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Final Report

The Detection of DWI Motorcyclists

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16. Abstract

A set of 14 behavioral cues associated with impaired motorcycle riding has been identified based on interviews with expert law enforcement officers, archival research of almost 1,000 motorcycle DWI arrest reports, and the conduct of three separate field studies. The field studies involved the participation of 50 law enforcement sites, representing 19 separate agencies and eleven states.

Data were collected during the field studies concerning all enforcement stops made of motorcyclists, regardless of the disposition of the stops. By collecting data about all stops of motorcyclists, it was possible to calculate the proportion of the time that specific cues were observed in association with DWI; those proportions could then be expressed as probabilities of DWI detection. Preliminary detection guide and training materials were tested during the 1991 riding season in a major validation study. It was found that use of the detection guide and exposure to the training materials substantially improved the abilities of law enforcement officers to detect impaired motorcyclists, especially on the cues dependent on balance and vigilance skills.

A Motorcycle DWI Detection Guide, associated booklet, and 12-minute training video, present the 14 rider behaviors, or cues, that were found to best discriminate between impaired and unimpaired operation of a motorcycle. The cues are presented in two categories. Excellent Predictors (cues with a probability of DWI of 50 percent or greater) are drifting during turn or curve, trouble with dismount, trouble with balance at a stop, turning problems, inattentive to surroundings, and weaving. Good Predictors (cues with probabilities of DWI between 30 and 49 percent) are erratic movements while going straight, operating without lights at night, recklessness, following too closely, running stop light or sign, evasion, and wrong way.

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CHAPTER 1:
INTRODUCTION

This report presents the results of a research project conducted by Anacapa Sciences, Inc.; the goal of the research was to develop techniques and training materials to assist patrol officers in the accurate detection of motorcyclists who are driving while intoxicated (DWI). The research and development project documented in this report was conducted over a two-year period and involved the participation of more than two-thousand law enforcement personnel from across the United States.

BACKGROUND

There are approximately 4.2 million motorcycles registered in the United States that are designed to be legally operated on roads and highways. In 1990, the most recent year for which complete records are available, there were about 100,000 reported accidents involving motorcycles, resulting in more than 3,200 fatalities–more than 7 fatalities per 10,000 registrations, nationwide (FARS 90). In other words, one out of every 40 registered motorcycles was involved in an accident, and one out of every 1,300 motorcycles was involved in a fatal accident during 1990. When miles traveled are considered, the fatality rate for motorcyclists is about 20 times that of the operators and passengers of other motor vehicles. The National Highway Traffic Safety Administration (NHTSA) estimates that 52 percent of motorcycle driver fatalities involve alcohol (FARS 90).

Both the number of motorcycle accidents and motorcyclist fatalities per 10,000 registrations have declined during the past decade. While these trends may be attributable to the effectiveness of motorcycle safety programs and a general aging of the population, motorcyclist are still exposed to considerable risk, especially those who operate their vehicles under the influence of alcohol.

Clearly, enforcement of DWI laws is an important key to reducing the number of alcohol-related motorcyclist fatalities. *But what are the cues that law enforcement personnel should use to detect impaired motorcyclists*? The identification and development of a useful and reliable set of cues to assist law enforcement personnel is the objective of the research effort described in this report.

ORGANIZATION OF THIS REPORT

The study was conducted between 1989 and 1991. Phase I of the study consisted of three major project tasks, performed to obtain both subjective and objective data concerning the behavioral cues exhibited by impaired motorcyclists. The ultimate objective of Phase I was to develop a preliminary list of riding behaviors or cues that law enforcement officers could use to detect impaired motorcyclists. The Phase I tasks were,

- Personal interviews with subject matter experts,
- Review of DWI motorcycle arrest reports, and
- Ride-along observations.

The technical approach followed during Phase I of this study avoided exclusive reliance upon a single source of potentially biased information concerning behavioral cues used by law enforcement personnel to identify impaired operator performance. In particular, the approach recognizes the unobtrusive value of archival records-analysis, but also recognizes potential problems associated with relying on a single, convenient form of information. That is, while arrest reports are reasonably available and provide valuable information, they are always prepared *after the fact,* and therefore are subject to error; lack of inter-officer comparability of terms and misinterpretation are additional possibilities associated with exclusive reliance upon archival records from a variety of sources. To avoid these problems, the approach followed during Phase I of this study included an appropriate mix of archival research, expert opinion, field data collection, and analysis.

The three major Phase I research tasks resulted in substantive information regarding a variety of issues related to the subject of impaired motorcycle operation and the detection of DWI operators by patrol officers. Each of the Phase I tasks is summarized in subsequent chapters in chronological sequence, and results are presented. Resulting cue inventory, definitions of specific cues, and our overall understanding of motorcycle DWI detection reflect an evolutionary process, beginning with subject matter expert interviews, augmented by archival arrest report research, and a preliminary field study.

A description of Phase II project activities is presented following the discussion of Phase I tasks. A major, national-level field study was conducted during Phase II. The field study led to the development of a motorcycle DWI detection guide, training video, and printed training materials to assist law enforcement personnel in the accurate detection of impaired motorcyclists.

Finally, a validation study was conducted to test the set of behavioral cues and the training materials developed at the conclusion of Phase II. A revised set of motorcycle DWI enforcement training materials (training video, DWI brochure and detection guide) are the final products of the validation study.

