# Down with the sickness? Los Angeles burglary and COVID-19 restrictions

Joshua Hill[1,2] · George Raber[1] · Laura Gulledge[1]

## Abstract

**Objectives** To provide a partial test of routine activities theory through a spatio-temporal analysis of the impacts of COVID-19 restrictions on burglary in Los Angeles.
**Methods** Spatial point pattern tests, clustering, and non-parametric permutations tests were used to identify changes in burglary in the highest restriction period of 2020 as well as comparison periods for the past 10 years while controlling for the zoning within Los Angeles.
**Results** COVID-19 restrictions significantly increased crime in commercial/industrial areas while it reduced crime in residential areas.
**Conclusions** The predictions of routine activities theory were supported in regard to the importance of capable guardianship. Findings indicate that not only were the areas expected to see an increase in capable guardianship shown to have reduced crime, but that crime more generally across the city became more commercially oriented in terms of zoning as more individuals were confined to residential areas.

**Keywords** COVID-19 · Spatio-temporal · Quasi-experiment

## Introduction

The COVID-19 pandemic and the associated stringencies that have been put in place in an effort to curtail the spread of the disease have generated considerable changes in everyday life. From individual mask-wearing mandates to city-level lockdowns and bans on international travel, the effects of the pandemic have touched individuals, neighborhoods, cities, and nations. One of the intended consequences of the stringencies that have been implemented has been to reduce the confluence of people in time and space, thus reducing the likelihood of contagion. Put differently,

✉ Joshua Hill
joshua.b.hill@usm.edu

1   The University of Southern Mississippi, 118 College Drive, Box #4042, Hattiesburg, MS 39406, USA

2   Institute for Advanced Analytics and Security, Hattiesburg, MS, USA

the changes that have been put in place have led to a change in the routine activity at the micro-level with people required to stay home, the meso-level with businesses across cityscapes forced to close their doors to customers and patrons, and the macro-level with nation-states restricting movement potential and thus in many cases commerce across borders (Felson et al., 2020).

These observable changes in people's routine activities appear to have had profound effects on whether, where, and when crime occurs. Indeed, a multitude of media and police reports, as well as scholarly studies, have highlighted the significant effect that the pandemic and associated stringencies has had on crime across localities around the world (Felson et al., 2020). There have been some possible exceptions, notably with domestic violence (which increased, at least temporarily), vehicle theft, and motor vehicle violations (Mohler et al., 2020; Piquero et al., 2020). Many of these reported changes have been borne out in the quickly growing literature surrounding crime and the pandemic (Ashby, 2020; Borrion et al., 2020; Mohler et al., 2020).

A large proportion of this literature, however, has been limited in its scope to the temporal dimension of crime patterns (Ashby, 2020; Borrion et al., 2020), largely ignoring the question of whether during this period of unprecedented and punctual change in routine activity the location of where crime emerged followed a similar spatial trajectory in terms of where it clustered in space (for an exception, see Felson et al., 2020). This paper seeks to—at least partially—fill this gap in the literature on COVID and crime by analyzing intra-city spatial burglary patterns across the post-restriction period, the period immediately prior to the lockdowns, and the same period from previous years. It does so by isolating a specific crime, burglary, in a specific spatio-temporal context: Los Angeles in the highest lockdown period. This focus allows us to better understand a crime that is likely to be among the most highly impacted by changes in routine activities, and as such, provides context in which to understand COVID's effects on crime more generally, and routine activities and environmental criminology's predictions more specifically. In the section that follows, we detail the theoretical framework that underpins the hypotheses explored herein. Next we describe the crime and target data that are leveraged for the analysis as well as the analytical process that is utilized. The results of the analysis are then described along with their implications for practice, policy, and theory. We conclude with a discussion about some potential limitations of the current study, but also steps for future studies that will better enable researchers to more completely understand what happened to crime during the pandemic.

## Theoretical background

### Routine activities and crime

Studies examining the relationship between people's environments and crime are nothing new (Harries, 1976). Not only have the geographic components of criminality been widely examined, but the relationships between specific sets of socio-demographic characteristics and features of the built environment have been

widely studied (Felson & Eckert, 2019; Morenoff et al., 2001). The findings are, generally, unambiguous: crime is affected by some combination of both the social and built features of a given environment (Kurland & Johnson, 2019; Mletzko et al., 2018; Weisburd & Telep, 2014; Weisburd et al., 2012). Numerous theoretical explanations for the relationship between the geography of cities and criminality exist. Arguably, routine activity is the most influential of these approaches (Cohen & Felson, 1979; Felson & Cohen, 1980; Massey et al., 1989; Tillyer & Eck, 2011). Specifically, Cohen and Felson's (1979) original article examined how structural changes in the spatial and temporal dimensions of society might explain changes in crime patterns, proposing that their routine activity approach could account for increases in crime in the USA after WWII. During a time at which women were moving into the workforce, and various social conditions were arguably improving, the authors suggested that these structural changes had inadvertently caused crime to increase as daily activities were diverted away from households which then also facilitated increased opportunities for crimes to occur (Cohen & Felson, 1979; Felson, 2016). In this approach, crime is the result of the influence of spatial and temporal conditions of everyday life, and the routine activities (e.g., family, work, leisure) that structure it. The three main components identified by Cohen and Felson (1979) are (1) motivated offenders, (2) suitable targets, and (3) capable guardians. The authors proposed that crime increases when there is a convergence in time and space of these three main components. Specifically, crime is more likely to occur when there exists people who are motivated to commit a crime, a potential target or victim of criminal victimization is available, and the presence of a guardian, who could deter or intervene in these processes, is absent (Cohen & Felson, 1979).

Routine activity suggests that a change in any of these three components would then also change the crime rate, and that crime is merely a function of risk. The more exposure to risk, specifically embodied by motivated offenders, suitable targets, and a lack of capable guardianship, the greater the likelihood of crime occurring (Felson & Eckert, 2019; Tillyer & Eck, 2011). As noted above, this risk has both spatial and temporal dimensions, as places of business, for instance, have more potential guardians during normal business hours (and under what would have been previously described as normal conditions), while empty homes have less during the same hours (if the occupants are away). The patterns of activities that emerge from the normal rhythm of everyday life constitute the "routine activities" that condition the locations and times where crime is most likely to emerge. Relevant to the current study, the COVID-19 pandemic caused dramatic changes in the routine activities of people across the world at the micro-, meso-, and macro-level (Buchanan et al., 2020; Felson et al., 2020; Goh et al., 2020). Forcing businesses to close and shelter-in-place orders led to predictable changes in people's daily activity — including both temporal and spatial dimensions. Children, for instance, were taken out of school, and daycares closed, while non-essential businesses were either closed outright or forced to reduce their interaction with customers (Felson et al., 2020; Hawdon et al., 2020; Mohler et al., 2020). Evidence shows that these changes, in turn, had some impact on the level of crime within cities (Ashby, 2020), though differences have not been entirely consistent (Ashby, 2020; Piquero et al., 2020), owing

the multitude of units of analysis and methods employed in the various COVID and crime studies, as the next section will discuss.

## COVID and crime

Shortly after routine activity within cities shifted due to pandemic-related stringencies, there was anecdotal evidence that crime too had shifted as a result of COVID-19 (Felson et al., 2020). This evidence included a variety of sources like police reports and news sources (Felson et al., 2020). Early empirical studies indicated that crime had shifted in ways that could be accounted for by changes in routine activities associated with COVID-19. For instance, those crime types that require suitable targets or victims in Los Angeles such as robbery, shoplifting, theft, and battery all declined, but the same effect was not found for motor vehicle theft, burglaries, assault with a deadly weapon, or intimate partner violence (Campedelli et al., 2020). An academic review of the evidence shows that Los Angeles was not the only city to note such ostensible declines, New York, San Francisco, Chicago, and Philadelphia also experienced crime declines during the "lockdown" periods in early 2020 (McDonald & Balkin, 2020).

Other quantitative studies that were undertaken shortly after the lockdown period commenced have examined the question of COVID-19's impact on criminality and crime. Ashby (2020), using a seasonal ARIMA to generate weekly forecasts for the shelter-in-place period, in one of the earliest analyses (just 16 weeks after the start of the pandemic), found that the pandemic response had mixed impact on crime across 16 cities. Specifically, he found that assaults in public did not decrease, while in some cities there were changes in residential burglary rates but no changes in non-residential burglary. Findings regarding motor-vehicle thefts were also mixed when comparing cities (Ashby, 2020). McDonald and Balkin (2020) also found mixed results using the Balkin-McDonald street crime model regarding auto-theft across 5 cities (findings were more consistent with other street crimes — showing decreases), where Balmori de la Miyar et al. (2020), using a difference-in-difference model, found that organized crime generally was unaffected in Mexico City, Mexico.

