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Show Me What Happened: Analyzing Use of Force through Analysis of Body-Worn Camera Footage

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Abstract

Objectives: Using temporal sequencing of unedited police body-worn camera (BWC) footage of use of force incidents, we test four hypotheses to understand how incident-characteristics influence use of force, duration of that force, and the type and severity of force used by police. *Method:* We code and analyze using data visualization techniques and regression analysis unedited BWC footage involving use of force in a single police agency in the United States. *Results:* Use of force occurs relatively early in most interactions, though gender, race, and behavioral factors partially explain when and how much force is used. Regression results indicate that force is used more quickly against Black suspects and males. Suspect resistance predicts both time to force (TtF) and the duration of force applied. Finally, police are more likely to use greater levels of force in longer, more drawn-out interactions. *Conclusions:* Our results appear to support existing theories for disproportionate use of force, though we caution restraint in generalizing

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our results. We find support only at our temporal level (TtF) and do not find support for the duration or severity of that force used. These temporal variables provide additional context toward better understanding and further contextualizing use of force by police.

Keywords
use of force, body-worn cameras, contextualizing use of force

Despite considerable interest in the use of force by police, much remains unknown about how and when police use force. This lack of knowledge can be traced to the type of data typically used to study police use of force. The literature on police use of force is inconsistent, with some research suggesting that suspect characteristics, including gender and race, and suspect behavior, including resistance, predict when and how force is used. Yet, other research runs contrary to this and challenges some of the commonly held assumptions on police use of force, namely, that police use of *lethal* force does not appear to be racially biased (Fryer 2016; James, James, and Vila 2016). Importantly, the works of Fryer (2016) and James et al. (2016) despite employing different techniques, with different samples, arrived at similar conclusions.

These studies are not immune to criticism, as the generalizability of James et al. (2016) is cautioned (see Fridell's [2016] essay on interpreting biased in the use of force literature) and early criticism (Feldman 2016; Phelps 2016) of Fryer (2016) speaks to issues with the reliability and interpretation of data. Yet, the discrepant results of Fryer (2016) and James et al. (2016) highlight that many issues related to the use of force by police are unresolved. A key challenge facing research on police use of force is that currently available public data focus narrowly on lethal incidents and are ill-suited for understanding police use of force (Barber et al. 2016; Fyfe 2002; Klinger 2008, 2012; Loftin et al. 2003; Mumola 2007) and yet considerable research uses such data (Jacobs 1998; Nowacki 2015; Smith 2004; Terrill and Reisig 2003; White 2001; Willits and Nowacki 2014).

We argue the coding and analysis of body-worn camera (BWC) footage is an important tool for understanding police use of force. Although some recent studies explore alternative data sources, including detailed department records (Fryer 2016), crowdsourced data (Ross 2015), and experiments (James et al. 2016), we suggest that filmed observations provide insights into force that cannot be captured by other data sources. While

we recognize the value of studying use of force rates and its correlates, we believe it is equally valuable to narrow the lens of analysis from beyond *if* force occurred, to explore *how* force occurred. In this regard, we conceptualize our research as building off the foundation laid by prior observational research on policing (e.g., see Klinger 1995; Terrill 2003, 2005). A key advantage of BWC footage is that it can be rewatched and coded, whereas in-person observation approaches are dependent on the notes taken during the incident. Moreover, BWC footage, in certain contexts, may allow for the study of police interactions in a manner that minimizes the Hawthorne effect which might be prevalent in other observational designs.

The current study has two goals. First, we highlight the potential of analyzing camera footage to study police use of force and police interactions more broadly. Second, we use this largely untapped data source to provide additional evidence on the degree to which suspect characteristics and behaviors affect when and how police use force. Specifically, we examine BWCs footage recorded between mid-2013 and spring of 2016 in which police officers from an agency in the Pacific Northwest applied some level of force (ToF). Like use of force, BWCs have also become a hot topic in the policing literature. Yet, much BWC research focuses on their implementation (Makin 2016; Nowacki and Willits 2016) or influence on policing outcomes (Ariel, Farrar, and Sutherland 2015; Ariel et al. 2016). The current study provides one of the first efforts at using BWCs as a source of policing data, rather than as an outcome or point of intervention. While acknowledging the importance of other methods and sources of data, we argue that analysis of camera footage allows us to better capture the totality of a use of force incident and generates a more in-depth understanding of police use of force and how it occurs.

Police Use of Force

Bittner (1973) argued that state-authorized use of force is a fundamental aspect of the police role in contemporary society. Yet, while police are legally authorized to use force, there is considerable debate about when and what type of force should be used. The police in the United States have long been criticized for an overreliance on force (Nelson 2001). While the application of force is necessary for certain contexts, the undue application of force or the overapplication of force can have tremendous consequences for police–community relations (Littlejohn, Smitherman, and Quick 1984) and research suggests that an absence of a cooperative and supportive community relationship reduces police ability to do legitimate police work

(Murphy, Hinds, and Fleming 2008; Ren et al. 2005; Viki et al. 2006; Weitzer, Tuch, and Skogan 2008). Research shows that people vary considerably in how they view the use of force by police (Barkan and Cohn 1998). In particular, there are racial differences in support of police use of force (Cullen et al. 1996), which itself may be traced to evidence that minority urban areas are more heavily policed (Brunson and Miller 2006) and that African Americans and Latinos are stopped at disproportionate rates (Gelman, Fagan, and Kiss 2007).