CHAPTER 2:
INTERVIEWS WITH SUBJECT MATTER EXPERTS

The first major project task performed in this study was the conduct of personal interviews with experienced patrol officers, and other experts, concerning the behaviors indicative of DWI motorcycle operation. More than forty subject matter experts (SMEs) were interviewed, including police personnel representing 11 jurisdictions and five states. All of the police personnel interviewed were DWI-detection specialists. The combined police experience of the key SMEs interviewed totaled 626 years; individual experience ranged from three to 27 years. The average experience level of the law enforcement experts was 17.4 years per patrol officer.

In addition to law enforcement personnel, selected civilian motorcycle experts were interviewed to obtain their special perspectives on the issues central to the research project. Civilian experts interviewed included the Vice-President for Safety Programs of the Motorcycle Safety Foundation, a key member of the University of Southern California's Head Protection Research Laboratory team, the motorcycle and DWI instructor at the Institute for Police Traffic Management (University of North Florida), and the editors of two popular motorcycle magazines; each of the editors had recently published in their magazines credible articles concerning the effects of alcohol consumption on motorcycle operation.

All of the interviews were conducted by the Project Director, and most were performed by telephone; the average interview duration was approximately 30 minutes. On several occasions, follow-up calls were made to obtain additional information or clarification of issues raised in previous conversations.

The following pages summarize the results of the SME interviews. Results are presented under three headings: Results of Patrol Officer Interviews, Results of Civilian Expert Interviews, and Motorcycle DWI Cues Identified During SME Interviews.

It is important to emphasize that the number of times that a cue was reported during interviews must not be interpreted as a measure of the cue's ultimate value or likely inclusion in a decision-aid. The primary purposes of SME interviews were to obtain expert opinion, develop a preliminary inventory of cues to facilitate the performance of subsequent project tasks, and develop an understanding of the conditions under which motorcycle DWI detection is made.

RESULTS OF PATROL OFFICER INTERVIEWS

Interviews with patrol officers were valuable for a variety of reasons. In addition to obtaining information that would be used to construct a preliminary list of DWI detection cues, substantial insight was gained to the conditions under which patrol operations are conducted and DWI stops are made. Perhaps equally important, it was found that even highly-experienced officers differ widely in how easily impaired motorcyclists can be detected.

In fact, patrol officers can be categorized as belonging to one of three groups, in terms of their professional opinions concerning how easily DWI motorcyclists can be detected; the groups are of roughly equal size. The division of opinion among patrol officers appears to be significant.

Group 1 Officers

Many officers express the belief that impaired motorcyclists are very difficult, if not impossible, to detect by their riding behavior alone. These officers are described as belonging to Group 1, for purposes of this discussion. Many Group 1 officers believe that DWI motorcyclists cannot be detected because, "...motorcycles don't weave as much as cars, due to the gyroscopic effect of the wheels." Paradoxically, other officers maintain that motorcycles weave *more* than autos, and that movement within a lane is a fundamental component of good defensive riding procedures. From these comments one might conclude that weaving is a poor indicator of DWI, either because it rarely occurs, or because it occurs too frequently to discriminate between impaired and normal vehicle operation.

Officers of this category commented that while speeding is frequently associated with DWI, it is not a reliable DWI cue "because all motorcyclists speed" ("...after all, the machines are built for speed, especially the cafe racers and competition bikes so prevalent today"). In this regard, several officers expressed the widely-held belief that riders of touring-style bikes might speed, but they are *never* drunk. Similarly, some Group 1 officers mentioned that it is extremely rare for DWI motorcyclists to have blood alcohol concentrations (BACs) greater than .13, believing that, "Very drunk people don't ride motorcycles."

The general consensus among Group 1 officers is that DWI is rare among motorcyclists, the few DWI motorcyclists on the road cannot be detected by their riding behaviors, and detection can only be made by smelling the odor of alcohol on an operator's breath following a stop for another infraction. Even then, detection is made more difficult by conditions unique to motorcycles. In particular, a light breeze can dissipate alcohol odors that are otherwise contained within an automobile, and bloodshot eyes can be caused by wind in the rider's face, as well as by alcohol consumption. As evidence of their difficulties with this subject, some of the Group 1 officers interviewed could not recall ever arresting a motorcyclist for DWI during 15 to 20 years of patrol experience.

Group 2 Officers

A second category of officers, characterized as Group 2, believes that detection of DWI motorcyclists is identical to that of typical DWI automobile drivers. These officers focus on speeding, weaving, and stop sign/signal violations as the cues most indicative of DWI. To a large extent, Group 2 officers are correct in their assumptions, but their DWI-detection capabilities are limited by those same assumptions. In other words, speeding and weaving result in large numbers of motorcycle DWI arrests, but other cues may be available that are predictive of impairment.

Group 3 Officers

The responses of Group 3 officers, however, were vastly different than those of their Group 1 and Group 2 colleagues. Group 3 officers, most of them experienced motor-patrol officers, believe that DWI motorcyclists can be detected accurately by their overt riding behavior. In addition, Group 3 officers perceive a broad range of riding behaviors to be indicative of DWI. Officers of this category use some of the same cues as Group 2 officers, but with greater sensitivity to deviations from normal riding procedures. For example, while Group 2 officers cite excessive speed as a DWI cue, Group 3 officers specify *high* speeds (20 or more miles per hour over the limit) and "aggressive riding behavior" as relevant to DWI detection. Conversely, "overly cautious" riding can also be evidence of DWI to some Group 3 officers. It was explained that because most young motorcyclists typically ride "pretty hot" (fast, but not necessarily illegally), when one is observed riding slowly, this deviation from the norm might be cause for suspicion (i.e., "...the rider knows he is deuce [i.e., DWI] and is compensating by riding very slowly").

