 2, we propose three parking alternatives for the Summer Palace, and the details are as follows:

Plan I, Parking Lot B is located at Liulang Natatorium. The potential undeveloped lands next to the Summer Palace can be developed to recreational facilities such as restaurants and coffee shops. Tourists can park their vehicles at this leisure area and walk about 10 min to the Summer Palace, enjoying the moderate scenery along the green shaded trail.

Plan II, Parking lot C is located at Winter Palace. Tourists can park their vehicles at this attractions, and travel to the Summer Palace by public transit (*i.e.*, Subway Line 4) within 10 min.

Plan III, Parking Lot D is located at Huangdichuan Wharf. Tourists can park their vehicles at the Wharf and then take the water shuttles to the Summer Palace along a scenic route within 45 min.

The surveys were conducted during three major holidays in Qingming Festival (5 April 2016), Labor Day (1 May 2014), and Dragon Boat Festival (2 June 2014) in 2014. In total, 480 subjects were taken with 37 choice responses dismissed. The efficiency of the questionnaire is 92.3%.

4. Methodology

4.1. The Multinomial Logit Model

Logit models are widely used in transportation analysis because of its simple structure and strong interpretability. The models can present the relationship between a dependent variable and explanatory variables. In this study, four different parking choices are proposed and multinomial logit is employed to describe the tourists' parking preferences. This model is a kind of general multivariate logit selection model for analyzing the relationship between the selection probabilities of certain choices and the characteristic variables of the decision-makers. According to the random utility theory, the selection branches refer to the various available options, and the satisfaction degree of the branches is called as a utility.

In a random utility model, it is assumed the decision-maker n has J options, and the utility that a person n receives from choosing alternative j (j = 1, 2, 3, ... , J) is U_{nj}. Based on people's general choice behaviors, we make the following assumptions on the utility: in every selection, decision-makers choose the most utilized selection branch; the utility value of each selection branch is determined by the characteristics of the decision-maker and the branch itself. However, due to the various factors affecting the utility, the final utility includes two parts: the known component of utility based on the measured attributes V_{nj} and the unobserved random components ε_{nj}, namely:

$$U_{nj} = V_{nj} + \varepsilon_{nj} \tag{1}$$

The observed portion of utility can be further divided into X_{jnk} and θ_{kj}, where X_{jnk} is a vector describing the attributes of alternative j's Kth variable and θ_{kj} is a vector of weights on those attributes. Therefore, the determined utility can be described as:

$$V_{nj} = \sum_{k=1}^{K} \theta_{kj} X_{jnk} \tag{2}$$

When ε is assumed to have a Type I extreme value distribution, the probability expression of multinomial logit model is given by:

$$p_{nj} = \frac{\exp(V_{nj})}{\sum_{j} \exp(V_{nj})} \tag{3}$$

4.2. Data Description

The survey includes two sections. The first section is about tourists' demographic information and their concerns on parking. The second section is the tourists' responses to the alternative parking choices.

The descriptive statistics about tourists are mainly collected from the driver of vehicles, as shown in Table 1. Among the subjects, 68% drivers are local residents in Beijing and only 32% drivers are from other regions. This indicates the majority parking demand from the local tourists. These local drivers are familiar well with the roadway system and parking facilities. The 67% tourists are the middle income families with ¥50,000 to ¥300,000 per household per year. This result is consistent with the report that the growing middle class is the main consumers of the domestic and holiday tourism. Over 51% tourists are traveling in groups over two, and 31% with elders and children in their groups. 55% drivers are in middle-ages and 42% drivers are females. Comparing with commuters on the workdays, tourists are like to travel with families and more females would drive for holiday trips.

Table 1. Statistics of survey sample.