In another recent study, researchers utilized time series analyses to examine the impact of pandemic restrictions on various types of crime across multiple countries and cities finding that stay-at-home orders were associated with reductions in urban crime, but showed considerable variation across cities and types of crime (Nivette et al., 2021). Utilizing a difference-in-difference model with data from 25 large US cities, Abrams (2021) found that while some types of crime increased (e.g., burglaries and car theft), others remained unchanged (e.g., homicide and shootings) or decreased (e.g., theft, simple assault, and rape). Again, while many cities showed reductions in crime, substantial variation existed across cities. In one of the only studies to investigate cybercrime during this period, Buil-Gil et al. (2020) utilized Poisson mean tests and found an increase during the initial, strictest months of the lockdown in the UK, while Gerell et al. (2020) examined levels of crime in Stockholm, Sweden, a city and country for which there was no official lockdown, and

found that assaults, pickpocketing, and burglary had decreased while robberies and narcotics crimes remained unchanged.

Other researchers identified increases in domestic violence, at least initially, in response to pandemic restrictions, while some found this may have decreased thereafter (Goh et al., 2020; Leslie & Wilson, 2020; Piquero et al., 2020). There have been some suggestions that family violence may have also increased due to the restrictions (Zhang, 2020). Conversely, a recent systematic review and meta-analysis on studies assessing the impact of COVID-19 on domestic assault found that most estimates indicate a significant positive effect of the pandemic on this type of violence (Piquero et al., 2021). Indeed, researchers have been critical of some of the aforementioned methodological techniques and the dissemination of these findings to the public and media, in particular relation to family violence offenses, as these have important implications not only for policy but also for continuing pandemic mitigation efforts (Reingle Gonzalez et al., 2020).

In terms of routine activities theory itself, these findings can be interpreted as generally consistent with the theory. Despite some findings seemingly contradicting the theory's predictions (e.g., public assaults, auto-theft), these can be seen in terms of either the time-frame in which the studies were conducted — lockdowns were largely new at the time of those studies — or in terms of unknowns in particular elements of the theory, like domestic violence where there is an unknown effect on capable guardianship, but an increase in the proximity of offenders and suitable targets for significant amounts of time. Since the initial COVID-19 restrictions, there may have been shifts in these crimes as well, to be more in line with traditional hypotheses derived from routine activities theory, and indeed, it seems as if the later studies tend to find more support. Additionally, it is likely that there were inconsistencies in both the degree and times of restriction enforcement across cities, making findings particularly hard to interpret relative to routine activities theory.

Also of theoretical significance within this discussion is the incorporation of Felson's more recent work in which he revisits the meaning of a guardian (Felson, 2006), defining guardianship as "someone whose mere presence serves as a gentle reminder that someone is looking" or "ordinary citizens going about their daily lives but providing by their presence some degree of scrutiny" (Felson & Boba, 2010, p. 28, 37). Felson provides a notable distinction here that guardianship is not social control as it does not involve the intent to control the acts or behaviors of motivated offenders. Relevant to the current study and its focus on burglary, the impact of COVID-19 restrictions likely removed guardians from commercial areas more so than law enforcement officers, who continued to work and function as formal agents of social control in those areas. Taking into account Felson's refining of the concept of guardianship, however, these same restrictions would affect residential areas differently as the majority of regular citizens who were forced to stay at home would then be providing considerably more passive guardianship in those areas. Clearly, more research is needed in the examination of the effects of COVID-19 on crime not only as it relates to both short-term as longer-term trends, but also as to how pandemic restrictions had such variable effects across types of crimes and locations, and what this implies for routine activities theory.

Table 1, below, shows some of the initial findings thus far by crime type.

**Table 1** Crime types and direction of findings

| Author(s) | Single or multi-site | Residential burglary | Commercial burglary |
| --- | --- | --- | --- |
| Ashby | Multi-site | Mixed | Mixed |
| Borrion, Herve, Kurland, Tilley, & Chen | Single | N/A | Mixed |
| Campedelli, Aziana, & Favarin | Single | No change | No change |
| Felson, Shanhe, & Xu | Single | No change | Increase |
| Gerell | Single | Decrease | Decrease |
| Halford, Dixon, Farrell, Malleson, & Tilley | Multi-site | No change | No change |
| Hodgkinson & Andresen | Single | No change | Increase |
| Mohler, Bertozzi, Carter, Short, & Sledge | Multi-site | Decrease | Increase |
| Payne & Morgan | Single | No change | No change |

Perhaps most relevant to the current study, Mohler et al. (2020) examined different crime types in Los Angeles and Indianapolis relative to COVID-19 restrictions. Generalized linear models were used to compare crime levels during the period before, during, and after COVID-19 restrictions were in place, while controlling for a variety of factors (e.g., seasonality). They found that, as in other studies, there were some significant changes in levels of crime, but only for specific categories, and the effects were not always consistent across cities. Regarding burglary, specifically, Mohler et al. (2020) found that there was a decrease in residential burglary but an increase in commercial burglary. This is in keeping with previous findings on routine activities (Nee & Taylor, 2000) suggesting that as people have been forced to stay home due to COVID-19 restrictions, opportunities for burglary have been diminished while commercial burglary opportunities have increased because of less traffic in commercial facilities, and the relative rates of those crimes have followed suit.

These mixed results are interesting both because they suggest unclear patterns in changes across locations and also because they did not consider spatial elements within the cities, more specifically, the constellation of residential dwellings and commercial facilities. Understanding the spatial patterns that did (or did not) emerge is critical to developing a more comprehensive understanding of crime during COVID and importantly for examining the theoretical significance of routine activity for understanding how crime patterns changed during this period. The following section examines the limited literature that has taken on trying to describe (quantitatively) the spatial changes in crime generated by COVID-19, and considers some (of the many) questions that remain unanswered.

## Spatial analyses of COVID and crime

Given the relative recency of the COVID-19 pandemic, the literature examining the spatial components of COVID-19's impact on crime is somewhat limited. In the most notable study thus far to examine the spatial dimension of crime patterns

in the context of the pandemic, Felson et al. (2020) examined COVID-19 restrictions on burglary in Detroit. Using the block-group as the unit of analysis for reasons primarily related to the ability to extract land use information from readily available census data, they partitioned and coded each respective block-group as residential versus mixed land use, and compared the relative changes in rates of burglary across three temporal windows. While novel in its approach, this methodological setup is somewhat problematic. The temporal comparison periods were not matched, and were quite short — which may wash out variation that occurs when examining a longer temporal window. Furthermore, there was no examination of seasonality or trends in the data, which means the relationships identified may overstate (or understate) any differences found. Felson et al.'s (2020) findings suggested that there was little change in block-groups dominated by residential land use, but those with mixed land use saw a significant increase in burglaries.

In a study examining different neighborhoods in Chicago, Campedelli et al. (2020) used structural Bayesian time-series models to first forecast what the expected count of crime would have been in the absence of the COVID-19 restrictions, and then examined differences in reference to specific neighborhood effects using Firth's logistic regression. Their findings indicate that communities did not all respond the same way in terms of crime, and that different correlates seemed to have different effects given different geographical position within the city (Campedelli et al., 2020). Furthering this, Campedelli et al. (2020) again used community-level data in Chicago to examine whether daily trends differ across crimes and communities, as well as what contextual characteristics of these communities were associated with crime reductions. Consistent with prior research, results indicated that COVID-19 restrictions impacted crime in different ways across communities; however, mixed findings emerged in regard to what factors correlated with reductions in crime, with population being the only consistent positively significant factor associated with reductions (Campedelli et al., 2020).

A recent special edition of *Criminology and Public Policy* focused on various effects of COVID-19 on the criminal justice system. One such study examined the impact of lockdowns on criminal activity in Beunos Aires utilizing a victimization survey and data on detainees, as well as georeferenced property crime (e.g., robberies or thefts, burglaries, and larcenies) and reported homicides. Following lockdowns, results revealed a significant drop in property crime with reductions in criminal activity occurring in both commercial and residential areas, with even larger decreases seen in business and transportation areas (Perez-Vincent et al., 2021). The authors suggested that crime became localized as a result of pandemic-related restrictions reducing the average distance between location of criminal activities and detainees' area of residence. Another study in the same edition examined the impact of social distancing orders on gang-related crime in Los Angeles (Brantingham et al., 2021). Utilizing a time series forecasting approach to detect changes in the volume of crime, the authors found that gang-related crime remained stable, overall. Additionally, changes in gang crime spatial correlation before and after pandemic-related restrictions revealed that post-lockdown diffusion of gang-related crime hot spots was not statistically significant. In other words, the spatial distribution of

gang-related crime after restrictions went into effect was no more spread out than what would be expected by chance (Brantingham et al., 2021).

In a recent study that examined spatial changes in crime post-COVID, Moise and Piquero (2021) examined the change in clustering of violent crime during the 3 months following lock-downs in Miami. Results indicated that violent crime fell by roughly 7% in 2020, and although previous years revealed the presence of violent crime clusters, these clusters were unable to be identified during the study period. In the study most closely related to the current study, Yang et al. (2021) examine both the spatial and temporal dynamics of crime in Chicago as affected by COVID-19. Specifically, they used STL decomposition to remove both the trend and seasonal components of time series to test whether 2019 was substantially different from previous years at the daily (and hourly) level, as well as a Watson $U^2$ test to determine the magnitude of the differences across assault, battery, burglary, criminal damage, fraud, robbery, and theft. Findings indicated that while there were significant differences at the daily level, at the hourly level the changes did not reach significance (Yang et al., 2021). Importantly, Yang et al. (2021) also examined the *temporal* distribution of crime in Chicago, finding that there were significant differences in geography between 2019 and 2020 across all crime types, with burglaries shifting towards the downtown area of Chicago.