Perhaps more distinguishing of these officers' approach to detection are the subtle cues, many of them balance or vigilance related, that Group 3 officers say they use to detect DWI motorcyclists. Among the more subtle, balance-related causes reported is the shifting of weight from one foot to the other while at a stop. Normal operation at a stop involves placing one foot firmly on the pavement to balance the motorcycle and maintain a generally upright orientation. It is the experience of Group 3 officers, however, that DWI motorcyclists frequently have difficulty with this task. In the judgment of Group 3 officers, operators with impaired balance will often find it troublesome to keep their motorcycle upright while at a stop, shifting their weight repeatedly from one foot to the other to maintain balance. From a distance (e.g., a block away), this balance problem appears as a single tail or head light moving back and forth, as the operator attempts to prevent the motorcycle from falling to one side. Other reported examples of balance-related cues include early foot placement when coming to a stop, in anticipation of trouble balancing the motorcycle, and wobbling of the front wheel or handlebars while turning or at slow speeds.

A separate set of balance-related, behavioral cues are used by Group 3 officers after a stop has been made. Group 3 officers described the actions involved in stopping and dismounting a motorcycle as providing "a built-in field sobriety test." The operator must locate a suitable place to stop the motorcycle while making accurate estimates of the motorcycle's momentum and braking capability to smoothly come to a complete stop. The operator must then find the neutral position of the motorcycle's transmission (coordinating hand and foot actions), disengage the clutch, locate and deploy a kick-stand, transfer the weight of the machine onto the kickstand, then dismount. Dismounting a motorcycle usually involves standing on one leg while swinging the other leg over the seat. Impaired operators frequently have difficulty with one or more tasks in this demanding sequence.

Group 3 officers also tend to use vigilance-related cues in their decision-making processes regarding a DWI motorcycle stop. Group 3 officers mentioned that normal defensive riding practice demands that the operator constantly monitor the traffic in his or her vicinity. Understanding that automobile and truck drivers often fail to see, or

perhaps recognize motorcycles as vehicles, requires an extra measure of defensiveness on the part of a careful motorcyclist. This understanding is typically manifested as constant scanning behavior (i.e., to the front, sides, and rear) to alert the motorcyclist to the presence of potential vehicle threats (e.g., lane changes); in response to perceived threats, the motorcyclist might choose to move to the other side of a lane, change lanes, accelerate, or decelerate.

Group 3 officers are aware of these defensive riding strategies and do not attribute this kind of maneuver to impairment when it is accompanied by scanning behavior. In the absence of scanning behavior, however, the maneuvers described might be interpreted as suggestive of DWI; the absence of scanning behavior is observed from a distance as little noticeable head movement by the motorcyclist.

Additional vigilance decrements are also the focus of Group 3 officers. For example, exceeding the speed limit, but failing to check the rear view mirror frequently or look back at a highway on-ramp to determine if a patrol car is there, are DWI cues for some Group 3 officers. Similarly, riding in an "overly confident" manner and "seemingly unconcerned with detection" are subtle operator behaviors used by Group 3 officers as evidence of impaired judgment. Many officers believe that DWI motorcyclists consciously rely on officers' inability to detect impaired operation. In the words of a DWI-detection expert, "Motorcyclists are overlooked by officers because the officers don't know what to look for."

There is limited utility in distinguishing between "groups" of officers, in terms of their opinions regarding the detectability of DWI motorcyclists. It provided encouragement to the current study to discover that many officers believe that cues **are** available that can be used to detect DWI motorcyclists. Equally significant was the discovery that a substantial number of patrol officers, even some with many years of experience, are unaware of behavioral cues they might use to detect impaired motorcyclists. The results suggest that training materials developed as a result of this effort might benefit both new recruits and experienced officers, a larger population of law enforcement personnel than initially expected.

RESULTS OF CIVILIAN SME INTERVIEWS

Civilian motorcycle experts interviewed during the current study focused on the cognitive and psychomotor skills necessary for proficient operation, and the manner in which those required skills are degraded by alcohol consumption. For example, David Thom (of the USC Head Protection Laboratory) and Peter Fassnacht (Vice-President for Safety Programs of the Motorcycle Safety Foundation) referred to the tendency for a motorcycle to "go straight unless told otherwise," due to inertia and the gyroscopic nature of two-wheeled vehicles. As a result of this gyroscopic tendency, curving roads cause serious difficulties for operators with degraded skills and capabilities. Fassnacht reported that motorcyclists suffer a fatality rate 10 to 15 times greater than that of automobile drivers. Thom attributes much of that fatality rate to single-vehicle accidents, in which the road curves, but the motorcycle continues in a straight line until striking a stationary object. This represents the most common form of alcohol-involved motorcycle fatality, and it is typically associated with higher BACs, when a vehicle operator's

field of view is constricted, vigilance is impaired, and/or psychomotor capabilities degraded (Hurt, Ouellet, & Thom, 1981).