Still it is important to note that use of force by the police occurs infrequently (Adams et al. 1999; White et al. 2013) and is typically used at very low levels and often results in minimal to no injury to the officer or suspect (Klinger 1995). Research on nonlethal use of force focuses primarily on the deployment of force instruments (e.g., conducted energy devices and chemical sprays; Jenkinson, Neeson, and Bleetman 2006; Sousa, Ready, and Ault 2010; Taylor and Woods 2010; Terrill and Paoline 2013; White and Ready 2007). This emphasis on instrument-based force is likely a result of recommendations made by the International Association of Chiefs of Police (IACP), Police Executive Research Forum (PERF), and the increasing use of Lexipol by agencies seeking to reduce costs (insurance premiums) and liability (lawsuits) by standardizing policy and procedure (Rappaport 2016). It is noteworthy that many larger agencies employ practices restraining these devices to specific units, officers, and situations (White and Ready 2007) and the deployment of these devices is not the majority of force that is used by the police. Instead, physical force or "going hands on" is the most common method by which police use force and is an area in need of additional study.

Research suggests the application of instrumental and noninstrumental force varies by suspect demographics and resistance. Police are more likely to use force against males (Terrill 2005) and nonWhite suspects (Gau, Mosher, and Pratt 2010) and that the effects of gender and race are greater when suspects resist (Crow and Adrion 2011). Additionally, research from Kahn et al. (2016) tested intragroup bias, suggesting the less "White" a person is perceived, the more likely force is to be used. Still, this research is not conclusive, as some research also finds mixed results for racial or gender bias in noninstrumental force (Garner, Maxwell, and Heraux 2002). This inconsistency in research may result in skepticism of research (Gunther 1992). We argue the analysis of BWC footage can make an important contribution, as BWC footage provides data on actual police encounters. These recorded encounters provide insight into the totality of the interaction beyond the parties' interpretation of the events. BWC data

have implications for the study of factors like gender, race, and suspect resistance. Using recorded interactions, we are able to explore what *actually* took place. In this regard, we can examine how and when police use force and whether this varies systematically with suspect gender, race, and behavior. To the degree that race (and other factors) affects how quickly, what type, and how long force is applied, then footage data provide an important avenue by which to examine potential biases in policing.

Hypotheses

Although the study of police use of force can take a number of different directions, we argue that footage data are particularly well suited to explore how interactions unfold overtime. While much research focuses on the ToF and the justness of force, we suggest that it is also important to study how long it takes within a given situation for officers to use force and, once force is used, how long officers apply force.

Here we divide the issue of time into two elements: (1) how long does it take before officers' employ force and (2) once force is used, how long is it applied. We argue that time until force is applied and the duration that force is applied provide important details on how police–citizen encounters happen. Although most discussion of biases focuses on the ToF used, a bias in police use of force could also occur in that police officers more quickly use force against certain suspects or once force is applied, maintain force for longer periods of time. Indeed, much of lab work on officer decision-making focuses on when force is used. Less work has examined the duration of force (DoF) used, yet if force is used for longer periods of time against individuals with certain backgrounds, this could be suggestive of some of form implicit or potentially even explicit bias. Aside from demographic characteristics, situational and suspect behavioral factors could also affect when, what type, and how long force is applied. For example, research suggests that drawn out pursuits (Collins 2009) and anticipatory resistance (Alpert and Dunham 2004) might prime police officers for the use of force. Thus, when officers spend more time searching or anticipating contact with a suspect, they may more likely to quickly use force, at a higher level, and for a longer duration. It also may be that various time aspects of an incident are interrelated in other ways. For example, higher levels of force, like conductive energy devices (CEDs), may reduce the time that force is applied, as these techniques may more quickly subdue suspects.

It is straightforward to generate hypotheses linking suspect behavior and characteristics with use of force, given these factors have previously been linked to use of force (Garner et al. 2002). Thus, we hypothesize that force is used more quickly, for a longer duration, and at a higher level against suspects who are impaired and resist. Similarly, force may be differentially used against male (Kaminski, Digiovanni, and Downs 2004; Garner et al. 2002; Terrill and Mastrofski 2002) and minority suspects (Crow and Adrion 2011; Garner et al. 2002; Gau et al. 2010), though note the conflicting evidence regarding race and the decision of when and how to use force (Correll et al. 2007; James et al. 2016). Put briefly, it may be that officers are quicker to use force and at higher levels against male, minority, impaired, and resisting suspects. The literature provides a number of explanations for each of these factors, including the role of emotions (Collins 2009; Holmes and Smith 2008), implicit bias (Fridell and Lim 2016), focal concerns (Crow and Adrion 2011), and the interplay between officer and suspect behavior (Terrill 2005). While we are unable to test these processes and mechanisms with the data at hand, the literature and these theoretical perspectives generate a set of specific and testable hypotheses:

Hypothesis 1: Incidents following a longer time to contact (TtC) period are likely to result in a quicker application of force, a longer force duration, and a greater ToF applied.
Hypothesis 2: Suspect disposition, including level of impairment and active resistance, is related to use of force. Specifically, force is likely to be used more quickly, for a longer duration, and at a greater level against suspects who are impaired and who engage in active resistance to the police.
Hypothesis 3: Suspect gender and race/ethnicity are related to use of force. Specifically, force is likely to be used more quickly, for a longer duration, and at a greater level against male suspects and minority suspects.