Sample	Percentage
Gender	
Male	58%
Female	42%
Age	
Young (<36)	32%
Middle-age (36–55)	55%
Elder (>55)	13%
Residents	
Local (>6 months)	68%
Outsider (⩽6 months)	32%
Income	
Low (<¥50,000)	8%
Middle (¥50,000–¥300,000)	67%
Upper (>¥300,000)	25%
Size of traveling group	
One people	5%
Two people	44%
More than two people	51%

Figure 3 shows the statistics of tourists' intention to change to alternative parking lots. The change probabilities of the young (<36), middle-ages (36–55), and elders (>55) are 31%, 48%, and 21% respectively. The middle-ages are more likely to accept the new parking solutions while the elders (>55) dislike to change their parking habits. The reason might be that the middle-ages are full of energy and can afford to the new options. In addition, they may pay more attention to the new choices and like to put them into practice. However, with the growth of the age, the elder people prefers to reach the destination directly with short distance and time from parking lots because of their otherwise inconvenience of actions. According to the living duration in Beijing, the change probabilities of local (>6 months) and outsiders (⩾6months) are 60% and 40%. Local people prefers to go to alternative parking lots. The dominant reason is that the local people are much familiar with parking situation around the attractions. Therefore, they may modify their travel plans much faster when delaying in traffic congestions. The probabilities of low-income (<¥50,000), middle-income (¥50,000–¥300,000) and upper-income (>¥300,000) choosing alternative parking lots are 6%, 40%, and 54% respectively. Upper income families are more willing to accept new solutions. The result shows that wealthy families are willing to spend more time and money on trip. Alternative parking solutions offer more parking spaces and entertainment opportunities for different age groups and income families on the holidays.

Figure 4 presents tourists' concerns about parking choices. We find that the cruising time for parking spaces is the key consideration of tourists. Besides parking time and cost, scenic roadway and alternative transportation modes are also important factors influencing tourists' parking choices.

Figure 3. Tourists' tendency to choose alternative parking lots.

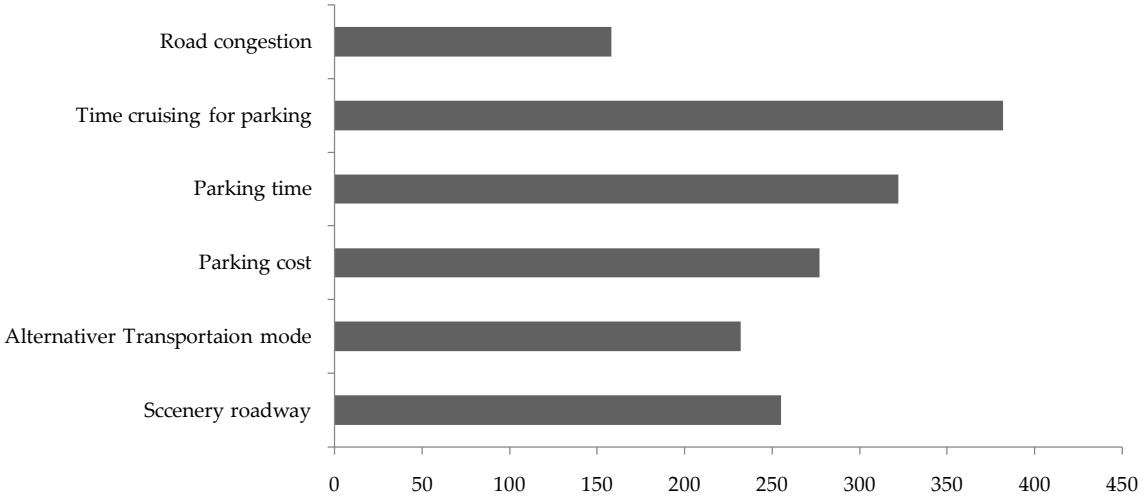

Figure 4. Comparison of tourists' concerns of parking choices.

Table 2 shows 10 explanatory variables used to establish multinomial logit model, including tourists' personal information, trip information, and parking information. Binary and ordinal number are used to represent these explanatory variables. "Elders & Children" means whether there are elders and children in the groups; "Road Congestion" means the traffic status to the Summer Palace; "Familiarity" means whether the tourists are familiar with the surrounding roads; "Time" means the parking time and travel time from parking lots to the Summer Palace; "Cost" means the parking fee and travel cost from parking lots to the Summer Palace; "Scenic Roadway" means the quality of roadway scenery; "Alternative Transportation Mode" means the transportation modes from parking lots to the Summer Palace; "Dining & Entertainment" means whether the parking area offers food and entertainment services; "Ticket Form" means whether the round-trip tickets can be purchased at parking lots.

Table 2. Data categories and variables.