Other behavioral cues are suggested by this common accident-type. If in extreme cases a motorcycle fails to negotiate a curve by going straight, in less extreme cases the motorcycle's radius on the curve might expand during an otherwise successfully-completed maneuver; in such cases, the motorcycle would appear to drift to the outside of the lane through the curve. Similarly, an exceptionally wide turn, or drifting during a turn, might be evidence of the same impairment that is the primary cause of single-vehicle motorcycle fatalities. In this regard, Neil Robars (Motorcycle Instructor at the Institute for Police Traffic Management, at the University of North Florida) cites late braking on a turn or curve as a good clue regarding a motorcycle operator's skills and capabilities. Normal safe riding procedures call for braking *prior* to a turn or curve, rather than during the maneuver. Like drifting, sudden braking, or other corrections during a turning maneuver or while following a curving road, might be evidence that a motorcyclist's skills and capabilities have been exceeded or degraded.

The latter statement raises an interesting methodological and operational issue concerning DWI detection cues. All of the civilian experts, and several of the expert patrol officers, mentioned that many of the riding behaviors that might be indicative of impaired operation are also indicative of novice operation. In other words, it might be difficult to distinguish between a drunk and a beginner on a motorcycle. Further, it is believed that alcohol effects interact with the skill level of a motorcyclist. Thus, a novice rider would be more likely to exhibit overt signs of impairment at a given BAC than an experienced rider.

Civilian experts and several patrol officers suggested mood changes resulting from alcohol consumption as the most significant effect on performance. Articles prepared by Ken Lee (1982) and Dexter Ford (1987) both commented on the significant changes in attitude experienced by motorcyclists who were administered controlled doses of alcohol in demonstrations designed to measure the effects of alcohol on motorcycle riding skills. These informal demonstrations found that essential riding skills are degraded at relatively low BACs (between .05 and .07) for most riders; .10 was roughly the level at which performance was seriously and overtly impaired. More important to the authors was the dramatic increase in *aggressive* riding behavior exhibited by some motorcyclists in response to very low doses of alcohol. Lee (1982: 138) reported that,

> Long before we saw any loss of motor control, we witnessed distinct transformations in personality and losses of judgment. The effects of the alcohol upon our test subjects were not linear; when the BAC curve was rising, all three drinkers showed a much greater reaction to the booze than their BAC figures would otherwise suggest, and once all testers were up to the legally drunk limit, the variations in attitude and physical effects were strikingly dissimilar. BAC is no indication of the "berserk" factor, which may be the one that really counts.

Similarly, Ford found that among his dosed motorcyclists, one or two drinks seemed to remove "the healthy fear of crashing, while leaving their other riding skills largely intact" (1987: 82).

These observations are consistent with comments made during interviews with police experts. According to many law enforcement personnel, motorcyclists who have been drinking, whether they are legally drunk or not, are frequently observed to operate their vehicles in an aggressive manner. They are said to exceed the speed limit, follow too closely, change lanes abruptly and frequently, negotiate curves and turns at speeds considered to be unsafe for themselves and other motorists, and the like. In short, these interviews suggested that at lower BACs motorcyclists tend to ride aggressively and take chances (evidence of lowered inhibitions and impaired judgment); at higher BACs, essential riding skills are noticeably affected. Behaviors associated with these levels of alcohol-induced impairment can be articulated as observable cues for use by law enforcement personnel.

MOTORCYCLE DWI CUES IDENTIFIED DURING INTERVIEWS

Table 1 presents the inventory of motorcycle DWI cues obtained from interviews with patrol officers and civilian experts. Cues have been categorized as, 1) Riding Behaviors, 2) Post-Stop Behaviors, and 3) Equipment Factors. Numbers following a cue indicate the number of times that cue was reported by the 40 SMEs who were interviewed.

TABLE 1
PRELIMINARY LIST OF MOTORCYCLE DWI CUES OBTAINED FROM SME INFORMAL INTERVIEWS

RIDING BEHAVIORS	Number of Times Reported
1. Excessive speed	26
2. Weaving (primarily at slow speed–difficulty in maintaining a consistent track)	15
3. Drifting during turn or curve (not necessarily out of the lane)	9
4. Inappropriate foot actions (puts feet down too soon or too late at stop, or drags feet–impaired or just a bad riding habit, evidence of novice behavior)	8
5. Shifting weight at a stop (from a distance officer might see taillight moving side to side–a balance problem)	8
6. Jerky or abrupt stops (officer might observe front forks pumping up and down)	7
7. Aggressive riding (and attitude)	6
8. Exhibition of speed (e.g., wheelies, burnouts, fast acceleration–an auditory as well as a visual cue, e.g., winding out high RPMs)	6
9. Jerky starts from stop	6
10. Improper gear shifts (e.g., missing shift)	5

