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I Saw the Sign! Using Behaviourally-Informed Signs to Encourage Parking Compliance

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Knowledge Summary: This project aimed to improve compliance with paid parking in the City of Vancouver. New "Behavioural Insights informed" parking signs incorporated salience by increasing sign and font size and adding more colour. Due to feasibility constraints, the control and BI-informed signs were compared in a quasi-experimental trial between two locations in the city. Although the BI-informed signs did not significantly increase parking compliance, the project team has several recommendations, including trialing in other locations and trialing signs incorporating other Behavioural Insights.

Keywords: *behavioural insights, nudge, salience, loss aversion, compliance, signage, parking*

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Executive Summary

The goal of the project was to nudge drivers in the City of Vancouver to increase compliance with on-street metered parking. In the City of Vancouver, there are approximately 12,000 metered parking spaces. Metered parking is an important source of revenue for the city, collecting about $60 million annually from parking fees. It is estimated that even a 1% increase in compliance would generate a revenue increase of thousands of dollars. Also, as on-street metered parking is carefully calibrated to meet parking demand, an increase in compliance will ensure that drivers can find parking when they need it.

Cognitive, social, and situational barriers affect paid parking compliance. These include unfamiliarity with the parking payment process, being unaware that parking spots are metered, confusion caused by multiple and unclear signs, and failure to notice signs due to environmental factors, amongst others.

Pilot data collection revealed a base rate of 69% for compliance. An exploratory survey asked drivers why they chose not to comply with paid parking and to identify ways in which paying for parking could be made easier. This revealed improved signage as the top suggestion to make paid parking easier.

Based on our findings, the project team, along with the City of Vancouver and PayByPhone, designed a set of BI interventions to improve paid parking compliance. The interventions aimed to make the parking signs and paystations more visible by highlighting salient information, to provide timely prompts to drivers to pay at the time of parking, and to influence conscious cues to pay for parking when exposed to the interventions.

The effectiveness of the BI signage intervention was tested in a field experiment. Two areas of the city were selected and divided into treatment and control conditions. Data was collected over a three-week period by city officials who scanned vehicle license plates using handheld scanners and recorded paid or not paid for each vehicle. The results showed that the BI signage intervention did not significantly affect paid parking compliance compared with the control condition.

Overall, the team was able to work with the city to implement a unique BI solution in a timely and effective manner. Although the team did not find significant results, null results are helpful for clients to assist them to identify BI interventions that do not work and to avoid a poor return on investment. Based on these results, we recommend that additional research be conducted in other locations within Vancouver as well as adjusting the BI solutions to include other key features.

Part A. Problem Background

There are approximately 12,000 metered on-street parking spaces in Vancouver, from which the city collects $60 million annually in revenue from parking fees (City of Vancouver, personal communication, October 21, 2021). Metered parking is an essential source of revenue for the City of Vancouver and is also used to help manage the demand for parking. When drivers do not comply with paid parking regulations, the demand for parking can exceed the supply, making it difficult for users to find parking when needed. Non-compliance can also result in parking fines for those who do not pay.

This study aimed to increase compliance for metered on-street parking by implementing a Behavioural Insights (BI) solution to nudge non-compliant drivers to pay for parking. A nudge is defined by Thaler and Sunstein (2021, p. 8) as "…any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives." The City of Vancouver estimates that even a 1% increase in compliance would generate a revenue increase of approximately $600,000 annually. As such, increasing compliance would help to increase the city's annual revenue, as well as ensuring that there are enough parking spaces available to meet demand. According to the City of Vancouver, there are 200,000 unique PayByPhone app users each month (City of Vancouver, personal communication, October 21, 2021). A secondary goal was to increase the use of the PayByPhone app within the City of Vancouver.

Payment non-compliance is often framed as an example of deviant behaviour (Adams & Webley, 1997). Other behaviours classified as "deviant" range from parking in loading zones, sidewalks, or handicapped spaces and speeding (McAndrews & Li, 2017). Most studies that focus on payment non-compliance assume that people make rational decisions and that, based on the cost-benefit ratio, if it is not in their best interest, people will not pay for parking (Shoup, 2017). However, research has shown that people are not rational actors (e.g., Tversky & Kahneman, 1974).

To better understand the magnitude of paid parking non-compliance, we obtained parking data from the Seattle Department of Transportation (Williams, 2016), which found that 68% of those using metered on-street parking were payment compliant. Of the 32% who were non-compliant, 53% did not pay at all, 24% had expired time, 14% had extended beyond time limits, 8% were parked illegally, and 1% were recorded as delivery vehicles or taxis. These results are similar to a study conducted by Seattle in 2011 with payment compliance rates of approximately 69% across 16 areas of the city (McAndrews & Li, 2017). Our team asked the city of Vancouver to collect pilot data on pay parking compliance to obtain a current base rate for Compliance, which was found to be 69% across two areas of the city.

Additionally, we constructed an exploratory survey to better determine why some drivers choose not to pay for parking (see Appendix I for full details). Survey questions were created using Qualtrics online software and employing Prolific, an online participant recruitment program paying respondents $0.62 per survey. As shown in Table 1, when asked to rate the importance of reasons for not paying for parking, the main reasons given were: In a hurry or did not have time, time on the meter ran out, did not think they would get a ticket, and did not know it was paid parking.

Table 1. Reasons in Terms of Importance that Led Respondents Not to Pay for Parking (1-7 scale; N = 96)

Reason	Mean
In a hurry/didn't have time	4.64
Time on the meter ran out	4.36
Didn't think I would get a ticket	4.30
Didn't know it was paid parking	4.16
Preferred to risk a ticket	3.86
Distracted/forgot to pay	3.40
Too difficult to pay for parking	3.40
Didn't have enough money	3.08
Unsure how to pay for parking	2.92
Other	2.16

We also asked respondents an open-ended question: "Is there anything you can think of that would be helpful to make paying for street parking easier?" As shown in Appendix 2, responses were arranged into five main categories: signage (49%), payment (43%), parking (35%), PayByPhone app (27%), and other (1%).

Part B. Behaviour and Context

Population of Interest and Target Behaviour

The population of interest is drivers parking in the City of Vancouver's 12,000 metered on-street parking spaces. To measure on-street paid parking compliance, City Enforcement Officers often use handheld scanners to check licence plates of vehicles occupying parking spaces to determine if those vehicles have paid for parking. A count of on-street parking violation tickets could be considered as an alternative measure of non-compliance.