Method

Data

To test these hypotheses, we examine unedited BWC footage of use of force incidents. We argue specifically that BWC data provide an important resource that addresses some of the limitations of other data sources on police use of force. Traditionally, police use of force is studied with

incident-level police records which have been critiqued in terms of accuracy (Klinger 2008; Klinger and Brunson 2009). Two alternative designs commonly used in the literature are laboratory experiments (Correll et al. 2007; James et al. 2016; James, Vila, and Daratha 2013) and field observations (Klinger 1995; Terrill 2003; Terrill and Mastrofski 2002; Weidner and Terrill 2005). Although these approaches have produced important results on police use of force, both lab experiments and observational studies have been critiqued. For example, Fridell (2016) and Terrill (2016) note that lab scenarios do not carry the same risk as real life, and thus responses to experimental stimuli may not reflect actual behaviors in the field. Lab experiments are also often critiqued for lacking generalizability and their inability to capture contextual factors (Falk and Heckman 2009; Roussell et al. 2017). Field observations are known to suffer from social desirability on the part of the researcher and subject, the Hawthorne effect (in which behavior is influenced by observation), and the potential lack of objectivity (Musante and DeWalt 2010; Schwartz and Schwartz 1955).

We argue that studying BWC footage, a form of recorded observational analysis, provides an important part of this puzzle, which other methods may miss. BWC footage reflects actual police interactions and our design builds on interdisciplinary research using objective video records of interactions (Caldwell and Atwal 2005). Filmed observational research greatly reduces issues related to recall, social desirability, lack of objectivity, and, because there was no researcher present during the encounters, reduces the threat of the Hawthorne effect. Unlike prior studies, none of the officers in our sample were aware these incidents would be studied nor was the agency itself conducting research on BWCs when the footage was collected. Although research suggests that BWCs may reduce the rate at which officers use force (Ariel et al. 2015; Welsh and Farrington 2009), the "self-awareness" mechanism potentially associated with BWCs applies to all incidents in the sample. Put another way, this agency in question has adopted BWCs: wearing and using these cameras is now standard operating procedure. Because this footage was not collected for any special project and instead was collected as a matter of department policy, we believe the recorded interactions reflect policing as it actually occurs in this jurisdiction. Had this data been collected as part of an ongoing study, then the recorded interactions might be more vulnerable to the Hawthorne effect. It is worth noting that BWC footage provides only a single perspective on a given encounter (unless multiple officers respond) and that this perspective can be obfuscated or turned off due to officer discretion or equipment malfunction. Thus, while BWCs provide an important data source, other

potential data sources, like closed-circuit television (CCTV) and dash camera footage, provide a data source that cannot be easily turned off or knocked aside should also be considered as a potential data source for future research on police interactions.

Data for this study were acquired from a police agency in the Pacific Northwest. The agency also provided us with basic information related to each incident, though not full access to incident reports. The agency has less than 100 officers serving a smaller community (under 100,000). This agency's use of force policy requires officers' file a report when force is used to subdue (restrain) an individual. Agency policy requires that officers activate their BWC when they engage community members. We were able to gather and code data on all 174 use of force incidents occurring between mid-2013 and spring of 2016. This period marks the implementation of the BWC program in the agency. It is important to note that coding this footage was a challenging endeavor. During coding, it was at times difficult to classify the type of force used and the time at which the force was used. When an officer engages a citizen, the camera may not be focusing on elements that are important to code. Similarly, some interactions are quite loud and occur in heavily crowded places, making the coding of audio data difficult in some situations, though we compensated for this by examining multiple videos when needed (and when they were available). Related to this, some interactions are quite immediate and in those cases, BWC data were not available to capture the totality of the incident. That is, in some instances, the police approached an already occurring scene and the footage is picked up in progress. Although we fundamentally believe that coding such footage provides a better and unfiltered representation of how police interact with the public than analyzing incident reports, we acknowledge that coding video requires researcher judgments. All 174 incidents were double coded, with each coding discrepancy discussed until a consensus was reached. In order to minimize the effect of our judgments, we followed a strict coding protocol and discussed all coding discrepancies until we reached a consensus on the codes for a given incident.

Initial analysis of footage resulted in the removal of 79 videos, with 95 videos meeting the specific criteria suitable for analysis, which required that (1) the incident must clearly contain use of force (at a level higher than the application of handcuffs) against a human and (2) the totality of the incident can be ascertained, that is, incidents were excluded if time to force (TtF) and DoF could not be established. Although the analysis of use of force would ideally include interactions where the police do not use force, these data were not available to us. Thus, our focus is limited to

understanding variation in how and when force is applied during use of force encounters.

The unit of analysis for this study is the incident. Although a large number of videos included various recordings of a single incident, we counted each incident one time. In fact, on average, there were seven videos attached to a single incident—containing different perspectives or processes documentation. The highest number of videos for a single incident was 27. In general, we coded a single video per incident (the primary video that captured the totality of the situation and provided full information on all variables we wished to code). When needed, we coded additional incident videos to capture variables which we could not ascertain from the primary video.