11.	Failure to stop at light or sign before turning right	4
12.	Inattentive to surroundings (e.g., does not use rear view mirror or look back at on-ramps to check for patrol cars, little head movement, no evidence of normal scanning behavior, failure to respond to other vehicles)	4
13.	Splitting traffic	4
14.	Riding too slowly (over-cautiousness–a cue for higher BACs or novices)	4
15.	Running light or stop sign	4
16.	Erratic movements of motorcycle while going straight (e.g., sudden corrections)	4
17.	Wobbling of front wheel or handlebars when stopping	4
18.	Erratic movements of motorcycle while turning (e.g., sudden corrections)	4
19.	Frequent crossing of the center "oil" in a lane (for no apparent reason–inability to maintain position in a lane)	3
20.	Jerky lane changes	3
21.	Following too closely	3
22.	Frequent lane changes	2
23.	Revving engine at stop	2
24.	Inability to maintain a constant speed	2
25.	Stopping beyond the stop limit lines	2
26.	Evasion ("rabbit" almost always drunk and almost always crashes–many jurisdictions have decided not to pursue to minimize injury and liability)	2
27.	Passing on the right	2
28.	Taking chances ("recklessness")	2
29.	Facial expression (appears to be drunk)	2
30.	Seemingly unconcerned with detection (over confident)	2
31.	Failure to use turn signal	1
32.	Snaking through traffic (passing on both sides)	1
33.	Failure to respond to officer's lights or hand signals	1

34.	Difficulty starting motorcycle	1
35.	Failure to respond to green light	1
36.	Doing something other than turn left from a left turn lane (e.g., going straight, turning right)	1
37.	Coasting down a hill	1
38.	Normal behaviors, but in the extreme (e.g., splitting traffic is normal, but doing it fast is evidence of DWI)	1
39.	Late braking on a curve (failure to brake prior to entering a curve, requiring braking during the curve)	1
40.	Improper lean angle on a curve	1
41.	Running into vehicle from behind	1
42.	Riding with kickstand deployed	1
43.	Riding three abreast (when only two abreast is legal)	1
44.	Carrying open container of alcohol in hand	1
45.	Carrying case of beer under one arm, operating motorcycle with other	1
46.	Passenger exhibiting “strange” behavior	1
47.	Rider carrying inflatable party doll	1
48.	Rider urinating at side of road	1
49.	Passing on left across double line	1
50.	Early foot placement	1
51.	Operating as if a novice	1
52.	Accident	1

POST-STOP BEHAVIORS

53.	Difficulty with kickstand (cannot find or trouble deploying)	7
54.	Knocks motorcycle over accidentally	3
55.	Has trouble with balance during dismount (dismounting is a built-in field sobriety test)	2
56.	Abrupt response when officer “lights them up” (signals rider to stop)	2

57.	Leaving motorcycle in gear when turning off engine	2
58.	Stopping at a location where the kickstand cannot be safely or effectively deployed (reported as an indirect indication of impaired judgment following a stop)	1
59.	Kicks motorcycle seat during dismount	1
60.	Uses motorcycle for support while waiting for officer to approach	1
EQUIPMENT FACTORS		
61.	Helmet attached to side of motorcycle, rather than being worn (reported as an indirect sign of impaired judgment)	3
62.	Operating without lights at night	3
63.	No helmet	2
64.	Silly headgear (e.g., cap on backwards)	1
65.	Inappropriate clothing for the conditions (e.g., T-shirt in cold weather)	1
66.	Improper wearing of safety glasses (some states have a safety glasses laws but no helmet law)	1
67.	No protective gear (other than helmet)	1
68.	Loud motorcycle	1
69.	Leaning forward over tank to maintain balance at a stop	1
70.	Wearing helmet while talking to officer	1

It is important to note that an infrequently-reported cue does not necessarily indicate that the cue is unusual or unlikely to discriminate between DWI and unimpaired operation. To the contrary, some of the cues were apparently reported infrequently because most law enforcement personnel are unaware that they might be associated with DWI. For example, *Improper lean angle on a turn or curve,* is explained as a fundamental reaction to a balance problem experienced by either novice or DWI motorcycle riders. An unimpaired and experienced rider typically leans *into* a turn or curve to perform the maneuver, rather than remaining upright and turning the handlebars. Novice and DWI motorcyclists, however, might approach a turn or curve, misjudging their speed or distrusting their ability to maintain balance. As a result, they attempt to remain in a vertical orientation through the maneuver and must use the handle bars to turn. To the careful, intuitive, or trained observer, the action is evidence that the operator is not in full control of the motorcycle.

Similarly, situational and conditional differences are reflected in the relative reporting of cues by patrol officers and other experts. For example, many expert patrol officers were interviewed before the cue *Facial expression* was reported by two motor patrol officers who work an inner-city jurisdiction. They mentioned, in separate interviews, that most of the DWI motorcyclists that they arrest are detected while riding in the opposite direction, rather than from behind, as is the norm for police cars and highway patrol units. These urban police officers have found it productive to ride in the number one lanes of city streets, searching the oncoming traffic for facial expressions indicative of alcohol impairment (i.e., droopy face, watery eyes). They then make U-turns to follow a suspect vehicle, monitoring driving behavior for other overt evidence of DWI. The applicability of this very effective technique is probably limited to urban street conditions.

The inventory of motorcycle DWI cues obtained through personal interviews with SMEs was used to develop a data-collection form designed to facilitate the review of DWI arrest reports. A discussion of that project task is provided in the following chapter.

CHAPTER 3:
REVIEW OF DWI MOTORCYCLE ARREST REPORTS

There were two reasons for conducting archival research among police arrest records: 1) To develop quantitative data concerning the use of visual cues by law enforcement officers in the detection of DWI motorcyclists; and, 2) To collect data that might suggest relationships between specific cues or cue types and BAC levels. The results of this project task are presented in three sections: Background, which describes where and how the archival research was performed; Descriptive Statistics, which describes the "sample" of DWI motorcyclists and the riding behavior that led to arrests; and Data Analysis, which summarizes the results of both qualitative and quantitative analyses performed.