## The current study

The current study extends the existing literature of COVID-19's impact on crime in two ways. First, we provide a stricter test of RAT's predictions as we (1) limit the temporal window to *only* the periods of time with the highest-level COVID restrictions and (2) we examine robbery specifically in light of commercial/industrial areas relative to those restrictions — a time period in which we should see the starkest differences in crime patterns. Second, we examine this difference going back 10 years in the data, to understand the patterns of change and get an idea of the "difference in difference" of burglary in commercial areas.

To do this, we use several techniques including a spatial permutation approach for comparing point patterns within Census Block Groups, along with a spatially modified Poisson test to compare the counts and rates across the full city. Additionally, we look to see if the *rates* of burglary, irrespective of spatial dynamics, have increased relative to previous periods. Thus, we are able to get a more complete picture of the COVID-19 restrictions' effects upon burglary and more directly test RAT predictions.

## Hypotheses

Given that restrictions related to COVID-19 largely reoriented people from commercial facilities to their homes, and that the most common target for burglaries is residences, there is an expectation that there was a decrease in overall burglaries during the lockdown period, relative to the comparison periods.

More specifically:

$H_{10}$: $\mu_{pre-COVID} = \mu_{lockdown}$

$H_{11}$: $\bar{X}_{pre-COVID} > \bar{X}_{lockdown}$

In addition to the general decrease in burglaries across areas, and again given the change in location by people because of COVID-19 restrictions, there is an expected difference in the direction of the relationships in commercial versus residential areas. Specifically, we would anticipate burglaries in residential areas to *decrease* while we would expect commercial/industrial areas to *increase*. More specifically:

$H_{20}$: $\bar{X}_{commercial_{pre-COVID}} = \bar{\Delta}_{commercial_{lockdown}}$

$H_{21}$: $\bar{X}_{commercial_{pre-COVID}} > \bar{\Delta}_{commercial_{lockdown}}$

And:

$H_{30}$: $\bar{X}_{residential_{pre-COVID}} = \bar{\Delta}_{commercial_{lockdown}}$

$H_{31}$: $\bar{X}_{residential_{pre-COVID}} > \bar{\Delta}_{commercial_{lockdown}}$

Finally, the proportion of areas experiencing difference between pre- and during COVID-19 restrictions will be larger in residential areas, given the higher number of incidents that occur within residential areas.

$H_{40}$: $\bar{\Delta}_{residential} = \bar{\Delta}_{commercial}$

$H_{41}$: $\bar{\Delta}_{residential} > \bar{\Delta}_{commercial}$

## Data and methods

### Study setting — Los Angeles

While there have been at least two studies examining the effect of the lockdown on crime in Los Angeles (Campedelli et al., 2020; Mohler et al., 2020), neither considered the spatial dimension of the city. Given the size and diversity of the Los Angeles, this is likely to have significant impact on any analyses of crime, particularly given the large variation in land-use (Felson & Cohen, 1980). A map of Los Angeles can be seen in Fig. 1, below.

### The LA lockdown

Los Angeles experienced its first COVID-19 death on March 11th, 2020. By March 16th, bars, gyms, and entertainment centers were ordered closed, with restaurants restricted to take out only. On March 19th, there was a statewide stay-at-home order issued, which severely restricted all but those businesses deemed essential, and increased the number of people who were working from and schooling at home. Additional key stringency dates can be seen in Table 2, below. In Fig. 2, the full COVID-19 Stringency Index for California can be seen. The box covers the times of highest restriction early in the COVID lockdown period.
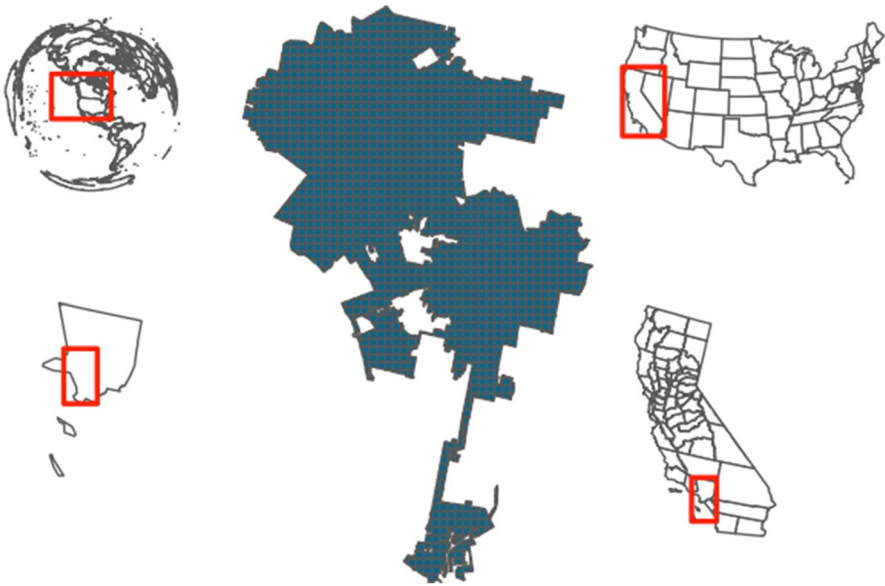
**Fig. 1** Map of Los Angeles

**Table 2** Stringency dates for Los Angeles

| Stringency | Date |
|---|---|
| School closing start | 2020-03-07 |
| Cancel public events | 2020-03-07 |
| Stay at home | 2020-03-11 |
| Restrict gatherings | 2020-03-11 |
| Workplace closures | 2020-03-19 |

It is clear from Fig. 2 that the stringency level rose quickly and remained generally high over much of the course of the pandemic. This, in turn, could have effects on the level of burglary even past the "initial" lockdown period. The initial period of high restriction, which we examine, runs from March 18, 2020, to August 27, 2020.

**Crime data for Los Angeles** Police-recorded crime data was sourced from the Los Angeles data hub (https://geohub.lacity.org/). The data was combined from two datasets within the hub, specifically "Crime Data from 2010 to 2019" and "Crime Data from 2020 to Present" (https://data.lacity.org/browse?q=crime&sortBy=relevance). These datasets contain information on a variety of incident-specific variables, including the crime codes which indicate the primary (and secondary, tertiary, etc.) type of crime for the incident. For purposes of this study, we were interested in incidents coded as "Burglaries" (crime code 310). The level of burglaries for Commercial and Residential areas, as well as the rates of change from the prior year, can be seen in Table 3, below.

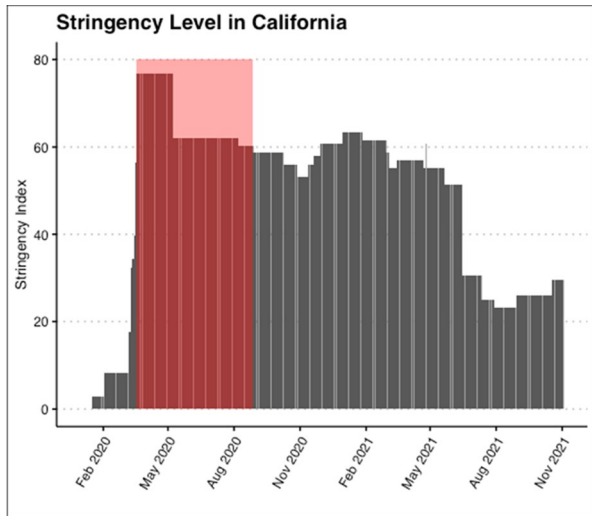**Fig. 2** COVID-19 stringencies in California



**Table 3** Rates of change by year for burglaries in LA

| Year | Rate of change | | Count of robbery | |
|------|----------------------|-------------|------------------------|-------------|
| | Commercial/industrial | Residential | Commercial/industrial | Residential |
| 2011 | Increase by 4.10% | Decrease by − 3.50% | 4426 | 9560 |
| 2012 | Decrease by − 1.70% | Decrease by − 6.00% | 4340 | 8967 |
| 2013 | Decrease by − 8.40% | Decrease by − 1.60% | 3923 | 8808 |
| 2014 | Increase by 0.60% | Decrease by − 4.30% | 3952 | 8380 |
| 2015 | Decrease by − 0.50% | Increase by 8.00% | 3928 | 9169 |
| 2016 | Increase by 2.80% | Decrease by − 6.20% | 4068 | 8558 |
| 2017 | Increase by 6.10% | Increase by 4.00% | 4372 | 8957 |
| 2018 | Decrease by − 0.50% | Decrease by − 2.40% | 4346 | 8719 |
| 2019 | Decrease by − 8.70% | Decrease by − 17.50% | 3916 | 6988 |
| 2020 | Increase by 21.10% | Decrease by − 8.90% | 4966 | 6111 |