Variable Label	Notation	Values
Target Variable		
Parking Preference	y	0 = Park at Lot A, Summer Palace; 1 = Park at Lot B, Liulang Natatorium; 2 = Park at Lot C, Winter Palace; 3 = Park at Lot D, Huangdichuan Wharf.
Personal Information		
Residents	x_1	0 = Outsider; 1 = Local.
Elders & Children	x_2	0 = No; 1 = Yes.
Trip Information		
Road Congestion	x_3	0 = No; 1 = Yes.
Familiarity	x_4	0 = Unfamiliar; 1 = Familiar.
Parking Information		
Time	x_5	1 = "⩽10 min"; 2 = "11–30 min"; 3 = "31–60 min"; 4 = ">60 min".
Cost	x_6	1 = ¥0; 2 = ¥10; 3 = ¥50; 4 = ¥100.
Scenic Roadway	x_7	1 = Poor; 2 = Moderate; 3 = Good.
Alternative Mode	x_8	1 = Walk; 2 = Public transit; 3 = Water shuttle.
Dining & Entertainment	x_9	0 = No; 1 = Yes.
Ticket Form	x_{10}	0 = One-way ticket; 1 = Round-trip ticket.

4.3. Model Results and Discussion

Table 3 presents the summary of the proportions of the sample. The 38% respondents still choose to park in the parking lot at the Summer Palace, while 37% tend to park at the Liulang Natatorium and then walk on trails to the Summer Palace. Among all the subjects, 12% prefers the Huangdichuan Wharf, and 13% will go to the Winter Palace first, and then takes the public transit to the Summer Palace. From this result, we find that three parking alternatives have significant effects for the parking pressure relief at Summer Palace. Especially, the solution of using leisure areas of Liulang Natatorium is presented.

Table 3. Parking preference.

Results	Proportion
Summer Palace	38%
Liulang Natatorium	37%
Winter Palace	13%
Huangdichuan Wharf	12%

Table 4 presents the estimated coefficients and related statistical results of the multinomial logit model. In the model, parking in Summer Palace is set as the baseline. Liulang Natatorium, the Winter Palace and Huangdichuan Wharf are assumed to be Scenario 1, Scenario 2 and Scenario 3 respectively.

Table 4. Estimated results of the multinomial logit model.

Variable	Scenario 1 (Liulang Natatorium)		Scenario 2 (Winter Palace)		Scenario 3 (Huangdichuan Wharf)	
	Coefficient	Odds Ratio	Coefficient	Odds Ratio	Coefficient	Odds Ratio
Elders & Children	1.29	3.63	−0.26	0.77	0.18	1.20
Scenic Roadway	0.20	1.22	0.17	1.19	0.62	1.86
Time	−0.14	0.87	−0.20	0.82	−0.19	0.82
Cost	−0.16	0.85	−0.10	0.91	−0.17	0.84

It can be found in Table 4 that the factor relating whether elders and children travelling within the groups have significant effects on the parking choices. The positive coefficient associated with Scenario 1 (OR = 3.63) implies that the tourists group with elders and children are 3.63 times more likely than those without elders and children to park in Liulang Natatorium. The positive coefficient associated with Scenario 3 (OR = 1.20) implies that the tourists group with elders and children have a 20% higher probability of parking in Huangdichuan Wharf than those without elders and children. Then negative coefficient associated with Scenario 2 (OR = 0.77) shows that the probability of parking at the Winter Palace for those with elders and children is 23% less than those without elders and children. Comparing to parking at the Summer Palace, the tourists with elders and children are more like to choose parking lots at Liulang Natatorium and Huangdichuan Wharf, and dislike parking at the Winter Palace. The possible reason might be that tourists with elders and children may require more comfort and convenience of travels. Therefore, they prefer to park in places where the leisure and recreational activities can be also provided, such as restaurants and shopping. In addition, it may be inconvenient for those tourists to take public transit such as subway. Therefore, the Winter Palace is not recommended for the tourists with elders and children.

The positive coefficient of scenic routes indicates that the tourists are more likely to go to alternative parking lots. If the trails from the parking area to the destinations are in scenery, the tourists willing to pay more money to park there. The coefficient associated with Scenario 1 (0.20) indicates that tourists are likely to parking at Liulang Natatorim and willing to pay ¥1.25 (0.2/−0.16) more for parking if they can walk along green shaded trails to the destinations. The coefficient associated with Scenario 3 (0.62) indicates that tourists prefer to park at Huangdichuan Wharf and would like to spend ¥3.65 (0.62/−0.17) more for parking if the water way from the parking lot to the destinations with great scenery. It is different from commuters that the scenic roadway does not significantly affect their parking preference.