BACKGROUND

The target number of arrest reports to be reviewed was set at approximately 1,000 to ensure a robust database. Anacapa Sciences had originally proposed to collect archival data in six law enforcement jurisdictions characterized by high motorcycle ridership. Preliminary research indicated that six jurisdictions would provide too few reports, and would likely result in insufficient geographic coverage. Table 2 provides a list of the eight jurisdictions that provided access to DWI motorcycle arrest reports

TABLE 2
JURISDICTIONS/AGENCIES THAT PROVIDED ACCESS TO DWI MOTORCYCLE ARREST REPORTS

California
California Highway Patrol
Los Angeles Police Department
Florida
Dade County State Attorney's Office
Duval County Sheriff's Office
Hillsborough County State Attorney's Office
Orange County State Attorney's Office
New Mexico
New Mexico Traffic Safety Bureau
Virginia
Norfolk Police Department

The method of storage for arrest reports was different in each jurisdiction. In most jurisdictions, it was necessary to manually search through volumes of arrest records to find a relatively small number of motorcycle DWI reports. For example, at the headquarters of the Los Angeles Police Department, nearly 17,000 reports were reviewed by hand to identify 180 that involved motorcycles. In Miami, Florida (Dade

County), more than 1,000 state attorney's DWI case files were reviewed, but only two were found that involved motorcycles (and one of those was a DWI accident). Case files were searched in Orlando and Tampa (Orange and Hillsborough counties), with considerably better success than in Miami, even though DWI case files were not segregated from those of other major traffic offenses. Jacksonville, Florida (Duval County) was particularly productive, due largely to the meticulous record-keeping of the local toxicologist; approximately 3,700 reports were reviewed and 44 motorcycle DWIs identified.

New Mexico was the only jurisdiction examined with a statewide system designed for automated tracking of DWI arrest data. In New Mexico, the Project Director was provided a list of all motorcycle DWI reports to be reviewed on microfilm, eliminating much of the tedious searching required elsewhere. The California Highway Patrol and the Norfolk Police Department facilitated our research effort by sending motorcycle DWI arrest reports directly to Anacapa Sciences for review and data entry.

The format of DWI arrest reports varies from jurisdiction to jurisdiction. All reports, however, contain a section in which the arresting officer describes, in his or her own words, the operator behaviors that led to the enforcement stop. It is this "narrative" description that was the focus of our archival research. Appendix A provides three examples of narrative sections of actual DWI motorcycle arrest reports. These examples were selected for inclusion in this document because they provide illustrations of the different content found in the narratives.

Archival research was facilitated by the development of a standard data-collection form (see Appendix B). The original version of the form contained a total of 83 behavioral cues, obtained through interviews with SMEs and a review of the relevant literature (including reports documenting previous research conducted by Anacapa Sciences, Inc.). Ten additional items were added to the form as new cues were identified during the course of the archival research. An additional cue was identified during post-collection analysis, when the cue *Vehicle defects* was divided into equipment and license/registration problems.

Although the narrative sections were the focus of the arrest report reviews, additional information was recorded on the data-collection forms (e.g., date and time of arrest, subject gender, age, etc.). In no instance was information collected that could be used to associate a report with an individual offender or officer; assurances of complete confidentiality were required to obtain access to most jurisdictions' and agencies' records. Anacapa has not retained any files that would permit identification of specific individuals.

It is estimated that more than 27,000 DWI arrest reports were "handled" during the conduct of this project task, to obtain a total of 954 motorcycle DWI reports. The resulting ratio of motorcycle DWIs to all DWIs does not reflect naturally occurring ratios. This is because the California Highway Patrol, State of New Mexico, and Norfolk Police Department provided motorcycle DWI arrest reports only, eliminating the need to sift through all DWI reports for those jurisdictions. Actual ratios of motorcycle to "other vehicle" DWIs ranged from a high of one motorcycle DWI in 62 DWI reports in Orange County, Florida, to a low of one in 500 in Dade County, Florida. Additional ratios that

could be calculated are, Duval County: one in 83; Hillsborough County: one in 100; and Los Angeles Police Department: one in 94.

Table 3 summarizes the distribution of DWI motorcycle arrest reports among the participating jurisdictions, or agencies. Agencies known to have large numbers of registered motorcyclists were asked to participate. Only a few agencies declined our invitations. Among the reasons provided were concern for the confidentiality of arrest report data and lack of interest. The project team is grateful to those individuals and agencies that provided access to arrest reports. Although we are particularly grateful to those agencies that contributed large numbers of reports to the study, the number of reports provided reflects the size or constituent population of an agency, rather than the level of cooperation or interest in the study; that is, all of the agencies that participated in the study were eager to cooperate and sincerely supportive of the objectives of the research.