## Property type

Data was again obtained from the Los Angeles data hub (https://geohub.lacity.org/) related to the type of zoning in a given area. For purposes of this study, commercial and industrial zoning types were combined, as both were affected by the stringencies. Residential was the other zoning type used. This partition allows for the examination of burglaries not just by geography, but also by *type of target*. This is essential as routine activities theory, and environmental criminology more generally, suggests that crime is shaped by the confluence of motivated offenders
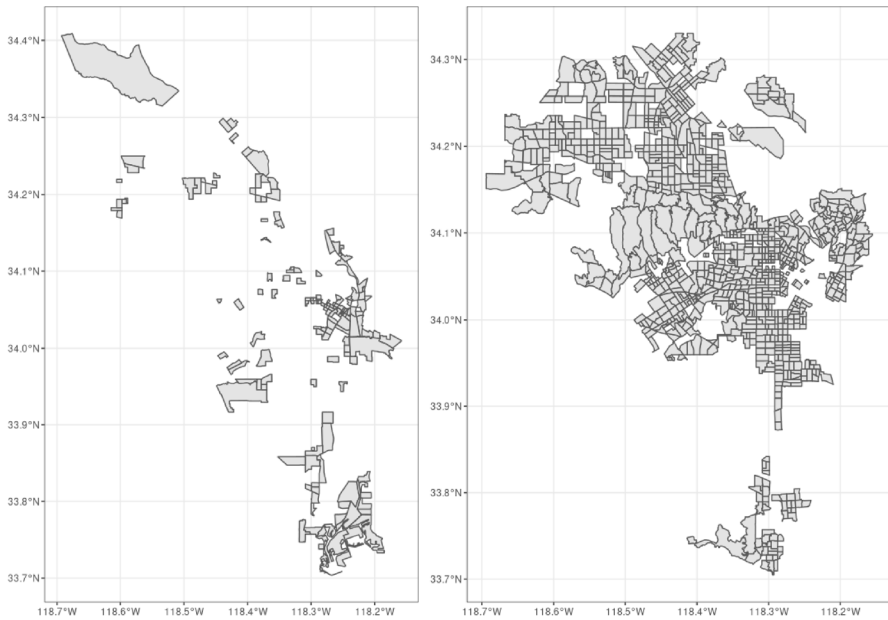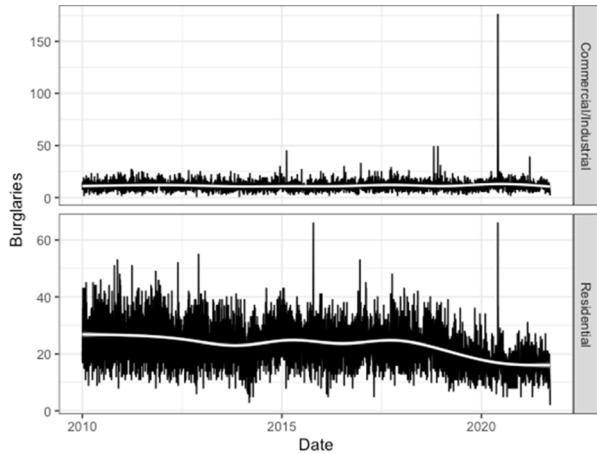
**Fig. 3** Commercial/industrial (left) vs. residential (right) areas of Los Angeles

and suitable targets in time and space. This, in turn, is affected by the distribution of capable guardians, something that business closures during COVID-19 had direct impact upon and which can be measured by separating out residential and non-residential areas of the city.

## Spatial unit of analysis

In order to measure the impact of COVID-19 restrictions not just in terms of target type but also in terms of location within the city, Census Tracts were used.[1] In Fig. 3 below, the divisions between the commercial/industrial sections of Los Angeles, as provided in the zoning data available through the LA Data Hub (https://geohub.lac-ity.org/) are depicted. For purposes of this analysis, and to ensure parsimony regarding the different zoning types, we used *majority* types for overlapping commercial/industrial and residential of the city based on area.

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[1] We also tested other spatial units of analysis, including Census Block Groups and Census Blocks, as well as a "neighborhood" level, as defined by the City of Los Angeles. The findings were largely similar across areal unit types, with the exception of Census Blocks, where the statistical power was too low to examine changes because of the small size of the units, and neighborhoods where there were too few commercial areas for meaningful analysis.

Fig. 4 Burglaries 2019–2020



## Analysis

The following section is divided into two based on the analytic approaches identi-fied above. In the first part, we examine the temporal patterns of burglary relative to residential versus commercial/industrial areas of Los Angeles during the COVID-19 stringencies' peak in 2020 compared to previous years. In the second part, we examine the spatial distributions of burglary, again relative to the different zoning areas as well as in comparison to previous years.

### Temporal analysis

Examining the totality of the dataset (from 2010 to 2021), we can see the variation across time within both the commercial and residential areas of the city in Fig. 4, below.

While there is clearly some variation over the course of the series, it is equally clear that there is a small set of days with a significant spike. This spike is related to the #BlackLivesMatter protests that took place in late May, 2020. In the subsequent analyses, a smoothed version of the variable was used, to account for the outlying nature of burglaries on that date.[2,3] A smoothed version of the data for 2019–2020 can be seen in Fig. 5, below.

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[2] The median was used to replace any value greater than 5 times the standard deviation above the mean of burglaries.

[3] There were no substantive changes in the results between the smoothed and unsmoothed versions of the dataset. The smoothed was chosen to ensure that there was no influence of a single small period of time.

**Fig. 5** Burglaries 2019–2020,
smoothed
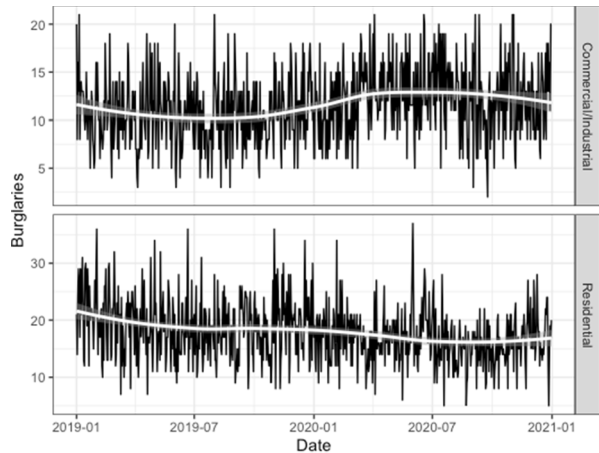


## STL decomposition

Though there was clearly a decrease in the number of burglaries from the previous
year in residential areas as seen in Table 3, it is important to examine the differ-
ences in the context of overall seasonal and trend patterns. To account for these,
STL decomposition was done on the daily series across all years within the dataset.
The seasonal component was done weekly, while the trend was across 90-day peri-
ods. The results of this can be seen in Fig. 6, below.

Of particular importance in Fig. 6 is the trend across the series. This is a roll-
ing 3-month ($n = 97$ days) period examining changes in the trend of burglary across
commercial and residential areas. The trends are quite different between the years,
with burglary in commercial areas trending generally down in 2019, but up sharply
in the period of interest in 2020. We see a similar pattern in residential burglaries
across the years of interest as well. Particularly important to note is the trend in
residential burglaries, which at its highest level in 2020 does not reach the lowest
level in 2019, indicating a significant reduction in the number of burglaries across
the period of interest. The magnitude of the difference is not quite as high for com-
mercial and industrial areas, but both the direction and magnitude of the trend is
substantially different in 2020 in the expected direction.

## Non-parametric permutation test

In addition to the STL decomposition, we use a permutation[4] test to examine
whether the differences between 2019 and 2020 for the period of interest are sig-
nificant. Additionally, we tested previous years to understand whether these changes