Of the 95 incidents meeting these criteria, the average incident was 20 minutes. Missing data on timing variables (described below) lowered the sample size to 80 to 85 incidents, depending on the specific dependent variable. The coding of the 95 incidents used in the data involved watching 1,899 minutes and 51 seconds of camera footage, with the section of the video involving the use of force being viewed at least two times.

On average, TtC between police and citizens occurred 2 minutes and 40 seconds after the start of the video. Department policy requires officers to turn on their BWCs as they approach a call for service, thus most videos start with the officer in the car or walking toward a scene. Moreover, the BWC system buffers the prior 30 seconds of video, so even in cases where the officer approaches an ongoing incident, the footage captures time period just prior to this. Although this is an imperfect measure (as it often misses much of the commute to a scene), we noted during our initial coding of incidents in which the officers had to look for suspects more seemed more emotionally and physically intense and thus this measure formally added to the data collection process. On average, police employed force at 5 minutes and 18 seconds into the interaction and force lasted approximately 36 seconds. There were a pair substantial outliers in terms of TtC and TtF usage, with two incidents taking over 20 minutes for the officers to locate the suspect and apply force. Officers would typically turn on BWCs while arriving at an incident and the cameras passively record the prior 30 seconds of footage prior to activation. Thus, officers would often spend time searching for the appropriate location or people before contact was made. Eight-two percent ($n = 78$) of use of force incidents occurred with male suspects. Of the 95 incidents, 62 percent ($n = 59$) of those experiencing use of force were White. Hispanic and Black suspects were 14 percent ($n = 13$) and 15 percent ($n = 14$), respectively. Middle Eastern ($n = 5$), Asian ($n = 2$),

Table 1. Frequencies and Percentages for Sociodemographic Variables.

Variables	*N*	Percentage
Gender		
Male	78	82
Female	17	18
Total	95	100.0
Race/ethnicity		
White or Caucasian	59	62
Hispanic	13	14
Black or African American	14	15
Other	9	9
Total	95	100.0
Resistance		
Active resistance	21	22
Passive resistance	74	78
Total	95	100.0
Impairment		
Drug or alcohol	76	80
No drugs or alcohol	19	20
Total	95	100.0

American Indian ($n = 1$), and suspects with an unknown race were represented in 9 percent of the remaining use of force incidents (Table 1).

Measures

Dependent variables. As our primary hypotheses concern TtF, DoF, and ToF used, we provide both a descriptive and regression-based analysis of each variable. Calculating TtF necessitated establishing the point of contact, TtC represents the minute and second (M:S) when the officer *clearly* made it known they were a police officer. We marked this time point and calculated the duration of time before the initiation of force by the officer, thus TtC represents how long it took to make contact, while TtF represents how long it took force to be applied after contact was made. DoF represents the time in minutes and seconds that force was applied until the suspect was *both* restrained and under control. For example, a suspect may have been taken to the ground and held by two officers. However, until a restraint device (i.e., cuffs) is placed on the person, we do not consider the application of force to have stopped.

Table 2. Types of Force.

Variables	*N*
Takedown (officer uses physical force to push the suspect to the ground for restraint purposes)	61
Hold (officer uses physical force to constrain the range of motion of the suspect)	45
LVNR (officer uses a lateral vascular neck restraint)	9
Push	8
Controlled (officer pushes the suspect to effect restraint)	6
Noncontrolled (officer pushes the suspect, though the push was not intended for restraint)	2
Strike/impact (officer physically strikes the suspect—does not include the use of an instrument)	5
OC spray (officer deploys "pepper spray")	1
CED (officers deploys a conductive energy devices)	8
Nonlethal ammunition (officer deploys a bean bag round or other nonlethal ammunition)	1
Firearm (officer points a firearm at the suspect)	3
Total	149

Following the work of Terrill (2003, 2005), we view force as a continuum reflective of the harm force generates against the suspect. Unfortunately, the data provided include only cases in which physical force was employed, thus we are unable to examine verbal force as recommended by Terrill (2005). Table 2 displays a breakdown of each type of force used. These categories were decided before the coding process began, as we anticipated creating a use of force coding scheme similar to the one used by Terrill (2003). Still, some codes (like uncontrolled push and the lateral vascular neck restraint [LVNR]) emerged after we started the coding process, as these applications of force seemed qualitatively different than controlled pushes and standard grips or pain compliance techniques. We combined these different force types into an ordinal variable with four levels, where ToF is coded as follows: (1) hands-on force, including takedowns and basic restraint holds, (2) the LVNR, (3) the use of strikes or impacts, a hard push, or takedown which forces the suspect into an object, and (4) the deployment of a force instrument, like a CED, or pointing their service weapon at a suspect. Higher values on our LoF Scale indicate a greater ToF used, though we note that our coding scheme is not intended to address the appropriateness of force used.

Independent variables

Suspect resistance. Indicates active resistance by the suspect. Statements made by officers "to not resist" or similar phrasing were not coded as resistance unless the video corroborated active resistance. Of those incidents coded, 22 percent ($n = 21$) of interactions contained active resistance, with nearly identical rates of resistance for both males (23 percent) and females (22 percent).