TABLE 3
MOTORCYCLE DWI REPORTS BY AGENCY

Agency	Reports	Percent of Sample
California		
California Highway Patrol	499	52.3
Los Angeles Police Department	181	19.0
Florida		
Dade County	2	0.2
Duval County	44	4.6
Hillsborough County	16	1.7
Orange County	22	2.3
New Mexico		
New Mexico	178	18.7
Virginia		
Norfolk Police Department	12	1.3
Total	954	

DESCRIPTIVE STATISTICS

Table 4 and Table 5 provide background information concerning the sample of DWI motorcyclists obtained by reviewing arrest reports. Table 4 indicates that women represent only one percent of the sample (10 women out of 944 reports in which gender was recorded). The racial distribution of DWI motorcyclists in the sample consisted of 78 percent white, 17 percent Hispanic, three percent black, and the remainder composed of motorcyclists reporting Native American, Oriental, or Polynesian descent. Table 5 provides the distribution of DWI motorcyclists by age; Figure 1 illustrates the age distribution. As indicated in Table 5 and Figure 1, DWI motorcyclists in the sample ranged in age from 16 to 64 years old; the average age was 28.7 years, and the mode was 24 years. It is important to note that motorcyclists between the ages of 21 and 26 years old represent nearly 40 percent of the sample of 908 DWI motorcyclists for whom age is known. It is not surprising, however, to learn that young men, recently of legal drinking

age (21 to 26 years of age), are disproportionately represented among DWI motorcyclists.

TABLE 4
DWI MOTORCYCLISTS BY GENDER

Gender	Motorcyclists	Percent
Male	930	98.9
Female	10	1.1
Total	940	

TABLE 5
DWI MOTORCYCLISTS BY AGE CATEGORY

Age	Motorcyclists	Percent
15-17	6	.7
18-20	79	8.7
21-24	241	26.5
25-34	408	45.0
35-44	124	13.7
45-54	45	5.0
55-64	4	.4
Total	**907**	

Average age = 28.7 years

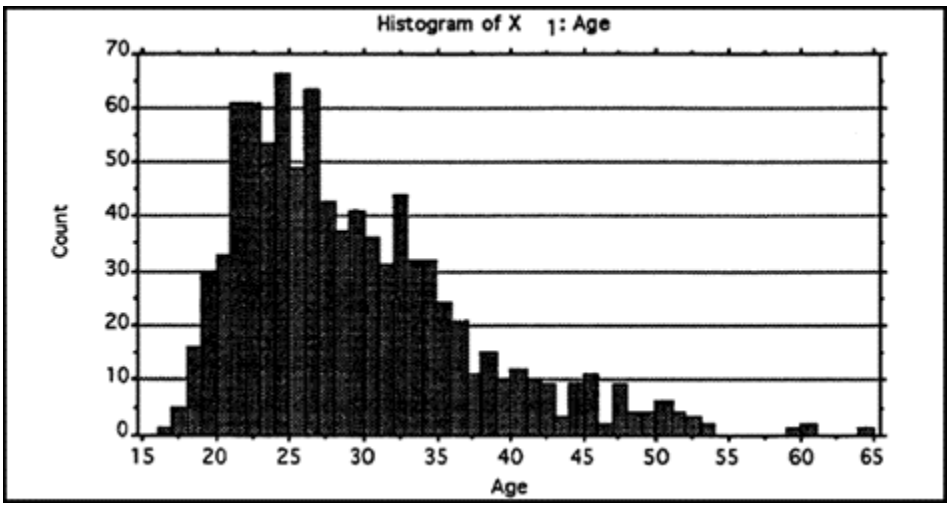

Figure 1. Distribution of DWI motorcyclists by age.

Table 6 provides the frequency of BAC testing method obtained from the review of motorcycle DWI arrest reports. The most common method is the breath test, representing more than 76 percent of the sample.

TABLE 6
BAC TESTING METHOD

Method	Tests	Percent
Blood	157	19.8
Breath	607	76.4
Urine	30	3.8
Total	794	

Table 7 presents a summary of the distribution of BAC levels obtained from the review of motorcycle DWI arrest reports. Blood alcohol concentration (BAC) data were obtained for 644 of the 954 DWI reports that constitute our motorcycle DWI database; that is, BAC level is known for 68 percent of the DWI reports reviewed. In nearly all cases, BACs were available only when a breath test was the method of BAC determination; when a breath test is administered, the arresting officer typically either conducts the test or receives the test results immediately, which permits the officer to include that information in his or her arrest report. On some arrest reports, breath test results were not recorded, and some of the reports reviewed in prosecutors' case files contained blood or urine test results, which require several days or weeks to become available. Approximately ten percent of the arrest reports reviewed indicated that the motorcyclist refused to submit to any form of chemical testing. Although empirical data were not systematically collected to support this contention, it appears that many of those who refused chemical testing had records of previous DWI arrests and/or were operating their vehicles with invalid driver's licenses.

TABLE 7
BAC LEVEL OF DWI MOTORCYCLISTS

BAC Level	Motorcyclists	Percent
Less than .05	27	4.2
.05 to .09	68	10.6
.10 to .14	224	34.8
.15 to .19	196	30.4
.20 to .24	88	13.7
.25 to .29	35	5.4
.30 or greater	6	0.9
	644	
Refused All Tests	96	
Data Not Available	214	
Total	954	

Of the 644 BACs contained in the database, 95 BACs are below .10, the legal limit. Twenty-six of the reports with BACs below .10 indicated drug use that contributed to the DWI arrest. A total of 54 reports in the complete sample indicated drug use (both prescription and illegal drugs), covering nearly the full range of BACs recorded. Many of the 26 motorcyclists stopped for drug-related impairment (with BACs below .10) were stopped for *Vehicle defects*, rather than moving violations. In general, those arrested for drug-related impairment with BACs below .10 seemed to display less risk-taking behavior (speeding, recklessness, etc.) than other impaired riders without drug involvement and with BACs below .10. When considering all 54 DWI arrests in which drug use was suspected (and alcohol involved in more than half of them), only the most obvious and general statements can be made. For example, those motorcyclists suspected of stimulant use were apparently engaged in risk-taking behavior indicating impaired judgment; motorcyclists suspected of using depressants showed behaviors suggestive of impaired balance; and the few suspected phencyclidine (PCP) users tended to fall from their motorcycles. No specific behaviors were identified to correlate with suspected marijuana use.