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[4] The non-parametric permutation test was used because of the non-normality of the distributions. It was
calculated by randomly permuting 10,000 times across each set of comparison years, and identifying the
mean difference for each permutation. The resulting distribution of mean differences was then used to
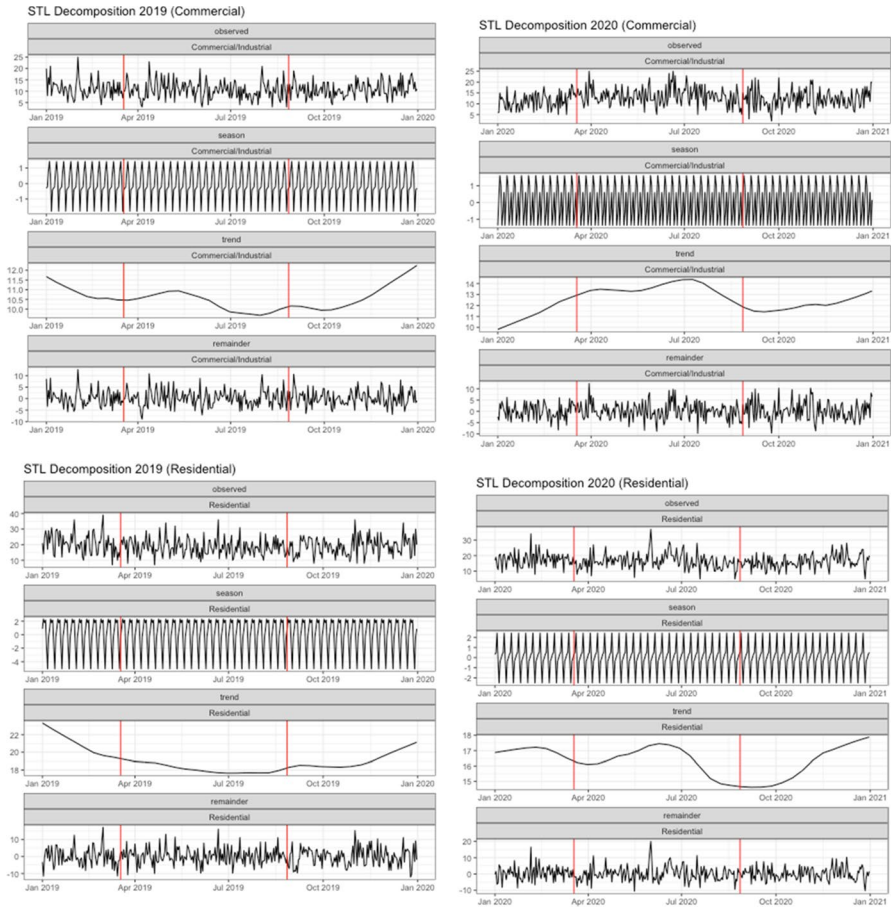estimate the significance of the actual mean difference between years.

**Fig. 6** STL decomposition plots by type, 2019 and 2020

**Table 4** Permutation test results, year over year

| | Commercial/industrial | | Residential | |
|---|---|---|---|---|
| Year comparison | Mean difference | *p*-value | Mean difference | *p*-value |
| 2020–2019 | 4.155 | .000 | − 1.696 | .0171 |
| 2019–2018 | − 0.901 | .061 | − 5.161 | .000 |
| 2018–2017 | − 0.460 | .580 | − 0.0745 | 1.0 |
| 2017–2016 | 0.646 | .314 | 0.646 | .701 |
| 2016–2015 | 1.056 | .029 | − 1.335 | .124 |
| 2015–2014 | − 0.752 | .162 | 1.311 | .132 |
| 2014–2013 | − 0.068 | 1.0 | − 1.342 | .159 |
| 2013–2012 | − 0.5652 | .377 | 1.025 | .391 |
| 2012–2011 | − 0.491 | .598 | − 2.460 | .007 |

were consistent year over year, or unique to the comparison of 2019 and 2020. The results for this analysis can be seen in Table 4, below.

Examining Table 4, we can see that the year-over-year change in the examined period is generally stable in commercial/industrial areas, with only one significant change aside from 2020 to 2019. Additionally, the magnitude of the difference in 2020–2019 is much larger than even the previous significant period (2016–2015) — at roughly four times higher. Residential areas are somewhat less stable over time, with significant changes in 2020–2019, 2019–2018, and 2012–2011. Furthermore, though the largest magnitude change was in 2019–2018, it is worth noting that even after such a sharp decline, the decline in burglaries the year before, the decline in burglary in residential areas was still significant during the pandemic lockdown period.

In total, both of the above analyses suggest that the pandemic had the effects anticipated in crime, temporally speaking. Burglaries in commercial areas sharply increased during the most stringent portion at the beginning of the pandemic, and residential burglary decreased — even with a large decrease in the year prior.

## Spatial analysis

While the temporal analysis is suggestive, examining the spatial elements of the changes in burglary related to COVID restrictions helps to identify specific areas where crime changed.

### Poisson point pattern test

Examining the results from the Poisson spatial point pattern test (PSPPT), we can see that there are similar differences in 2019–2020 as there were in the temporal results. Important to note is the directionality of the tests. Because the hypotheses derived from existing research were directional, one-tailed tests were used for each of the zoning areas. In the case of residential areas, the direction of difference was *less*, with the reference year being the most recent. In the case of the commercial/industrial areas, the direction of the test was *greater*, again with the later year as reference. Specifically, we can see that in the commercial/industrial areas the largest change in terms of proportion of areas took place in the last year of the analysis — during the COVID restrictions' highest levels. Additionally, commercial/industrial areas showed a larger proportion of areas changing than did residential areas in 2020–2019. The full results can be seen in Table 5, below.

### Residential

Examining the maps in Figs. 7 and 8 below, we can see that there are not many areas that have experienced significant differences between 2020 and 2019, indicating that

**Table 5** Global difference and similarity by year

| Years | Residential | | Commercial/industrial | |
|---|---|---|---|---|
| | Global D (less) | Global S (less) | Global D (greater) | Global (greater) |
| 2020–2019 | 0.048 | 0.952 | 0.134 | 0.866 |
| 2019–2018 | 0.061 | 0.939 | 0.027 | 0.973 |
| 2018–2017 | 0.047 | 0.956 | 0.054 | 0.946 |
| 2017–2016 | 0.035 | 0.965 | 0.034 | 0.966 |
| 2016–2015 | 0.044 | 0.956 | 0.054 | 0.946 |
| 2015–2014 | 0.048 | 0.952 | 0.054 | 0.946 |
| 2014–2013 | 0.055 | 0.945 | 0.034 | 0.966 |
| 2013–2012 | 0.042 | 0.958 | 0.020 | 0.980 |
| 2012–2011 | 0.059 | 0.940 | 0.007 | 0.993 |
| 2011–2010 | 0.049 | 0.951 | 0.027 | 0.973 |

though the *overall* rates of burglary declined, that decline was limited to a small number of areas (roughly 5%). This is generally consistent with the year-over-year changes from other tests, with the proportion of areas experiencing change ranging from 3.5% (in 2017–2016) to a high of 6.1% (in 2019–2018).

**Commercial**

When examining the results from the commercial/industrial areas, we can see that, as with the residential areas, the changes evident in the temporal analysis are happening in a limited number of places. However, unlike the residential findings, 2020–2019 provided the greatest proportion of difference across all year comparisons examined. In fact, the 13% difference between the years represents the greatest difference in the dataset, doubling the next closest year comparison (2018–2017). This can be seen in Figs. 9 and 10, below.

Across both, it is clear that the effects of the COVID stringencies were inconsistent across zoning type, though in the expected direction in both cases. The stringencies affected a higher proportion of the commercial/industrial areas than the residential areas. These effects seem to be in line with the temporal analysis, which suggested that commercial/industrial areas experienced a larger difference in crimes during the period of highest lockdown relative to previous years at the same time than did residential areas. Interestingly however, despite the large changes in relative *numbers*, the proportion of areas with significant differences in burglary was fairly small — certainly in the case of residential areas. This is largely in keeping with previous literature on RAT and spatial changes in crime.

**Moran's I and spatial change relative to zoning**

Similar to Yang et al. (2021), we examined the spatial clustering of the burglary pattern on the landscape. First, we calculated the global Moran's I statistic at
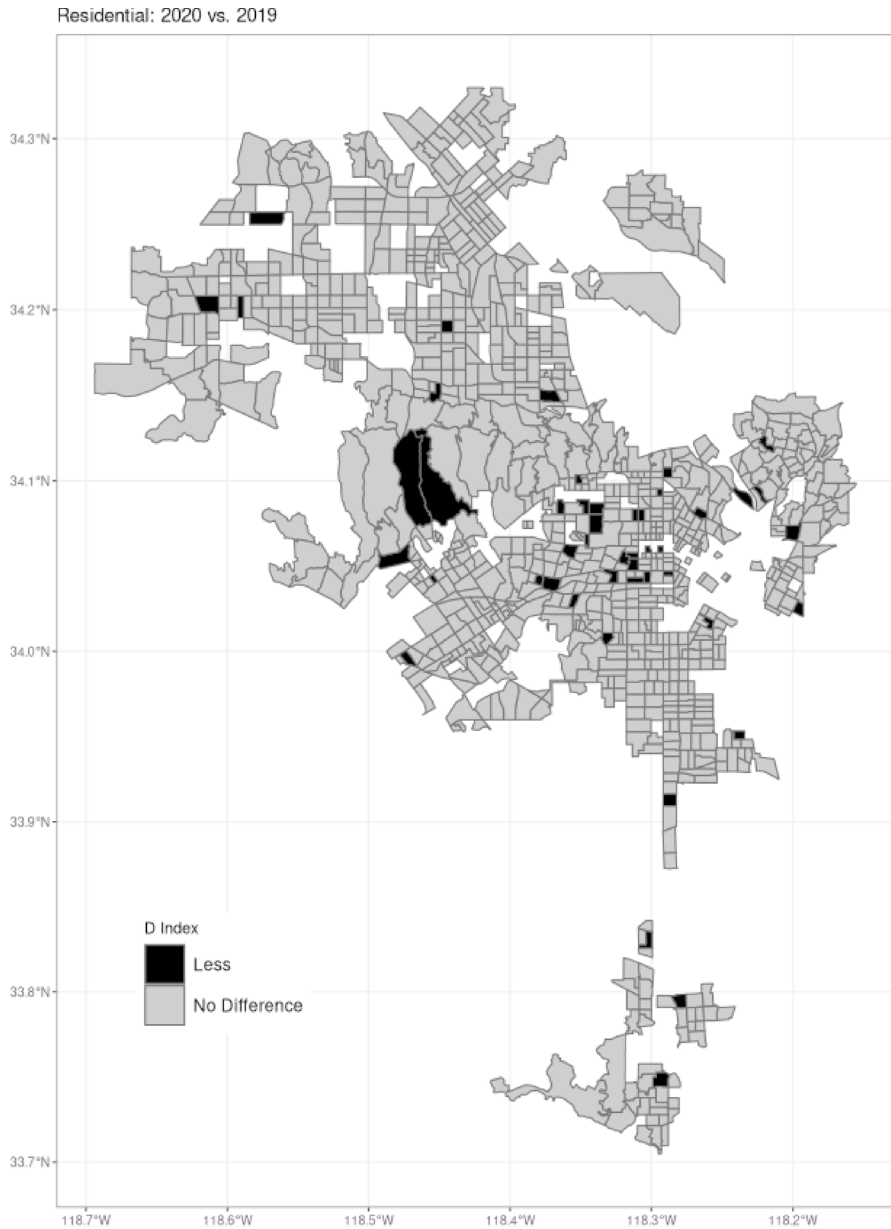
**Fig. 7** Poisson spatial point pattern test — residential