Suspect impairment. Incidents were coded based on the verification that drugs or alcohol were present in the system of the suspect based on official police records. Consistent with prior literature (see Kaminski et al. 2004), the majority of use of force incidents in our sample involved the presence of either drugs or alcohol at 80 percent ($n = 76$).

Suspect characteristics. Lastly, we include gender and race/ethnicity of the suspect in our modeling. Gender is coded as a dummy variable, indicating if the suspect is male. Race/ethnicity is a set of four dummy variables (White, Black, Hispanic, or other race), with Black/African American used as the reference category in the analysis below. We were unable to include officer demographics as the vast majority of the officers are male and White.

Results

We begin by describing our data using data visualization principles. With a relatively small sample size drawn from a single jurisdiction, data visualization allows us to identify patterns and trends in the data without an undue focus on statistical significance (Tukey 1977). Although data visualization is one of the primary elements of exploratory data analysis (Tukey 1977), it is generally underused in criminology and, when used, typically focuses on the presentation of results (Maltz 2006). Here present basic results via Kaplan–Meier (KM) plots.

A KM plot is a visualization of the KM estimator (Rich et al. 2010), which under cases with no censoring (as with our data), is simply the proportion of survivors just prior to a given time point (the empirical distribution function). In our case, the observations are suspects and "surviving" refers to the length of time until force was applied to the suspect. It should be noted that while our data contain no traditional right censoring, these plots still provide a useful visual tool for examining the time until the use of force by subgroups. Under large sampling conditions, the KM estimator reflects the population survival function for a given phenomenon (Kaplan and Meier 1958). Given the small sample, we would

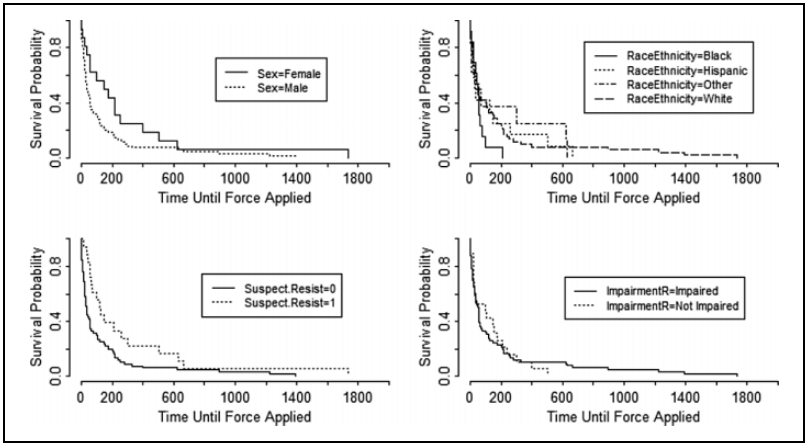

Figure 1. Kaplan–Meier plots of the time until force used.

strongly caution against taking these times as meaningful estimates for population TtF estimates and instead limit our use of the KM plot as an exploratory tool to show basic trends and patterns in how long it took for force to apply in different contexts. These KM plots allow us to visually present our data, while also addressing existing conflicting laboratory research on the role of race on how officers use force (Correll et al. 2007; James et al. 2016). Here we are able to examine how long it takes for more common types of force to be applied in actual police–citizen encounters. To address this, as well as the role of gender, race, and suspect behavior, we present a series of four KM plots in Figure 1.

The upper left-hand quadrant shows the KM plot disaggregated by gender. The solid line, depicting female suspects, runs above the dashed line for most of the survival curve. This suggests that, in general, police are slower to apply force to female suspects. The upper right-hand quadrant shows the KM plot disaggregated by race. Here there are very few racial differences in the early stages of encounters, meaning that if an officer is going to apply force early in an encounter (the majority of force applications), race is unimportant. As incidents progress, however, the curve for White suspects goes above the racial/ethnic groups, suggesting that officers take longer to apply force to Whites. The lower left-hand quadrant shows the time until force is applied disaggregated based on whether the suspect resisted the use of force or not. The KM plot here suggests that officers took longer to use force against resisting suspects. The lower right-hand quadrant shows the

time until force is applied disaggregated by the impairment of the suspect. The impaired and not impaired curves are close together, suggesting that impairment may not affect the time until force is applied. Taken together, the KM plots provide some support for Hypothesis 2 (that suspect disposition is related to how force is used, but only for resistance) and support for Hypothesis 3 (that suspect characteristics are related to how force is used).

Statistical Analysis

The above visualization shows the utility of examining footage data for understanding when force is applied in a police–citizen encounter. In an effort to examine whether other factors explain these time patterns, we use regression analysis. These models are presented in Table 3. Each of these models includes suspect resistance, impairment, gender, and race as independent predictors. Further, each model includes the time until contact, the number of videos associated with a particular incident (a proxy for incident complexity), and a set of dummy variables for the year of the incident as additional control variables in order to control for any changes in policy.