Touchpoints

Drivers can be reached through signage on streets, information displayed at parking meters and paystations, and through the PaybyPhone app. There are thousands of parking regulation signs and hundreds of paystations and pay meters in the City of Vancouver. With the City's approval, the existing parking signs and decals can be modified or replaced as part of a BI intervention. Additionally, a subset of the population can be reached directly via the PayByPhone app. However, since the majority of people who use the app are already compliant with paid parking regulations, this may not be the most efficient touchpoint for an intervention.

Key Barriers

Based on the insights from the exploratory survey conducted with the drivers in the City of Vancouver, some of the potential reasons that lead drivers not to pay for parking include:

1. Drivers fail to notice parking signs due to environmental factors. For example, parking signs are located

too far away, are obstructed by trees, have poor lighting, or have low visibility due to weather.
2. Drivers are confused by the presence of multiple parking signs and unclear which sign applies.
3. Drivers cannot read the small texts on the parking signs from their vehicles due to distance.
4. Drivers are unfamiliar with the parking payment process.
5. Drivers are uncertain that they are in a paid parking area.

We can further break these reasons for non-compliance down by identifying specific cognitive, social, and situational barriers.

Cognitive

1. If parking signs are located too far away, or are obstructed from view, drivers may fail to notice them.
2. Multiple parking signs confuse drivers and make it unclear which signs apply.
3. Due to the small font size on parking signs, drivers may find the signs difficult to read or misunderstand the information on the signs. For example, inputting the wrong location number into the mobile app.
4. Drivers are unclear about the consequences of non-compliance (i.e., parking fines).

Social

1. Drivers often do not see other drivers using pay machines, which decreases the normative aspect of paying for parking. For example, as many drivers pay for parking using the mobile app, paying for parking is not noticeable.
2. Drivers know of others that have not paid for parking and gotten away without a fine or penalty.

Situational

1. Drivers do not have enough cash to pay for parking.
2. Drivers only need to park for a quick "in and out."
3. Drivers do not accept that some spots are metered or think the parking fee is unfair.
4. Drivers believe the chances of getting a ticket or the vehicle being towed are low.

Several BI tools are appropriate to help address and overcome the cognitive problems described above due to our limited attention. These BI tools can help to increase accessibility, convenience, and simplification to influence drivers' behaviour by tapping into what Kahneman calls System 2 thinking. This mode of thinking is our conscious processing that "allocates attention to the effortful mental activities that demand it…[and] are often associated with the subjective experience of agency, choice, and concentration" (Kahneman, 2011, p. 21). For example, looking for information on paid parking procedures.

These behavioural insights aim to nudge the drivers to comply with on-street paid parking by:

1. Attracting drivers' attention by making the parking signs and paystations more visible and easier to spot.
2. Simplifying and making the payment process easier with easy-to-understand instructions.

Part C. BI Solution

Overall, our survey, cross-jurisdictional scans, and literature review indicated that paying for parking could be easier and that the signage could be clearer. In fact, a meta-analysis by Luo et al. (2021) identified effort and attention as being the most effective BI interventions. Below we expand on these concepts borrowing from the EAST framework (Behavioural Insights Team, 2014) and the MINDSPACE framework (Behavioural Insights Team, 2010), applying them to our BI solution.

Salience

Salience is a concept from the EAST framework wherein our attention is drawn to what is novel and to what seems relevant to us—what 'grabs' our attention (Behavioural Insights Team, 2014). Because we are inundated with an overwhelming number of stimuli every day, we unconsciously 'tune out' a lot of it from registering consciously. For example, we are more likely to filter out things that blend in, are inaccessible, or are complex. Because respondents reported that they "didn't know it was paid parking" as a main reason for failing to pay for parking and as the suggestion to "make paid parking easier" was related to making the messaging for the parking sign perfectly clear, we were able to quickly narrow our focus onto salience.

Ease

Simplifying messages to make them clearer often helps to increase communication response rates. *Make It Easy* from the EAST framework focuses on reducing friction toward a behaviour in order to help people adopt or increase that behaviour (Behavioural Insights Team, 2014). To make it easier for drivers to see the parking signs from further away, we increased the font size of the location numbers, increasing the likelihood of compliance. Additionally, we included payment method icons and information on where to download the PayByPhone app to make it easier for drivers to understand the expectation of payment. We initially thought to include a QR code to make it easier for drivers to download or open the PayByPhone app, but we abandoned the idea due to the risk of the signs being vandalized with fraudulent QR codes.

Priming

Priming is a concept drawn from the MINDSPACE framework. Although priming is often framed as acts being "influenced by subconscious cues" (Behavioural Insights Team, 2014, p. 8), here we are focusing on conscious priming. In essence, if people are exposed to certain sights, they may behave differently thereafter. For example, if someone sees the redesigned "park and pay" sign with information on how to pay for parking, they should be primed to use the PayByPhone app, paystation, or meter to pay once they park and see similar stickers on other paystations.

Design

To make street parking signage more salient, easier to act upon, and leverage priming we recommended incorporating several design updates:

1. Separate the existing sign into two separate signs to increase real estate for critical messaging.
2. Make the signs a reflective colour, such as the City of Vancouver's neon green.
3. Enlarge location numbers.
4. Add stickers with similar designs to the street-facing sides of paystations and digital meters.
5. Include information on how to pay for parking, an infographic design, and pay parking options directly on street signs.

We could not move forward with our exact design due to budget and timing constraints; however, the final designs used in the trial included the most essential recommended features.

Figure 1. Images of the existing and BI-informed signage.

(a) Existing sign

(b) Behavioral-insights informed sign

(c) Existing stickers

(d) Behavioral-insights informed stickers

The BI tools identified above are appropriate to address the problem because they are true nudges that are easy to implement but also easy for drivers to avoid (Thaler & Sunstein, 2021). One of the most important characteristics of nudges is that they are *liberty-preserving* in that, although choice architects attempt to steer target persons in a particular direction, they are still free to choose otherwise. Additionally, the suggested nudges are beneficial to drivers, and drivers would be expected to judge that benefit for themselves. In this sense, although some drivers are serial non-compliers who may prefer to risk a possible ticket over a guaranteed payment, it is believed that most drivers fail to comply for other reasons such as time constraints or forgetfulness. In this way, helping to nudge drivers to pay for parking helps them to avoid a fine. Finally, all the interventions described above are optional as drivers maintain freedom of choice and are not forced to make any particular decision.