the block group level for 2019 and 2020. We also calculated the statistic on the difference in burglaries for each block group between the two years. The weighting used in the Moran's I calculation defined a neighbor relationship (weight of 1) to include those polygons sharing at least one common vertex
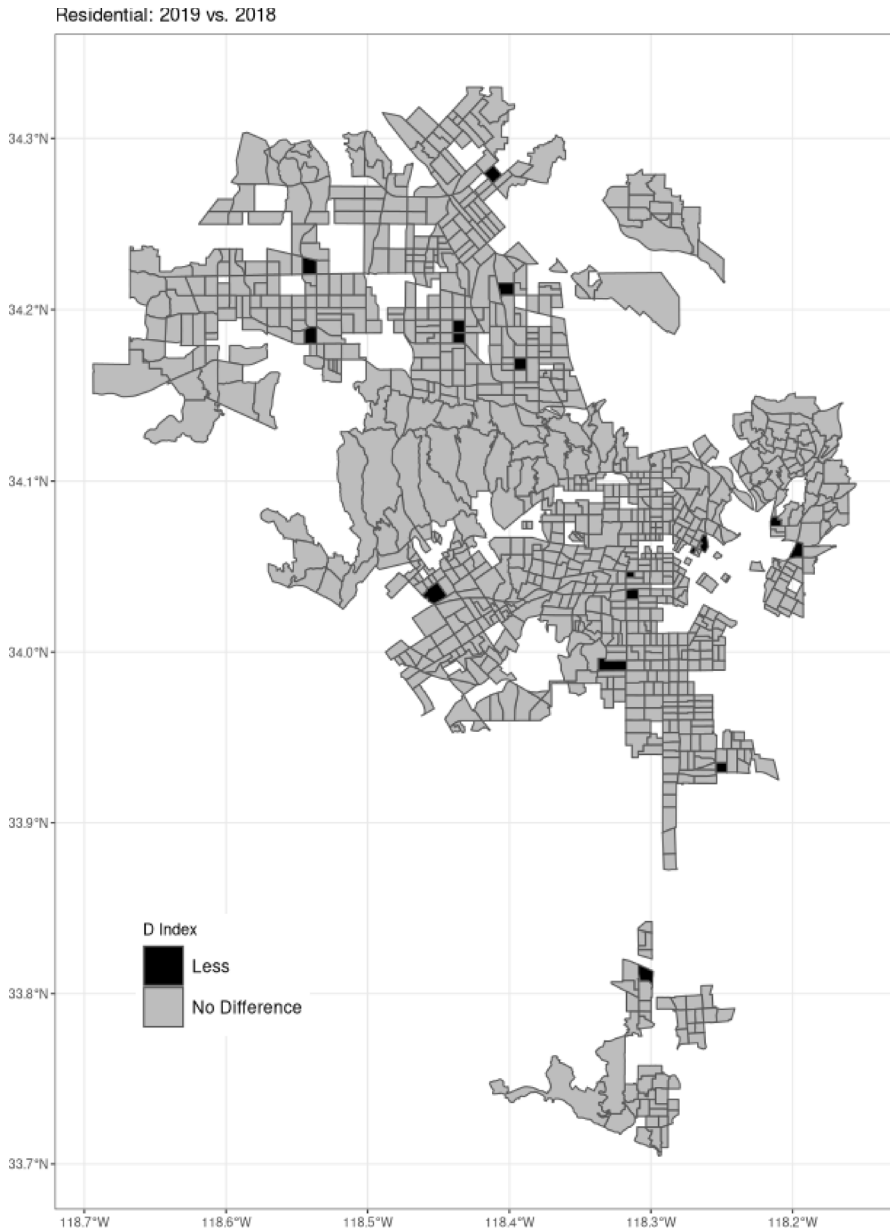
**Fig. 8** Poisson spatial point pattern test — residential