In model 1, we examine the time until force is used. We use Cox proportional hazard regression for this model. Although Cox models are typically used for data with right censoring (not present), we employ this model here due to both the skewed distribution of TtF and because we are interested in the hazard ratios. In order to test the proportional hazard assumption, we conducted the Schoenfield residual test, which tests the null hypothesis that the log hazard ratio is constant over time and found no evidence to the contrary ($\chi^2 = 3.03$). In addition to the variables common to all of our models, model 1 includes dummy variables for ToF as a predictor of TtF. We include ToF as a control measure to account for differences in the intensity and nature of a given encounter, not as a direct causal predictor of TtF (as LoF occurs after TtF in time order)

Results indicate that suspect resistance, gender, and race are all statistically significant. Specifically, the hazard for the use of force is lower for suspects who are actively resisting and greater for male suspects, results which were previously shown with KM plots. It is important to note the hazard ratios produced by Cox models cannot be specifically interpreted as time contingent, hence we supplement our analysis by also calculating the ratio of median survival times. For resisting and nonresisting suspects, this ratio is 120:30, while the ratio is 36:159.5 for gender. These results, in conjunction with the Cox model, suggest that force is typically applied to

Table 3. Regression Results on Level of Force Used, Time to Force Used, and Duration of Force.

	Model 1: Time to Force		Model 2: *ln*(Duration of Force)		Model 3: Level of Force	
	($n = 80$)		($n = 84$)		($n = 85$)	
Variables	*b* (*SE*)	Hazard Ratio	*b* (*SE*)	exp(*b*)	b (*SE*)	Odds Ratio
Suspect resistance	−1.336** (.418)	0.263	0.848** (.349)	2.335	−1.095 (1.092)	0.335
Suspect impairment	−0.162 (.297)	0.851	−0.332 (.291)	0.717	−0.532 (0.767)	0.587
Suspect male	0.911* (.352)	2.486	0.094 (.327)	1.099	2.633* (1.046)	13.910
Suspect Hispanic	−0.345 (.459)	0.708	0.349 (.449)	1.418	−0.457 (1.018)	0.633
Suspect White	−0.990* (.397)	0.372	0.437 (.391)	1.548	−0.327 (1.052)	0.721
Suspect other race–ethnicity	−0.495 (.512)	0.610	0.208 (.610)	1.231	−0.519 (1.351)	0.596
Force using instruments	−0.894* (.443)	0.409	0.039 (.395)	1.040	—	—
Force using strikes/impact	−0.622 (.507)	0.537	−0.481 (.318)	0.618	—	—
Force using LVNR	0.334 (.494)	1.396	−0.031 (.419)	0.969	—	—
Time to contact	0.0002 (.0008)	1.000	0.0004 (.0004)	1.000	0.002* (0.001)	1.002
Time to force (ln)	—	—	0.065 (.067)	1.067	0.297* (0.150)	1.346
Videos	0.025 (.037)	1.026	−0.052* (.023)	1.053	0.239** (0.069)	1.269
2014	−0.165 (.397)	0.848	0.286 (.357)	1.331	−0.142 (1.022)	0.868
2015	0.521 (.411)	1.684	0.032 (.388)	1.033	−0.610 (1.204)	0.544
2016	0.097 (.442)	1.102	−0.094 (.417)	0.910	−0.440 (1.322)	0.644
Constant	—		2.605** (.703)	13.531		
Model fit	$\chi^2 = 25.95$*		$R^2 = .270$		Pseudo $R^2 = .165$	

Note. Model 1 is Cox proportional hazard regression model predicting time to force, model 2 is an ordinary least squares model on log(force duration), and model 3 is an ordered logistic regression predicting level of force. *SE* = standard error; LVNR = lateral vascular neck restraint.
$^{+}p < .1$. $^{*}p < .05$. $^{**}p < .01$.

males much faster than females and to resisting suspects much slower than nonresisting suspects.

Model 1 also highlights a statistically significant difference between White suspects and Black suspects (the reference category). The hazard ratio for Whites is 0.372, suggesting the hazard for experiencing force for Whites is 62.8 percent smaller than for Blacks. For the White–Black comparison, the ratio of median survival times is 51:48. Although the median survival time is slightly longer for Whites and coefficient is significant in the Cox model, this ratio indicates that while race matters, it may matter substantially less than resistance and sex for determining when force is used.

For model 2, we used ordinary least squares regression to examine the DoF used. Although duration is also a time variable, our interest here is not in the time until an event occurred, but instead, the length of time that an event occurred. Preliminary analyses indicated no issues with multicollinearity (all Variance Inflation Factors (VIFs) < 2), but the Breusch–Pagan test indicated a substantial issue with heteroscedasticity ($\chi^2 = 49.17$, p-value $< .05$). The log transformation of DoF was applied, which mitigated heteroscedasticity concerns ($\chi^2 = 0.90$). We include all of the independent variables from model 1 and TtF in model 2. Only suspect resistance is significantly related to DoF. Specifically, when suspects resist, force is applied 133.5 percent longer.

Finally, in model 3, we use ordered logistic regression to examine the highest ToF used within an encounter. This model includes all of the variables used in model 2 except for ToF (which is the dependent variable in this model). Suspect gender, time until contact, time until force is applied, and the number of videos associated with an incident are significant predictors of the ToF in these models. The effects of gender are particularly pronounced, with male suspects at a substantially greater risk of receiving higher levels of force. In addition, time predicts ToF. If initial contact takes longer or if the decision to use force occurs later in an interaction, police are more likely to use a higher ToF. And finally, incidents which are associated with numerous videos are also more likely to result in higher levels of force. This result makes sense, as anecdotally, our coding of the videos suggested that incidents with more videos were more complicated, combative, and involved more officers than incidents with fewer videos.