Part D. Research Design

In our study we employed a quasi-experimental design using a pre-post comparison between treatment and control groups to weigh outcomes (Abadie, 2005; Impact Canada, 2019). In our design, the unit of analysis is the parked car, and the dependent variable is paid or not paid. The independent variables are the BI intervention condition, which consists of new parking signage, versus a control condition that did not receive the intervention.

The assumption is that only the intervention changes between the two measurements. However, because we know this rarely works in practice, we needed to consider time effects that could independently affect the outcome. For example, on-street paid parking compliance may change if a big event is held in the downtown core but not in other areas of the city. To control for time effects, we split each data collection area into two sections (A/B), each with a treatment and control section.

We hypothesized that paid parking compliance would be significantly higher for the treatment condition where drivers' attention is increased with a BI intervention compared with the control condition with no BI intervention. We did not expect a difference in compliance rates between the downtown and Olympic Village data collection areas.

More formally, the hypotheses can be stated as:

- H_0: There will be no significant differences between geographical areas, and no interaction.
- H_a: The treatment signs will lead to higher compliance than the control signs.

Additionally, we were interested in testing specific covariates such as time of day (morning versus afternoon), day of the week, and weather. Finally, we wanted to ensure that we designed the study in such a way as to be able to detect a significant result if one exists. As paid versus not paid is binary data, we investigated inference for proportions (comparing two independent samples; Brant, R., n.d.). In the pilot data, only 79% of 479 potential parking spaces were utilized during the study, leaving 378 parking spaces (189 per group). We determined the proportion of paid parking compliance to be .69 or 69%. We calculated that the power to detect a 3% increase in compliance, approximately 90% of the time at α = .05 (one-tailed), would require a sample size of 3,957 parked cars per condition. To achieve this, we would require data to be collected daily over 21 days or twice daily for 11 days, depending on the availability of city workers to collect the data. The details of the study were pre-registered through www.aspredicted.org.

After an initial discussion with our contact at the City of Vancouver around potential target areas for the BI intervention within the Vancouver area, the team suggested an area within the downtown core and an area outside the downtown core (i.e., Olympic Village; see Appendix IV). Each data collection area, although fixed, was manually divided into two even sections. These sections were then randomized using an online research randomizer to indicate which section would receive the treatment conditions and which would receive the control conditions. Two city workers were assigned to collect data each day by walking a predetermined data collection area of the city and by following a specific route. A handheld scanner was used to record each parking space's data (i.e., paid or not paid—the dependent variable).

Main Location Number Signs

The final design was developed by our team in conjunction with the city and created by the design team at PayByPhone. As shown in Figure 2a, the final design included a 45cm x 45cm aluminum sign, scaled down from 45cm x 90cm, incorporated the parking symbol, City of Vancouver logo, paystation number, PayByPhone

information, and where to download the app. The signs were intended to be created from aluminum blanks. However, due to a shortage of sign blanks and limited time, the signs were created out of coroplast (corrugated plastic). The signs would last for at least a year in the field—more than enough time to complete the trial.

The newly designed BI signage included several additions from the original regulatory signage:

1. The signage was larger than the original regulatory signage.
2. The location numbers were much larger to make the location number easier to read from farther away.
3. Most of the sign was covered in a bright green backing to make it more salient.

Figure 2. The BI-informed signage.

(a) BI-informed sign

(b) BI-informed paystation sticker for a location

(c) BI-informed paystation sticker for a single space

Paystation Stickers

Along with the City of Vancouver and PayByPhone, the team designed new stickers to be applied to the paystations, including a parking symbol, the location number on the front and both sides of the paystation, and PayByPhone information. The sticker design is an 11” x 13” decal to be placed on the back of the paystation (street-facing; see Figure 2b) and did not include location numbers on the sides of the paystations.

The team also advocated including new stickers for some single space meters within the testing area. These new stickers were created by PayByPhone based on the team’s specifications and included the same characteristics found in the larger stickers (see Figure 2c).

Installation and Data Collection

For street locations where there was no other existing sign infrastructure, some temporary posts were installed. Sign installation was delayed a handful of times due to other city events taking priority. City workers collected data using handheld scanners across two areas of the city—one in downtown Vancouver (DT) and one in the Olympic Village (OV) area of Vancouver.

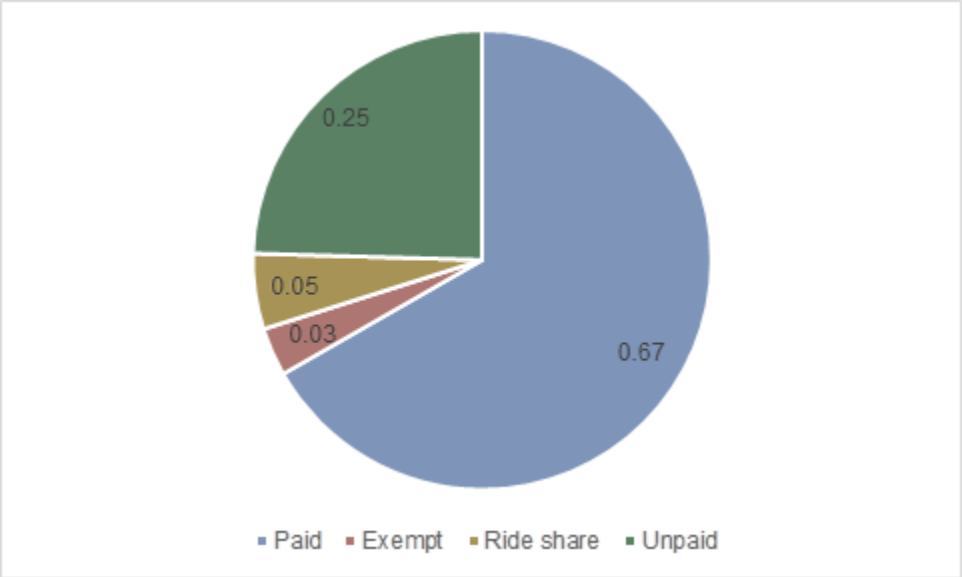
Part E. Research Results

Descriptive Statistics

The parking compliance study was conducted between April 25, 2022, and May 26, 2022. The sample size included 7,764 parked cars, with 3,580 in the treatment condition and 4,172 in the control condition. In the downtown area, there were 976 parked cars in the treatment condition and 1,834 parked cars in the control condition area. In the Olympic Village area, there were 2,604 parked cars in the treatment condition and 2,338 in the control condition.