and/or common edge boundary. In all three cases described above, Moran's I statistic was significant (*p*-value < 0.0001) and with a high, positive *z*-score (> 10) indicating clustering. These results when considered alongside the findings of the previous analysis are interesting because it indicated that although there
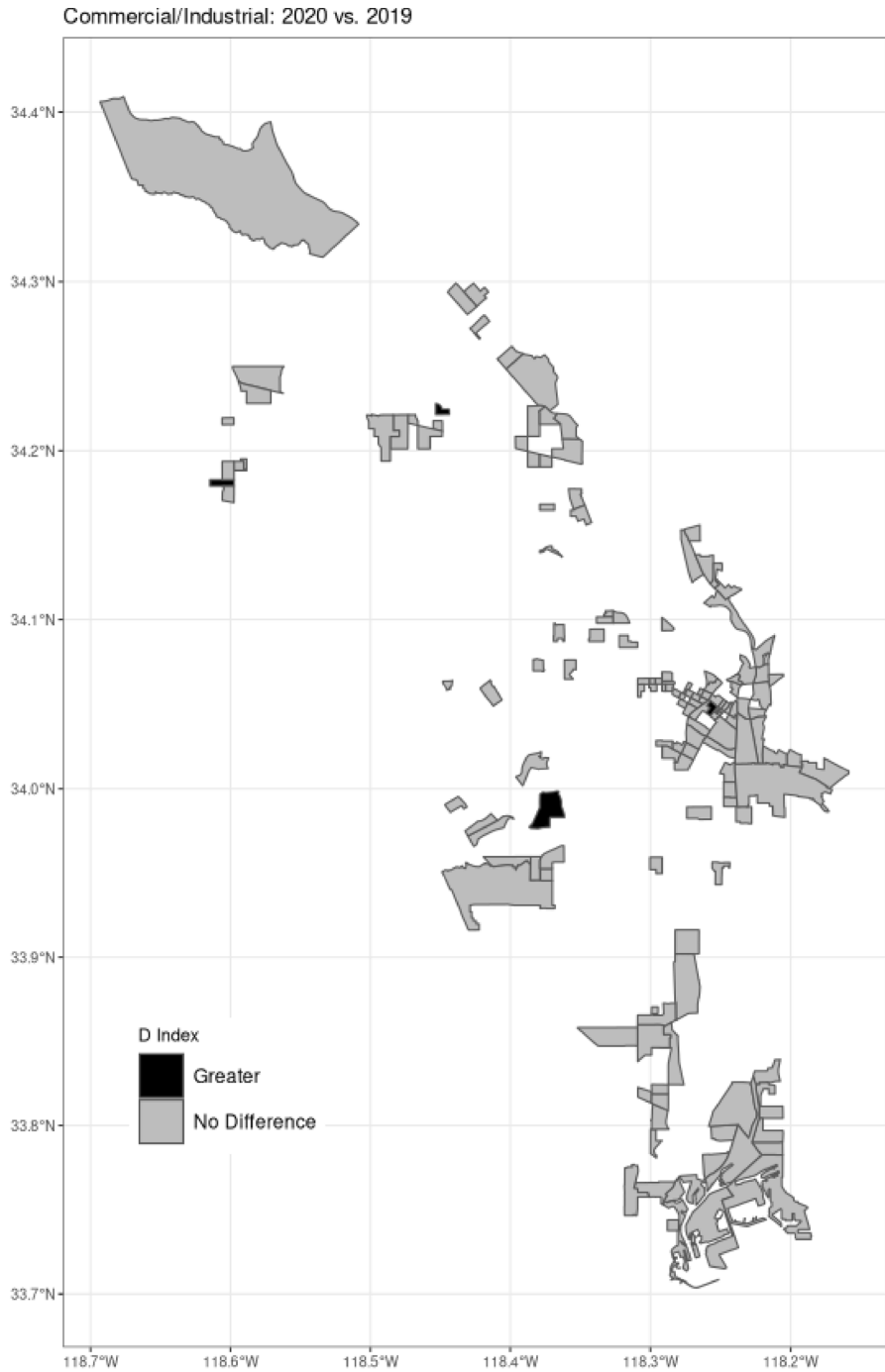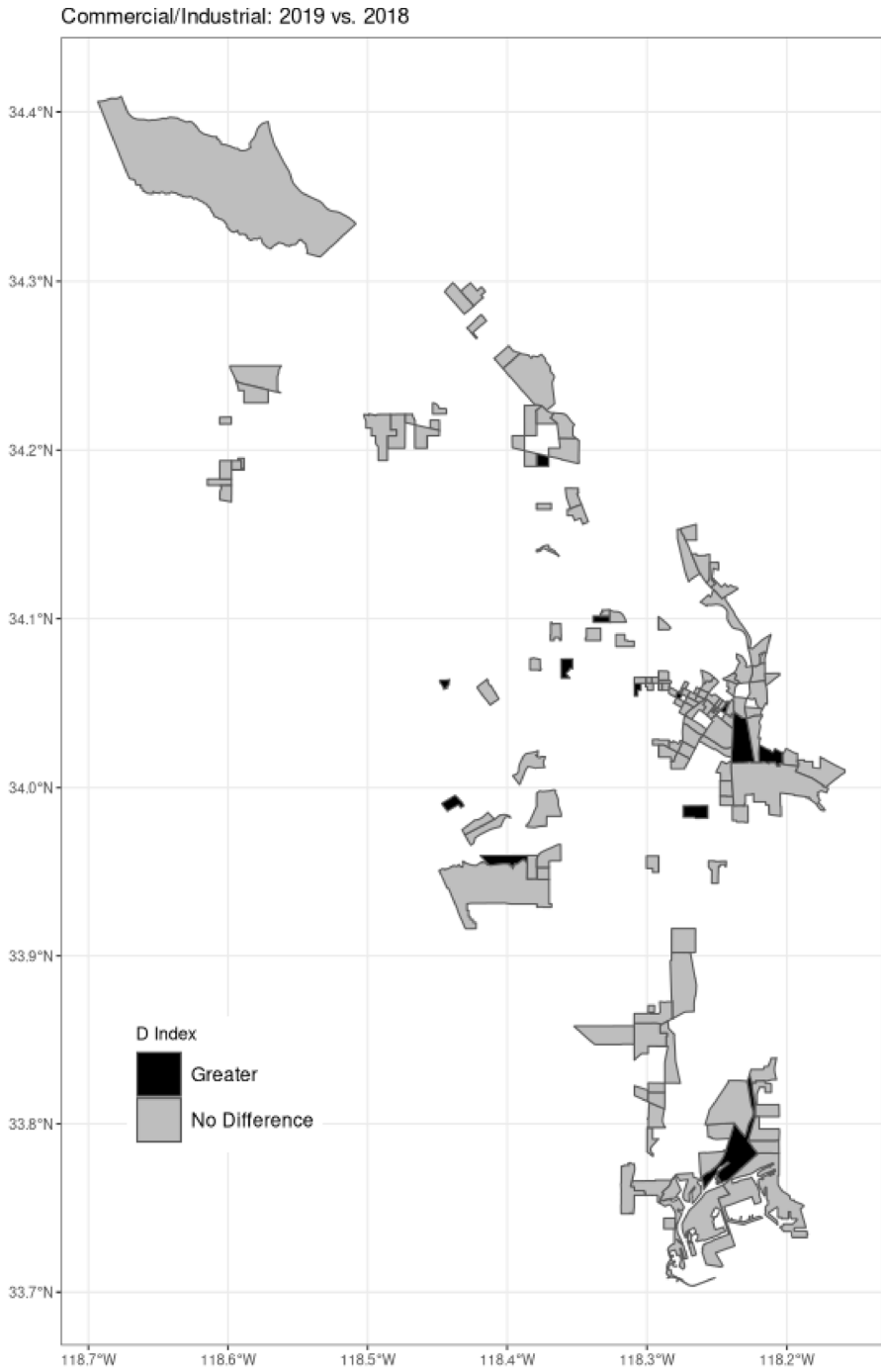
**Fig. 9** Poisson spatial point pattern test — commercial

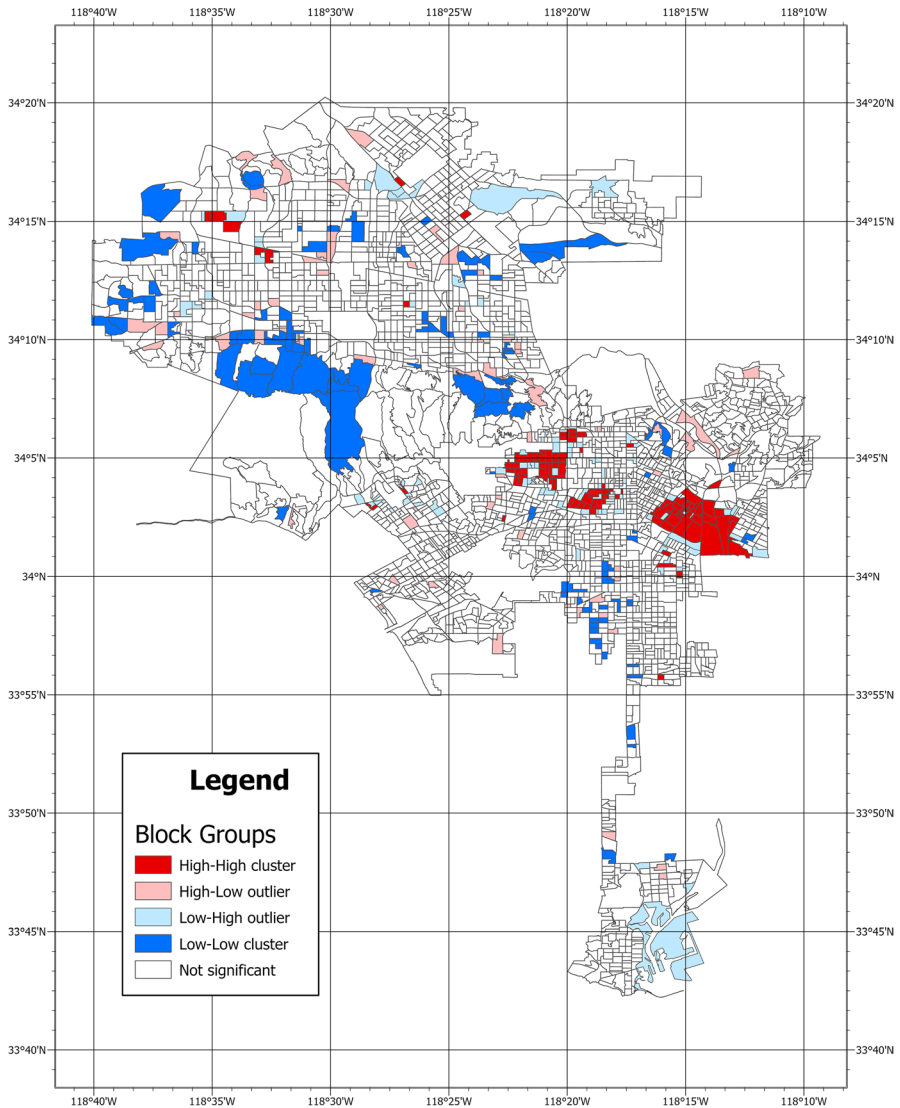**Fig. 10** Poisson spatial point pattern test — commercial

**Fig. 11** Local Moran's I analysis on the difference in burglaries (2020–2019) by block group — colored block groups represent significant clusters (red and blue) and outliers (pink and light blue)

were not that many areas experiencing differences in burglaries, these areas are clumped together spatially.

Upon establishing this, we also sought to map out the locations of these clusters within the city of Los Angeles. To do this, we employed a local Moran's I calculation, the goal of which is to identify units (in this case block groups) that are significantly similar to or different from that of its own neighbors.

**Table 6** Cross tabulation of zoning and local Moran's I categories for difference in burglaries in Los Angeles by block group (2020–2019)

| Zoning category→ | Commercial/industrial | | Residential | | Other | |
|---|---|---|---|---|---|---|
| Local Moran's category↓ | Count | Percent | Count | Percent | Count | Percent |
| High clusters | 36 | 30% | 70 | 58% | 14 | 12% |
| Low clusters | 6 | 6% | 88 | 88% | 6 | 6% |
| High/low outliers | 4 | 6% | 57 | 88% | 4 | 6% |
| Low/high outliers | 11 | 11% | 81 | 81% | 8 | 8% |
| Not significant | 164 | 7% | 1952 | 85% | 185 | 8% |

Local Moran's I yields a value for each unit examined. The local Moran's I values indicate clusters of high values (high-high units) and clusters of low values (low-low units) as well as highlight outliers. These include both low outliers, near high neighbors (low-high units), and high outliers near low spatial neighbors (high-low units). Figure 11 is the map yielded from this analysis. The value that we analyzed and depicted in the figure was the difference in burglaries in each block group between 2020 and 2019. Thus, a block group indicated as high-high is an area in which burglaries increased and that was significantly similar to its neighbors. Conversely, a low-low block group is an area that not only saw a decrease in burglaries, but also saw a decrease in the neighboring area as well.