Given the small sample sizes included in our analysis, we performed additional checks to determine if statistical power was a factor. Specifically, we reestimated models 1 through 3 but only included suspect resistance, impairment, gender, and race as predictor variables. For models 1 and 2, the

results are substantively similar to those reported here. For model 3, the male dummy variable dropped from significance and the model fit declined substantially, suggesting TtC, TtF, and video controls are important predictors of LoF and these factors enable suppression effects for the male dummy variable. These results are available upon request.

Discussion and Conclusions

The impetus for the present study was understanding the use of force beyond *if* force occurs by adding *how* and *when* to the equation. In our pursuit to understand *how* force occurs, our findings add support for many existing theories on police use of force. For example, Terrill's (2003) research, based on participant observation, revealed that use of force occurs at a higher level than suspect resistance (p. 72). This is consistent with our results, though our findings suggest that interpretation of these results must be placed into context because there are other factors which might explain the relationship between active resistance and TtF. For example, we find that when a suspect is actively resisting, police take significantly longer to use force. While the present study did not assess the demeanor of the suspect nor number of officers' or additional stakeholders present at the scene (all suitable explanations), it is possible that an officer takes longer to use force because they are attempting to de-escalate the situation or are waiting for more officers to arrive. This is corroborated with the type of force used. For example, as our results suggest, officers' who use instrument-based force (CED, OC spray, bean bag, etc.) take *more time* before using that force. Additionally, we find that police take *less time* to use force against Black suspects (and more time against White suspects). As Terrill (2003) offers, resistance and use of force are complex, and as Terrill and Reisig (2003) note, such results must be contextualized. We urge researchers to explore contextual factors associated with how use of force occurs. Could it be the presence of additional parties and stereotype-driven attitudes concerning young Black males reduce the TtF? This is an important avenue for research, as our results on nonlethal force run contrary to recent laboratory experiments on race and police use of lethal force (James et al. 2016).

Further, while we find racial differences, the differences by gender were substantially larger. From a TtF perspective, our findings suggest that officers are faster to use force against males and at higher levels, the latter of which is consistent with Kaminski et al. (2004). Additional work with larger samples will allow for an intersectional exploration of how factors like race,

gender, and class affect police decision-making. As aforementioned, while we do find that police use force more quickly against Black suspects, race does not appear to influence the type of force used. Thus, we find mixed results related to whether police officers are biased in how they apply force, though clearly more information about the incidents, officers, and suspects is needed before stronger conclusions can be made. Indeed, without further controls for other individual and situational factors, we argue that it would premature to draw conclusions from our data regarding gender and racial biases of officers, though our results suggest encounters involving suspects of different genders and races tend to play out differently. In an effort to examine force escalation, we ordered the type of force applied by time and tested what influence our independent variables would have on force escalation (results available upon request). We found that neither race nor gender of the suspect predicts escalation to higher levels of force (i.e., escalating from a push to a strike or CED).

Interestingly, we find more complex encounters (using number of video perspectives as a proxy), on average, result in higher levels of force. We caution interpretation because it is possible videos with more perspectives (officers') reflect incidents higher in antagonism or conflict (officers' may anticipate resistance). Additionally, as Alpert and Dunham (2004) suggests, anticipatory resistance influences use of force. In fact, our findings support the longer the TtC, and longer the TtF, the ToF is greater.

Our models were more successful at finding significant predictors of the TtF and ToF than they were at identifying the correlates of force duration. Only suspect resistance predicted the DoF. This is a reasonable result, for if a suspect is actively resisting, the police may be required to use force for a longer of time. Although resistance also predicted TtF, the other factors which predicted TtF did not matter for force duration. For example, demographic factors mattered for TtF and the ToF but not for the DoF applied. This suggests that while officer perceptions may affect when and how they apply force, once force is applied, the duration of said application seems to depend more on the characteristics of the incident and less on the characteristics of the suspect.

While our findings lend support for and introduce new findings on police use of force, our research is not without limitations. First, with the current data, we cannot specifically test causal mechanisms that have been suggested in the literature nor we can definitively identify why certain relationships exist. For example, while we suggested that officers take longer to apply force to resisting suspects in order to de-escalate and wait for backup, this relationship between TtF and resistance could also be

reflective of the buildup of emotional energy and confrontational tension (Collins 2009).

Moreover, there are numerous factors that can be included when coding video data. In the current study, time constraints and concerns about variability prevented us from including more factors. Specifically, we believe it is important to further contextualize use of force by adding additional situational and dynamic factors, which could explain how use of force occurs. For example, what influence does time on shift have on the TtF, DoF, and the type of force used? Moreover, what influence does proximity to other community members have on our outcomes? If more community members are in close proximity, does that influence the TtF and type of force used? These questions can be addressed with footage data, though we note analysis of footage data is time and labor intensive. Some other factors which have been identified as important in the past, like officer characteristics (Lawton 2007; McElvain and Kposowa 2008; Terrill and Mastrofski 2002), will require footage from additional agencies to generate sufficient variation. One important variable we are missing is the type of call/crime. Prior research has forcefully argued that this should be included in studies of police arrest decisions (Klinger 1996). Although our focus is not on arrest, type of call might still affect how police officers respond and, subsequently, use force. Unfortunately, while this information can sometimes be gleaned from the interaction itself, this approach to coding would have left many cases coded as "unknown." Future research examining BWC data should make every effort to ensure that researchers can access and link incident and calls-for-service data to camera data.