As shown in Figure 3, we found that overall, 5,666 parked cars were paid, 293 were exempt, 455 were ride-shares, and 2,085 were unpaid or non-compliant. In our analyses, we focused exclusively on paid versus unpaid, which showed that overall, 73% of parked cars were compliant (27% non-compliant). It is also important to note that only 59% of the total parking spaces available during the study (N = 14,437) were occupied.

Figure 3. Overall Proportion of Vehicles Included



Inferential Statistics

We used a simple proportional test to determine paid parking compliance between the treatment and control conditions. In contrast to our hypothesis, we found that compliance in the treatment condition (73%, N = 3,580) was significantly lower compared with the control condition (75%, N = 2,338), z = 2.81, p = .002, one-tailed. However, as this was a one-tailed test, a result in the opposite direction is non-significant. We compared this result against the pilot data collected by the City of Vancouver in 2021. Dividing the data in the same way as the experimental data (i.e., the regions later randomized into treatment and control conditions) simply to compare the pilot data proportions to the experimental data proportions, we found non-significant results, z = 0.7897, p = .21, although the trend was in the same direction (control: 70%, N = 788; treatment: 68%, N = 764). Our findings suggest that adding signs with larger location numbers and brighter colours had no significant effect and may have served to decrease paid parking compliance. However, comparing the experimental and pilot data, the proportion of paid parking compliance in the treatment area did not change. As such, there appears to be an existing trend in the data with location-based differences in compliance.

Using Univariate Analysis of Variance (ANOVA), we compared the conditions and data collection areas in a 2 (Condition: treatment vs. control) x 2 (Area: Downtown vs. Olympic Village) design on overall compliance, as shown in Table 2. There was a main effect found for condition, $F(1, 7735) = 4.489$, p = .03, and a main effect

for area, $F(1, 7735) = 72.330$, $p < .001$, which were qualified by a significant interaction between condition and area, $F(1, 7735) = 12.709$, $p = < .001$. To determine where the differences lay, we conducted a post-hoc Tukey HSD test. As shown in Table 3, compliance in the treatment condition in the downtown area was significantly lower than in the control condition, and significantly less than the Olympic Village treatment condition. There were no significant differences between the control conditions in either area and no significant differences between treatment and control conditions in the Olympic Village area.

Table 2. Means and Standard Deviations for Condition by Study Area, Downtown (DT) vs. Olympic Village (OV)

Condition	***Study Area***	***Mean***	***SD***	***N***
Control	DT	0.700	0.459	1834
	OV	0.753	0.431	2330
Treatment	DT	0.638	0.481	976
	OV	0.768	0.422	2599

Table 3. Post Hoc Comparisons - Condition by Study Area, Downtown (DT) vs. Olympic Village (OV)

		Mean Difference	***SE***	***t***	p_{tukey}
Treatment DT	Control DT	-0.061	0.017	-3.502	0.003
	Treatment OV	-0.130	0.017	-7.849	< .001
	Control OV	-0.114	0.017	-6.802	< .001
Control DT	Treatment OV	-0.069	0.013	-5.112	< .001
	Control OV	-0.053	0.014	-3.863	< .001
Treatment OV	Control OV	0.016	0.013	1.237	0.603

Note. P-value adjusted for comparing a family of 4

Using an ANOVA, we tested a 2 (Condition: treatment vs. control) x 3 (Weather: Cloudy, Rainy, Clear) design to determine if the weather during the days in which data was collected influenced paid parking compliance, as shown in Table 4. There was no significant main effect found for condition, $p = .250$, but a main effect for weather, $F(2, 7733) = 23.414$, $p = < .001$, $\eta_P^2 = .006$. This main effect was qualified by a condition x weather interaction, $F(2, 7733) = 3.683$, $p = .025$: In the treatment condition, cloudy was significantly different than rainy, and significantly different than clear, and rainy was significantly different than clear. In the control condition there were no significant differences between cloudy and rainy or cloudy and clear; there was a significant difference between clear and rainy.

Table 4. Post Hoc Comparisons - Condition by Weather

		Mean Difference	*SE*	*t*	p_{tukey}
Treatment Cloudy	Control Cloudy	0.001	0.014	0.090	1.000
	Treatment Rainy	0.085	0.022	3.854	0.002
	Control Rainy	0.024	0.018	1.322	0.773
	Treatment Clear	-0.061	0.016	-3.689	0.003
	Control Clear	-0.040	0.017	-2.320	0.186
Control Cloudy	Treatment Rainy	0.084	0.022	3.857	0.002
	Control Rainy	0.022	0.017	1.283	0.795
	Treatment Clear	-0.062	0.016	-3.871	0.002
	Control Clear	-0.041	0.017	-2.455	0.138
Treatment Rainy	Control Rainy	-0.061	0.024	-2.507	0.122
	Treatment Clear	-0.146	0.023	-6.200	< .001
	Control Clear	-0.125	0.024	-5.201	< .001
Control Rainy	Treatment Clear	-0.084	0.020	-4.302	< .001
	Control Clear	-0.063	0.020	-3.140	0.021
Treatment Clear	Control Clear	0.021	0.019	1.106	0.879

Note. P-value adjusted for comparing a family of 6

Additionally, we tested the influence of time of day on paid parking compliance using a 2 (Condition: Treatment vs. Control) x 2 (Time of day: AM vs. PM). City workers collected data from 10:30 am to approximately 5:00 pm. We found no main effect for condition, $p = .81$, and no significant interaction effect, $p = .90$. There was a main effect found for time of day, $F(1, 7735) = 7.454$, $p = .017$, in which compliance rates are higher during the morning ($M = .76$, $SD = .43$) compared with the afternoon ($M = .72$, $SD = .45$).