The parking choices are affected by the parking time and cost of the alternative solutions. The negative coefficient of parking time and cost implies that tourists are likely to spend less time and money for parking, just as the commuters' parking preference. The payment expressed in money can be used to evaluate the parking alternatives. According Table 4, at Liulang Natatorium, a tourist is averagely willing to pay ¥0.88 (−0.14/−0.16) more per minute for the parking spaces to be closer to the destinations. At Winter Palace, the tourists may spend ¥2.00 (−0.20/−0.10) more per minute for the parking spacces closer to the destinations. At Huangdichuan Wharf, the willing to pay average is ¥1.12 (−0.19/−0.17) per minute for a closer parking space to the destinations. The results reveal that the tourists' preference for the alternative transportation modes sequences is walk, scenic ride and public transit. Table 5 presents the marginal effect of the parking time and cost. While holding all other variables constant, if the time of parking is increased by one minute, the probabilities of choosing Liulang Natatorium, Winter Palace and Huangdichuan Wharf would be expected to be decreased by 30%, 12%, and 6%. In the same way, if the cost for parking is increased by ¥1, the probabilities of these three parking alternatives would be decreased by 6%, 1%, and 4% respectively. Comparing to parking cost, the tourists are more concerned about parking time. The preferred alternative sequence is walk, public transits, and scenic ride.

Table 5. Marginal effect.

Variable	Scenario 1 (Liulang Natatorium)		Scenario 2 (Winter Palace)		Scenario 3 (Huangdichuan Wharf)	
	Marginal Effect	Z Test	Marginal Effect	Z Test	Marginal Effect	Z Test
Time	−0.30	−4.69	−0.12	−3.10	−0.06	−2.23
Cost	−0.06	−2.40	0.01	−2.20	−0.04	−1.41

5. Conclusions

This paper discusses a new scheme to relieve parking pressure at tourist attractions during holidays. By traditional methods, more parking facilities could be built to satisfy the increasing demands of tourists. These methods will encourage tourists to use automobiles to the attractions, and then results in increase of traffic congestions. The scheme proposed in this study utilizes the existing parking facilities to disperse tourists by various parking locations and transportation modes. Based on the survey at the Summer Palace, we explore three parking alternatives to distribute the parking demands. These solutions depend on the tourists' characters and development of land uses, which would provide leisure and recreational activities such as food services, shopping, and entertainments. These alternatives are associated with various options of transport modes such as trails, public transits, and scenic rides. The results of the model show that the parking alternatives would take 60% share of the tourists' parking demand during holidays. The proposed method is an efficient solution for traffic congestions around the attractions.

The data analysis indicates that scenic routes, parking time, and costs are the most important predictors for tourists' parking preference. Tourists like to choose cheaper and more convenient parking solution, just as same as the commuters. The difference with the commuters is that the tourists are willing to spend more time and money on the journey with scenic roadway and recreational characteristics.

These findings can be used to develop the tourist-centered parking strategy in the attraction areas. To satisfy the peak demand of holiday parking, the existing traffic capacity and the traffic infrastructures should be fully adopted for the distribution of the peak parking demands by the hours and over the spaces at popular tourist attractions. Regional scenery, cultural, recreational attractions and leisure areas should be developed to provide potential parking facilities. While considering the convenience and comfort of the travel from parking lots to destination, it is desirable to design the journey with scenic roadways and variable services.

Along with the development of technology and the improvement of economy, more people will have more time to spare for travel during holidays. The demands on parking will be increased continually and the parking pressure will be even severer, especially around the top tourist attractions. The proposed scheme will ease traffic congestions and improve the quality of urban environments. In addition, it is the most important objective of the tourist-centered strategy to lead towards sustainable tourism.

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Author Contributions: Juan Li proposed the original idea, designed the survey and conceptual model. Jing Ye performed the survey and did data analysis, Qinglian He edited the paper. Chunfu Shao advised the theoretical method and reviewed the manuscript. All authors have reviewed and approved the final manuscript.

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