In addition to potential omitted variable bias, we recognize that there are other limitations present in our study. First, our results are generated from a single, smaller police agency. Although much work on use of force and especially work examining specific incidents draws from single agency studies, this limits our ability to generalize our results. Thus, these results may reflect the unique sociocultural context of the agency. It is crucial that future researchers explore the nature of how force occurs using camera data from a wider range of agencies. Further, some research suggests that what BWCs capture is related to police officers' compliance with BWC activation policies (Katz et al. 2014). Although we have no reason to believe office noncompliance was an issue here, more research with agencies with different activation policies is warranted. Indeed, other filmed data sources may be useful in studying police interactions, including the use of CCTV footage (Makin, Jenkins, and Gaffney 2016).

Second, concerns over our sample size are warranted and thus we further caution against generalizing our results. However, our research design, to our knowledge, is the first of its kind and required developing considerable trust on the part of our research partners. While a sample size of 80 to 95 incidents is small, it is not uncommon for research on use of force. For instance, recent research by James et al. (2013) used a sample size of 102 participants. Additionally, because we use strict inclusion criteria, we capture the totality of the incident. While we could have increased our sample size by using less rigorous inclusion criteria, it would have undermined our confidence in the results.

Third, we depend on the use of force investigation report as provided by the agency. While agency policy requires officers file a report when using force, it is possible all use of force incidents are not equally captured. This is an issue that goes both ways. Some videos which were flagged as use of force did not include use force (as classified by our coding scheme). Additionally, a small percentage videos were deleted from the system (assumingly because of the agencies retention policy in Evidence.com). Moving forward, a larger sample in which incidents involving no force and incidents involving lower levels of force (including the basic application of handcuffs) would more fully capture and describe how and when force is used by the police. While these data were not available to us at the time of this study, such an endeavor is certainly possible, though it will require significant time and resources.

Fourth, it is important to remember, as previously discussed, that coding of footage data is difficult. Police interactions, especially those involving the use of force, can be chaotic scenes, and a given camera did not always capture all of the data nor was it always easy to decide how to code each part of an interaction. Although we rigorously followed our codebook and used multiple videos when necessary, it is likely that some level of measurement error exists in the coding of interactions. Simply put, no data are unfiltered by human choices in what and how to measure. Camera footage is no different in that regard. Moreover, not all camera footage is the same. Future research should consider footage from other sources. For example, while BWC footage has the advantage of capturing up close video of dynamic situations, BWCs can fall off during an encounter, malfunction, or an officer could fail to turn on the system. As such, footage from CCTVs and dash-mounted cameras, which provide a permanent and fixed vantage, would complement this analysis considerably.

Recognizing these limitations, we do offer advice for researchers seeking to use BWC footage. (1) Concerning footage, ensure you have access to

the entirety of the agencies BWC footage. While data access is always difficult and compromises may be necessary, obtaining a clearer picture of the incident may require looking at footage from other officers, who may not have applied force at the scene. (2) As observational data adhere to best practices (see Ritchie et al. 2013). As aforementioned, while recorded observational data have their advantages in comparison to traditional field observation, a conservative coding scheme may be necessary to avoid researcher bias in the interpretation of the incident. Reviewing hundreds of hours of footage requires strict adherence to protocol and a codebook that is efficient and effective in capturing the necessary data. Establish time limitations on reviewing and coding to improve data quality. Check inter-rater reliability early to identify any potential issues in discrepancies, discuss those discrepancies, and if necessary further refine the codebook. (3) While it may seem worthwhile to enhance the video quality (adjusting brightness or contrast), we caution against doing so because it alters the nature of the video. Footage of a dark apartment reflects just that a dark apartment and the visible light available to the officer. There were times adjusting the brightness or contrast would have assisted in identifying variables or modifying the audio could have provided better information, doing so runs the risk of revealing information that was quite possibly not noticeable by the officer. (4) Validate incident-based data with the observational data. While not frequently occurring, there were incidents where the agency provided information did not correspond with what occurred in the video.

Quality of data remains an ongoing concern for police researchers. Regardless of the subject of analysis, the focal concern remains the reliability and validity of the data obtained. As Crow and Adrion (2011) offer, the most pressing challenge concerning understanding use of force (or police practice) is better data (p. 382). Routinely, over the years, researchers have offered caution in the interpretation of results because of context. Context matters and as Terrill and Reisig (2003) suggest, it is increasingly important because sociocultural factors change outcomes. For decades, we have come to understand if and when a myriad of factors influences police behavior. However, it is only recently, that researchers have held the ability to systematically study how that behavior occurs without inducing researcher effects. If use of force is situational and contextual, our research designs must move to a level that is capable of capturing the totality of the incident. Analysis of BWC footage provides a new source for understanding the complex relationship between police and community members. However, the most pressing challenge will not be coding or statistical modeling nor the creation of research questions or hypotheses. Instead, this is a

challenge of data access, agency trust, and receptivity to research (Telep and Winegar 2016). Without access to agency camera data, it will remain difficult to explain "what happened" when police use force.

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