Finally, we also tested differences between condition and day of the week on paid parking compliance as weekdays might also influence paid parking compliance. As such, we tested a 2 (Condition: Treatment vs. Control) x 5 (Day of the week: Monday, Tuesday, Wednesday, Thursday, Friday) design, as shown in Tables 6 and 7. Using an ANOVA, results indicated that there was no main effect for condition, $p = .31$, and no interaction effect, $p = .11$. There was a main effect for day of the week, $F(4, 7729) = 1.878$, $p < .001$, $\eta_P^2 = .003$. A follow-up post hoc comparison showed that compliance was greater on Fridays ($M = .77$, $SD = .42$) compared with Mondays ($M = .70$, $SD = .46$), Tuesdays ($M = .68$, $SD = .47$), and Wednesdays ($M = .72$, $SD = .45$), and marginally significant compared with Thursdays ($M = .73$, $SD = .44$).

Table 5 Means and Standard Deviations for Day of the Week

Condition	*Day*	*Mean*	*SD*	*N*
Control	Friday	0.744	0.437	907
	Monday	0.722	0.448	522
	Thursday	0.731	0.444	1257
	Tuesday	0.694	0.462	196
	Wednesday	0.725	0.446	1282
Treatment	Friday	0.784	0.412	1008
	Monday	0.675	0.469	372
	Thursday	0.730	0.444	977
	Tuesday	0.638	0.483	94
	Wednesday	0.717	0.451	1124

Table 6. Post Hoc Comparisons by Day of the Week

		Mean Difference	*SE*	*t*	p_{tukey}
Monday	Tuesday	0.027	0.030	0.888	0.901
	Wed	-0.019	0.017	-1.099	0.807
	Thursday	-0.028	0.018	-1.601	0.497
	Friday	-0.063	0.018	-3.486	0.004
Tuesday	Wed	-0.046	0.028	-1.658	0.460
	Thursday	-0.055	0.028	-1.977	0.277
	Friday	-0.089	0.028	-3.194	0.012
Wed	Thursday	-0.009	0.013	-0.691	0.958
	Friday	-0.043	0.014	-3.205	0.012
Thursday	Friday	-0.034	0.014	-2.500	0.091

Note. P-value adjusted for comparing a family of 5

Part F. Recommendations

In this study, we hypothesized that paid parking compliance would be significantly higher for the treatment condition where drivers' attention is increased by a BI intervention compared with the control condition with no BI intervention; we did not expect a difference in compliance rates between the data collection areas (downtown vs. Olympic Village). Our research results indicated that our behaviorally informed signs did not significantly impact paid parking compliance rates in the downtown or Olympic Village study areas. Additionally, neither area had a difference in pre-trial vs. trial compliance rates. Rather than helping non-compliant drivers become compliant, our signage changes may only have made it easier for compliant drivers to pay for parking.

To our knowledge, there has only been one other effort to determine paid parking compliance in the City of Vancouver. Hence, the current study helps to give insight into compliance rates and some reasons why people comply or do not comply with paid parking.

Based on the results of the current study, we recommend the following:

1. Do not scale

We do not recommend scaling the BI solution at this time. Although it is easy and inexpensive to implement the updated signs and decals from the study across to other parts of the city, we do not expect a return on investment for the city. Additionally, implementing the updated design could negatively impact future BI solutions to increase parking compliance by making it more difficult to detect a significant change in behaviour and confusing drivers with frequently updated signs.

2. Trial in new area

We suggest conducting additional research to better understand the results of the current study. In particular, the current study employed larger location numbers, brighter colours, as well as implementing new signage and stickers directly on the paystations. However, we discovered an anomaly that appears to be inherent in the choice of data collection area with compliance being greater in the downtown location for the control condition compared with the treatment condition—this anomaly was also found in the pre-trial data. As such we recommend choosing a different location to conduct additional research using different control and treatment locations. It is also recommended that data collection should be synchronized so that data is collected concurrently for both data target areas. This way any third variables due to time effects can be controlled.

3. Refresh BI solution and trial

We also recommend adjusting the BI solution by conducting another experimental study incorporating other BI design elements such as a larger sign face, bigger location numbers, a reflective coating, and including secondary 32mm x 32mm regulatory signs with the new BI design as the team believes that the additional signage would provide greater real estate for the BI sign messaging. The BI team based the original BI solution on exploratory research. Due to feasibility constraints, not all of these elements could be trialed. As the current BI intervention did not significantly increase paid parking compliance, paid parking compliance may be influenced by making the BI interventions even bolder.

Moreover, we recommend trialing a very different or stronger BI intervention. According to Baumeister and colleagues (2001), negative experiences are more powerful than positive ones (also see Rozin & Royzman, 2001). Loss aversion occurs when negative events carry more weight than positive events of the same amount (Kahneman & Tversky, 1979). In short, "pain is more dear than pleasure" (Johnson, 1774, p. 60). Loss aversion is often seen in studies looking at tax payment compliance. For example, Engstrom et al. (2015) looked at the

tax filing behaviour of Swedish taxpayers filing for the 2006 year. They found that taxpayers who owe additional taxes were more likely to claim deductions than taxpayers who expected a tax return. A BI solution that could be implemented to increase pay parking compliance would be through the use of slogans such as "Parking Enforcement in Effect" or "Don't Risk It, Avoid a Ticket". The idea is to tap into the user's sense of loss aversion. It is important to note that some researchers have illustrated that loss aversion does not happen for losses seen as small-to-moderate and only has an effect where significant amounts of money are at stake (i.e., a loss of $1000 or more; Yechiam, 2019). According to our exploratory data, of the 149 respondents who did not pay for parking, only 53 had received a parking ticket in the city of Vancouver, while the majority (96) had not received a ticket. Further, when asked about the cost of a street parking ticket in Vancouver, many respondents underestimated the actual cost of a ticket. To them, a seemingly small loss may be enough for them to risk the ticket.

Another slogan such as "You're Not a Cheater, Pay the Meter", is expected to invoke a positive view of oneself because being seen as 'good' is important to most people. So, when a person reads, "You're Not a Cheater…" it would be expected to tap into the desire to be good and, thereby, increase compliance. However, research has also shown that moderate levels of negative emotions like shame, guilt, and fear can also be very motivating. In fact, according to Habib et al. (2021) negatively framed messages are often more effective than their positive counterparts because they trigger anticipated shame. In this way slightly modifying the previous slogan to "Don't Be a Cheater, Pay the Meter" may be more effective in combating non-compliance as it activates anticipated shame.