To further examine the spatial pattern, we looked at the interaction of the zoning variables introduced earlier, with the results of the local Moran's I clusters. Table 6 is the result of a cross tabulation of the zoning (commercial/industrial, residential, and other) with the cluster and outlier types (e.g., high-high, low-low). There are a couple of noteworthy items in these numbers. First, although the majority of all cluster and outlier categories are residential, the proportion of high-high clusters labeled as "commercial/industrial" is considerably higher than in any other category (36 of 120 or 30%). Second, although not as different from the overall trend, the low-low cluster areas have the lowest proportion of blocks labeled "commercial/industrial" (6 of 100 or 6%). Overall, the clusters of increased burglaries are much more commercial and the clusters of decreased burglaries are a little less commercial (and thus more residential) than other areas.

We also calculated the distance in meters of each burglary incident in 2020 and 2019 to the nearest area (polygon) zoned commercial/industrial and to the nearest area zoned residential. The mean distance of all burglaries to residential zones increased from 65 m in 2019 to 79 m in 2020 (median: 13 to 19). Conversely, the mean distance to commercial/industrial zones for all 2020 burglaries decreased from 214 to 147 m (median: 102 to 23). This agrees with the Moran's I findings, further indicating that although still more associated with residential zones, in 2020 the spatial pattern of burglaries shifted to areas that were increasingly associated with commercial/industrial zones.

## Discussion

In general, the findings were in line with the hypotheses generated from the literature on environmental crime. Each of these will be discussed more completely in the sections below, and the findings explored both within the context of COVID-19 as well as the broader theoretical literature on crime prevention. We will also discuss several limitations of the current study.

### Hypothesis 1

The first hypothesis stated that there would be an overall decrease in the number of burglaries in Los Angeles, due to the COVID restrictions. This hypothesis was generally supported, though the differentiation between commercial areas and residential areas attenuated the overall decrease in burglaries. This differentiation, explored more completely in the sections below, is one that is directly in keeping within routine activities theory, suggesting the decrease (in commercial areas) of capable guardianship leads to increases in crime. Additionally, this is in keeping with recent findings in Chen et al. (2022), who identified fans attending the Olympic games as potential capable guardians relative to crimes (including burglary) committed there, demonstrating even passive guardians provide some protection from burglary.

### Hypotheses 2 and 3

Hypothesis 2 and hypothesis 3 were focused on the differentiation by commercial zoning type, indicating that commercial areas would experience an increase in burglaries and residential areas would experience a decrease in the number of burglaries. In both cases, the hypothesis was supported. This study strengthens the findings of others (e.g., Mohler et al., 2020) who also found decreases in residential burglary but increases in commercial burglary. This finding again speaks to the importance of capable guardianship within spaces that may experience crime. The shift provided by COVID-restricted populations was substantial, and the effects were immediate in both residential areas and commercial areas, respectively. The increase in commercial burglaries was the largest in the decade of data examined and the decrease in residential burglaries, while not the largest, was also one of the most substantial.

### Hypothesis 4

The final hypothesis, which was focused on the difference in proportion of reduction/increase of burglaries in residential versus commercial areas, was not supported. While the reduction of crime in residential areas was substantial, there were previous years (particularly 2018–2019) which experienced larger reductions in burglary, and the proportion of reduction was not greater than that of commercial/industrial areas in the same time period. This finding could be an artifact of

the areal units chosen for analysis (Census Block Groups), or might indicate that because there was not a *complete* lockdown of commercial and industrial areas, that the effects were attenuated. It could also be because there was an abnormally large drop in crime in the previous year (2018–2019), which might also have affected the relative rates of decrease that otherwise might have been seen.

## Routine activities

There are a number of important findings for routine activities theory that stem from the analysis here. First, while the findings were generally in keeping with the hypotheses generated, there are important differences across areas. Specifically, while there was a general drop in the level of burglaries within residential areas, and an increase within commercial areas, these were limited to relatively few block groups (5̃%). While there could be a few contributing factors (e.g., commercial or residential density), it may also be a function of differential distributions of capable guardianship across areas. In particular, if an area had a concentration of "essential workers," that area may have remained without (at least) passive guardianship throughout periods regardless of stringency. This could also interact with socio-economic status, at least within residential areas, as many jobs considered essential, and thus requiring workers' physical presence, were lower-wage jobs. COVID-19 restrictions certainly affected individuals differently by class as many white collar professionals and those with high incomes could more easily transition to telework, while essential and lower-income workers continued to work outside the home. Indeed, these differences could provide insight as to why decreases in burglary were experienced within a limited number of residential areas. Similarly, this could have had an effect on some commercial areas with a higher density of essential workers as well.

This also comports well with the findings regarding the cluster analysis. As the areas with the lower levels of burglary tended to be more residential and those with higher levels of burglary, relative to previous years, tended to be more commercial, with relatively few clusters at the highest and lowest levels of burglary, but high similarities within the areas that did experience changes, it was clear that the most homogenous areas tended to be those most affected by the changes caused by the COVID-19 restrictions. Moreover, the movement of burglaries away from zoned residential areas towards commercial areas also suggests that, perhaps, with the change in passive capable guardianship wrought by the COVID-19 restrictions, areas providing suitable targets with lower levels of guardianship were preferred as guardians became concentrated in residential areas.

In both cases, this speaks to both the power of routine activities as a theoretical approach, but also to essential elements in line with *what* kinds of variables structure people's routine activities. Socioeconomic status of areas, residential density, and the adjacency of commercial and residential areas all may have important roles to play in a complete explanation of how significant changes in routine activities play out in terms of crime. This may point to the need for additional theoretical integration of variables from other theoretical perspectives, like social disorganization.

## Summary

The findings, while not unexpected, are important in continuing to provide additional and rigorous evidence regarding both the importance of routine activities and environmental criminology more generally, as well as regarding the effects of COVID-19 restrictions on crime. This is among the most complete studies offered regarding COVID-19 and burglary, and the focus on a specific type of crime provides the opportunity for in-depth analysis regarding not just COVID generally, but the differential effects of the restrictions on burglary across commercial and residential areas. This approach demonstrates that as individuals move from one location to another, all else being equal, the change in capable guardianship does have a significant effect on burglary. Additionally, examining the spatial analysis, we can see that the effects are spatially constrained. The higher the "commericalness" of an area, the higher the increase in criminality. However, it also points to some theoretical gaps, which should be explored in future research, particularly in terms of the additional variables focused on the density of an area (either commercial or residential) as well as socioeconomic status, where we see differential changes in the routine activities of people affected by policy changes (as in the case of COVID-19 restrictions).

## Limitations

The current study, while rigorous, has two significant limitations. First, while the areal unit of analysis, Census Block Groups, was chosen because of the need to provide enough statistical power while maintaining enough granularity to understand spatial differences, it is possible that if a different unit of analysis was chosen, the results might differ. Additionally, because we focused on the period of the most intense lockdown — which is one of the strengths of the study — we lose the ability to examine the impacts of longer-term trends with more specificity. Additionally, as the restrictions were not "all or nothing," our analysis does not include the effects of less stringent periods of lockdown, which could provide additional insight to the effect of restrictions. These, however, are limitations inherent to spatial analyses or those which can be examined in future research.

## Conclusion

Overall, the findings here are in keeping with the literature on environmental crime, and routine activities theory specifically. They are important because of, first, the focus on a single crime (burglary) which is highly impacted by capable guardianship. Second, the analysis includes significant controls for both trend and seasonality, as well as a clear intervention period. Moreover, the addition of the spatial clustering analysis provides context for the changes in commercial and residential burglaries that the COVID-19 restrictions, and subsequent changes in capable guardianship, imposed. All told, this provides a quasi-experimental examination of the impacts of COVID-19 on burglary. Additional research should examine not only

different types of crime, to determine whether the impacts of changes in capable guardianship are consistent across areas, but should also examine what the longer-term impacts of the COVID-restrictions are on burglary.

To more closely examine change, if any, in the spatial distribution of burglary events, two tests were run. The first takes advantage of a spatial non-parametric permutation test developed by Kurland, Johnson, and Tilley (2014), which uses a Monte Carlo simulation to estimate the difference in counts across time periods within the same spatial unit of analysis. In the current case, the Global D (difference) is estimated across each of the excised time periods for the previous 10 years. This gives a sense of the overall change in the data, and then the change relative to COVID-19 restrictions, specifically. This is done for both residential and non-residential areas of Los Angeles, which will directly address the second set of hypotheses.

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