4. Iterate and innovate

If large cities in North America choose to conduct research around BI solutions and interventions, we suggest beginning with high traffic areas as these are the spaces that we feel would garner the highest compliance increases. It is highly recommended to run a qualitative study to better understand why some people are non-compliant and to compare those findings to the initial research and assumptions from the current study. Further, we suggest that larger cities collect data intermittently across different areas of the city in order to ensure compliance increases. We also recommend collecting data in different areas of the city, if feasible, as the non-significant results of the current study may be localized to the data collection areas chosen.

Part G. Discussion of BI & Research Ethics

Overall, our study adhered to current ethical guidelines. Our planned BI solution maintains freedom of choice, as individuals will be free to disregard the "nudge" to pay for parking (Thaler & Sunstein, 2021). In our estimation, the intervention was wholly transparent and complied with the publicity principle, which can be described as feeling comfortable if others (or the media) know that you are attempting to influence a person to change something using a BI intervention (Thaler & Sunstein, 2021). Because we are trying to increase compliance with a program that benefits society, the potential harms related to getting more people (including economically disadvantaged and vulnerable populations) to pay for parking do not outweigh these benefits.

Multiple parties are invested in increasing paid parking compliance: the City of Vancouver, PayByPhone, and our BI team. Of the three, PayByPhone may be the most motivated to increase paid parking compliance as it would be expected to increase revenue and extend contracts with the City of Vancouver. The city is concerned with allowing people to find parking when needed and collecting additional revenue. The BI team wants to "nudge for good" to help drivers quickly find and pay for parking. Although slightly different motivations are at play, there was no conflict of interest.

One ethical consideration worth noting for our intervention is that participants were not aware that they were participating in a research study. As such, they were not able to give informed consent to their participation and were not debriefed about the study. However, according to article 3.7A of the Tri Council Policy on research ethics (Canadian Institutes of Health Research et al., 2018), the Research Ethics Board (REB) may consider an alteration to the informed consent policy if the research is considered a minimal risk to participants, is unlikely to adversely affect participants, and if it is impossible to address the research question and carry out the research if informed consent was first required. Additionally, because our intervention meets the criteria for the publicity principle and that most drivers will be familiar with paid parking in Vancouver, we are satisfied that our research complies with expected ethical standards. To ensure all ethical considerations, the research procedure and plan were overseen by the UBC REB ethics board and project supervisor.

Part H. Project Reflections

By and large, the team was successful at creating a unique BI solution and were able to work with the city to implement that solution in a timely and effective manner. Although we found null results, identifying BI interventions that do not work are helpful for clients. In this situation the client may be spared from spending a large amount of money on new signage around the city that would not result in increased paid parking compliance and therefore would be a poor return on investment.

One of the challenges that we experienced was not being able to collect data at both data collection locations simultaneously to control for any time effects or other variables outside of our control. This was the result of issues around scheduling data collection that were unanticipated. As a result, we are unable to speak to any variables that may have affected data collection in one or both areas. For example, we found an interaction effect between condition and area which showed that compliance in the control condition for the downtown area was significantly higher compared with the treatment condition downtown. Is this an anomaly with the area which we chose to collect data or is it something else? We are also aware that a marathon was held in downtown Vancouver during some of the data collection dates, which may have inadvertently affected compliance. Similarly, as a result of other priorities happening in the city at the same time as data collection, we were also unable to consistently collect data on every weekday, which was unexpected.

Because the scope of our intervention was limited, a more dramatic intervention may yield different results (e.g., larger signage, regulatory signage, and QR codes). However, we also recognize that small signage changes may be ineffective. For example, it may be more practical to trial significant, sweeping changes to determine an effect, even at the risk of not easily disentangling the impact of multiple components of a BI solution.

We do wonder how much parking compliance might be based on attitude issues rather than behaviour. Perhaps we did make it easier for people who were already predisposed to be compliant to see the signs and pay for parking, but timely, salient, and easy to act upon signage appears to not be effective enough to drive serial non-compliers to pay for parking.

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Appendices

Appendix I. Survey Questionnaire

1. Have you ever paid for street parking within the City of Vancouver?
    a. Yes — proceed to next question
    b. No — proceed to question 10
    c. Unsure — proceed to question 10

2. How familiar are you with paying for street parking using a paystations in the City of Vancouver (as opposed to the coin-only parking meter)?

Not familiar						Very familiar
1	2	3	4	5	6	7

3. How often do you use paystations to pay for street parking in the City of Vancouver?
    a. Most of the time
    b. Some of the time
    c. Infrequently
    d. Never

4. How often do you use the PayByPhone app to pay for street parking in the City of Vancouver?
    a. Most of the time
    b. Some of the time
    c. Infrequently
    d. Never

5. Have you ever received a parking ticket for street parking within the City of Vancouver?
    a. Yes
    b. No
    c. Unsure

6. In your estimation, what is the cost of a street parking ticket in the City of Vancouver?
    a. $21 or less
    b. Between $22 and $45
    c. Between $46 and $77
    d. Between $78 and $99
    e. Over $99

7. Have you ever not paid for street parking when you were supposed to, even if you did not receive a parking ticket?
    a. Yes - proceed to next question

b. No - proceed to question 9

c. Unsure - proceed to question 9

8. Please rate the following reasons in terms of their importance that led you to not pay.

a. In a hurry/didn't have time to pay

Not important						Very important
1	2	3	4	5	6	7

b. Didn't know it was paid to park

Not important						Very important
1	2	3	4	5	6	7

c. Distracted/forgot to pay

Not important						Very important
1	2	3	4	5	6	7

d. Too difficult to pay for parking

Not important						Very important
1	2	3	4	5	6	7

e. Didn't have enough money to pay for parking

Not important						Very important
1	2	3	4	5	6	7

f. Didn't think I would get a ticket

Not important						Very important
1	2	3	4	5	6	7

g. Unsure how to pay for parking

Not important						Very important

1	2	3	4	5	6	7

h. Preferred to risk a ticket

Not important						Very important
1	2	3	4	5	6	7

i. Time on the meter ran out

Not important						Very important
1	2	3	4	5	6	7

j. Other (please state) _____

Not important						Very important
1	2	3	4	5	6	7

9. Is there anything you can think of that would be helpful to make paying for street parking easier?

10. What is your age _____

11. What gender do you identify with?
    a. Male
    b. Female
    c. Two spirit
    d. Non-binary
    e. None of the above. I identify with _____

12. Where do you live?
    a. Downtown Vancouver
    b. Greater Vancouver area
    c. Lower Mainland B.C.
    d. Outside of Lower Mainland B.C.
    e. Other ____

Appendix II. Exploratory Research

How Big of an Issue is Non-Compliance?

The task set out for the team in this project was to identify a BI solution to help increase metered on-street parking compliance. To help identify BI solutions to alleviate non-compliance, we first need to understand the problem. In other words, why do some drivers choose not to pay for on-street parking?

First, it is important to understand the scope or extent of paid parking non-compliance. As such, we obtained parking data from the Seattle Department of Transportation (Williams, 2016) in Seattle, Washington. The study recorded pay-to-park compliance for 457 total spaces with 30-minute observations from 8 am to 8 pm over a single day in 2016. The results showed that 73% of vehicles were general paid parking, while other vehicles such as Car2Go, government vehicles, service vehicles, and disability placards made up most of the other vehicles recorded. Of the 73% of vehicles recorded as general paid parking, 32% were found to be payment non-compliant. Breaking non-compliance down further, they found that 53% simply did not pay, 24% had expired time, 14% were extending time beyond time limits, and 8% were parked illegally—1% were recorded as delivery vehicles or taxis. Additionally, Seattle is one of many cities that use the PayByPhone app. They noted that 91% of payments were made at paystations, and only 9% used the PayByPhone app. These results are similar to a study conducted by the City of Seattle in 2011 with payment non-compliance rates of approximately 31% across 16 areas of the city (McAndrews & Li, 2017).

The City of Vancouver conducted a parking compliance study in 2015 (Streets and Transportation, 2015). Data was collected from every meter in the city (approximately 10,000 meters at that time) with 5 persons using handheld scanners, working 5 hours per day for 5 days. On average, pay parking non-compliance across the city of Vancouver was found to be 19%.

Our team asked the City of Vancouver to collect some pilot data on pay parking compliance to obtain a current base rate for non-compliance. They employed city workers using handheld scanners to walk two mapped areas—one in downtown (DT) Vancouver and one in the Olympic Village (OV) area of Vancouver. These two maps accounted for 479 parking spaces (DT = 278; OV = 201). There were 281 observations x block collected with 1,780 vehicles recorded. Of these, 1,074 were paid, 86 were exempt (city vehicle, veteran's plates, exemption decal), 128 were rideshare vehicles (Evo, Modo, Zero), and 475 were non-compliance (non-compliant unoccupied and non-compliant occupied).

These observations were broken down into 4 main categories: vehicles paid, vehicles exempted (city vehicle, veteran's plates, exemption decal), car share vehicles (Evo, Modo, Zero), and vehicles unpaid (non-compliant unoccupied and non-compliant occupied). As shown in the graph below, non-compliance was found to be 27% overall (31% when compared only with vehicles paid). Non-compliance rates were similar for both map areas measured with downtown non-compliance 27% and the Olympic Village area non-compliance 28%.

Overall, non-compliance rates were similar in our current compliance analysis (27%) and for both the 2015 (32%) and 2011 (31%) studies completed in Seattle, Washington. Parking non-compliance was found to be lower in the 2015 study by the Vancouver's Streets and Transportation (19%). The differences between these groups of studies may be that the first three were only carried out in some parts of the city, whereas the 2015 study in Vancouver was city-wide. As such, there may have been some particular areas of the city with very low compliance rates that brought the average down.

Why Do People Choose Not to Comply?

Payment non-compliance is often framed as an example of deviant behaviour (Adams & Webley, 1997). Other behaviours classified as "deviant" range from parking in loading zones, sidewalks, or handicapped spaces and speeding (McAndrews & Li, 2017). Most studies that focus on payment non-compliance assume that people make rational decisions and that, based on the cost-benefit ratio, if it is not in their best interest, people will not pay for parking (Shoup, 2017). However, research has shown that people are not rational actors and that their behaviour, in fact, is often irrational (e.g., Tversky & Kahneman, 1974).

There is a scarcity of literature looking at the reasons for non-compliance with paid street parking. However, other literature may be helpful to identify similar characteristics such as fare evasion on transit (e.g., train or bus) and tax evasion. Fare evasion has been characterized as falling within the broader category of "dysfunctional consumer behaviour" or "consumer misbehaviour" and is compared against other "petty crimes" such as shoplifting or tax evasion (Delbosc & Currie, 2019). Delbosc and Currie (2016) showed that fare-evaders scored lower on honesty and higher on aggression and risk-taking. Fare evaders are also often higher-income earners and educated (undergraduate degree; Cools, Fabbro, & Bellemans, 2016). A number of studies have found that attitudes, social norms, customer dissatisfaction, and customer experience or justification influence a person's decision to engage in these kinds of dysfunctional behaviours (Alm et al., 2012).

To overcome fare evasion using behavioural techniques, some studies have made riders' self-concepts salient by installing mirrors above paystations paired with a positive message focusing on positive attributes and identity (McGuffin, 2017), social norm messaging such as "9 out of 10 train customers pay their fares" (Cassidy, 2018), or using an image of watching eyes combined with descriptive social norm messages (Ayala et al., 2019).

We constructed an exploratory survey to better determine why some drivers choose not to pay for parking. Survey questions were created using Qualtrics online software and employing Prolific, an online participant recruitment program paying respondents $0.62 per survey. The survey took approximately 5 minutes to complete and included 12 questions. A total of 374 responses were recorded. Based on IP information, four respondents completed the survey twice. As such, these extra survey completions were removed from the analysis. Ninety-nine respondents answered no to the question, "have you ever paid for street parking within the City of Vancouver" and were removed from the analysis, which left a total of 271 respondents.
These respondents included 150 females, 116 males, 3 non-binary, and 2 who chose not to disclose their gender. The age of respondents ranged from 18 to 68 years of age (4 respondents did not disclose their ages). Forty-nine percent of respondents reported residing in the Lower Mainland (Downtown Vancouver, Greater Vancouver area, or Lower Mainland, BC), while 24% reported residing outside of the Lower Mainland, BC, and 27% chose "other." Respondents who chose "other" indicated that they had either previously lived in the Vancouver area or had visited in the past.

When asked to rate their reasons, in terms of importance, for not paying for parking, the main reasons given were: in a hurry/didn't have time, time on the meter ran out, they did not think they would get a ticket, and did not know it was paid parking. These findings are similar to the assumptions for non-compliance suggested by the City of Vancouver: drivers being unaware they are in a paid parking area, being uncertain how to pay for parking, or preferring to risk a possible fine over a sure payment.

In terms of the familiarity of using paystations to pay for parking, most users (74%) rated their familiarity as 4 or higher on a 7-point scale, with 7 indicating "very familiar." When asked how often respondents used pay

stations to pay for parking in Vancouver, it was nearly even, with 133 reporting “most or some of the time” and 138 indicating “infrequently or never.” In terms of using the PayByPhone app, 37% of respondents said that they use the app most or some of the time, while 28% use the app infrequently and 34% reported never using the app.

Can We Make Paying Easier?

In our Vancouver Parking Survey, we asked respondents an open-ended question: Is there anything you can think of that would be helpful to make paying for street parking easier? One hundred and three respondents answered “no” or a variation thereof. The remaining 155 responses were arranged into five main categories: signage (49%), payment (43%), parking (35%), PayByPhone app (27%), and other (1%). These categories, and examples, are included below.

Signage. The signage category includes five sub-categories:

- Parking Sign (e.g., Clear signs of when to pay, Clear signs with times, Having instructions on the machines or on posters on the streets)
- App (e.g., Make the app better, promote the app more for travellers or make it more commonplace)
- Paystations (e.g., Alternate payment methods, brighter colours used for paystations)
- QR Code (e.g., A QR code that brings you to a page to pay right away instead of having to search for it, QR codes to make lookup easier)
- Awareness (e.g., Making the apps more efficient and applicable to all areas of the City, Apps are the best way)

Payment. The payment category includes seven sub-categories:

- Charged for Time Used (e.g., Automated cameras that send you a message how much you owe, RFID tags on cars to auto-bill for the length of stay)
- Payment Option: Tap to Pay (e.g., touch-free pay, or via an app, Tap to pay by the stalls)
- Payment Option: Debit (e.g., Debit terminals on the street)
- Payment Option: Mobile Payment (e.g., Implementation of google pay, Pay with Apple pay or Ali pay)
- Payment Option: Other (e.g., Prepay card, pay electronically on a website)
- Payment Option: Cash/Coins (e.g., Maybe keeping coin/cash option available)
- More Paystations (e.g., Have more paystations available)

Parking. Parking includes two sub-categories, namely:

- Parking Availability (e.g., More parking most parking availability proper planning for adequate street parking, Increase parking supply and on-street/curbside parking provision)
- Cost of Parking (e.g., Reduce prices, make the cost of parking tickets lower)
- PayByPhone. The PayByPhone category includes two sub-categories:
- App Improvement (e.g., More user-friendly apps)
- App Feature (e.g., A setting to autoload and then renew? Like when you park, say put $20 there and keep renewing until you come back?)

Other. (e.g., A street camera that takes a picture of the car licence plate in order to make sure no one gets away without paying. And if they do, they get a parking bill in the mail with a penalty fee).

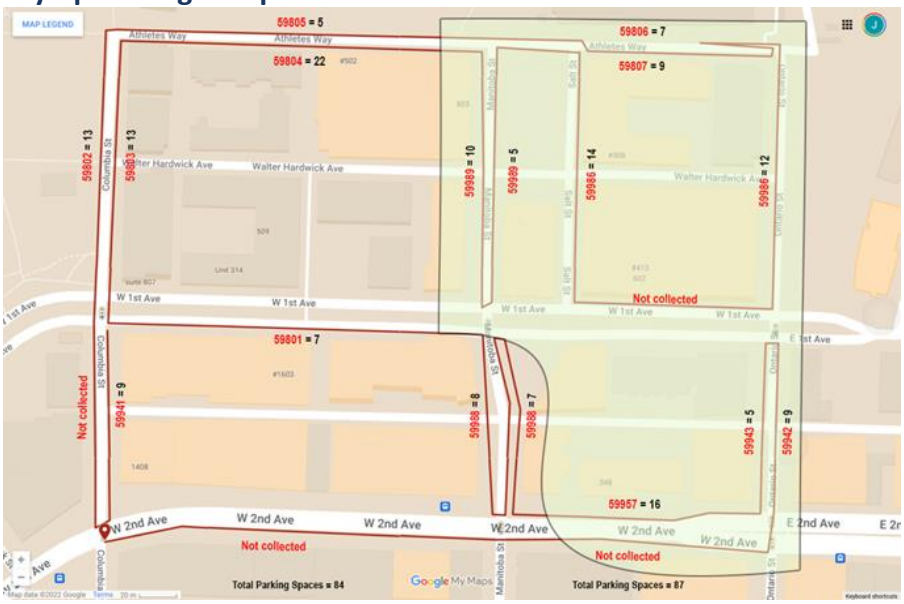
Appendix III. Data Categories Coded by Handheld Scanner

- Date - calendar date when data was collected
- Location ID - coded number for block (e.g., 1, 2, etc.)
- Study Area – mapped area within trial (e.g., DT, OV)
- Block ID – combination of location ID and study area (e.g., DT1, OV5)
- GIS METER ID – street name and block number
- SIDE – North, South, East, or West side of the street
- PBP # Location number for paystations
- Rush Regs
- TOTAL CAR SPACES – total car spaces within the block
- Total Car Spaces Override
- Confirm Spaces (Space length = 6 m) (DO NOT USE FOR OCCUPANCY CALCULATION)
- Spaces removed due to patios/parklets/construction (Space length = 6 m)
- Vehicles present at start time - vehicles present when data collector arrived
- Vehicles paid – vehicles recorded as paid as per handheld scanner
- Vehicles exempted (City vehicle, veteran's plates, Exemption Decal) - vehicles exempted as per handheld scanner
- Evo vehicles – ride sharing vehicle as per handheld scanner
- Modo vehicles – ride sharing vehicle as per handheld scanner
- Unoccupied Vehicles unpaid (non-compliant) – unoccupied and unpaid vehicle as per handheld scanner
- Occupied Vehicles unpaid (non-compliant) – occupied and unpaid vehicle as per handheld scanner
- Valid Check

Appendix IV. Mapped Data Collection Areas

Downtown Vancouver Map

Olympic Village Map



Note: Shaded areas within the mapped data collection areas are the treatments conditions.