Table 7 indicates that BACs below .10 represent 14.8 percent of all 644 BACs in the database; BACs from .10 to .19 account for the bulk of all BACs, with 65.2 percent; and, BACs greater than .20 (twice the legal limit), represent 20 percent of the sample of BACs. This latter category reflects a significant DWI problem, and contradicts a widely-held assumption, stated in the previous chapter, that very drunk people do not ride motorcycles. To the contrary, one in five of the known BACs are greater than .20, and the narratives suggest that many of those who refused to be tested might have received relatively high BACs had they been tested. Further, it is possible that many of those who chose blood tests did so to delay the BAC determination, to permit their bodies to metabolize some of the alcohol in their blood. (Drawing blood must be performed by medical personnel, which often requires transporting the DWI suspect considerable distance to a hospital; delays of an hour or more are not uncommon.) In other words, it is believed that if all data were available, the proportion of higher BACs would be greater than that reflected in the database.

Table 8 presents the distribution of the BAC level by age category in the sample. Table 9 summarizes the distribution by presenting the number of motorcyclists and average BAC in each age category. Data from this sample indicate a general tendency for BACs to be higher among older motorcyclists. During interviews with experts it was reported that older, more experienced drinkers often *appear* to be able to “hold their liquor” to a great extent, performing well on field sobriety tests (FSTs), but poorly on the road. It was reported that even some operators with very high BACs, who may have developed some tolerance for alcohol, can pass FSTs if they are accustomed to heavy drinking.

TABLE 8
BAC BY AGE CATEGORIES

	BAC Categories								
Age Categories	**<.05**	**.05-.09**	**.10-.14**	**.15-.19**	**.20-.24**	**.25-.29**	**.30+**	**Refused Test**	**Data N/A**
15-17									
Frequency	1	0	2	1	0	0	0	0	2
Percent	0.11	0.00	0.22	0.11	0.00	0.00	0.00	0.00	0.22
18-20									
Frequency	2	13	24	18	7	0	1	1	13
Percent	0.22	1.43	2.65	1.99	0.77	0.00	0.11	0.11	1.43
21-24									
Frequency	6	22	67	47	21	6	1	15	56
Percent	0.66	2.43	7.40	5.19	2.32	0.66	0.11	1.66	6.18
25-34									
Frequency	11	21	82	80	47	16	1	52	97
Percent	1.21	2.32	9.05	8.83	5.19	1.77	0.11	5.74	10.71
35-44									
Frequency	6	5	27	31	3	10	3	16	23
Percent	0.66	0.55	2.98	3.42	0.33	1.10	0.33	1.77	2.54
45-54									
Frequency	1	3	6	11	5	2	0	6	11
Percent	0.11	0.33	0.66	1.21	0.55	0.22	0.00	0.66	1.21
55-64									
Frequency	0	0	0	1	1	1	0	0	1
Percent	0.00	0.00	0.00	0.11	0.11	0.11	0.00	0.00	0.11
TOTALS	**27**	**64**	**208**	**189**	**84**	**35**	**6**	**90**	**203**

TABLE 9
SUMMARY OF BAC BY AGE CATEGORY

Age Category	**Number**	**Average BAC**
Age missing	31	.141
15-17	4	.098
18-20	65	.133
21-24	170	.143
25-34	258	.154
35-44	85	.152
45-54	28	.158
55-64	3	.230
Total	644	

Average BAC = .151

Two additional descriptive measures help to define the motorcycle DWI issue. Table 10 provides the distribution of DWI incidents by hour. These data indicate that 50.7 percent of all motorcycle DWI arrests are made during a four-hour period, between 2300 and 0300 hours (11:00 PM and 3:00 AM). While these data are consistent with the distribution of automobile DWI arrests, it is important to note that significant numbers of motorcycle DWIs also occur in the early morning, late afternoon, and evening, as well as late at night.

TABLE 10
DISTRIBUTION OF MOTORCYCLE DWI ARRESTS BY HOUR

Hour	DWI Arrests	Percent
Midnight-100	106	11.2
100-200	128	13.5
200-300	140	14.8
300-400	43	4.5
400-500	19	2.0
500-600	1	.1
600-700	2	.2
700-800	3	.3
800-900	4	.4
900-1000	2	.2
1000-1100	2	.2
1100-1200	4	.4
1200-1300	6	.6
1300-1400	6	.6
1400-1500	5	.5
1500-1600	6	.6
1600-1700	18	1.9
1700-1800	40	4.2
1800-1900	33	3.5
1900-2000	54	5.7
2000-2100	57	6.0
2100-2200	86	9.1
2200-2300	78	8.2
2300-2400	106	11.2

Finally, Table 11 summarizes data concerning the location at which DWI motorcyclists had been drinking prior to their detection and arrest. These data were extracted from 202 of the 499 arrest reports provided by the California Highway Patrol (CHP), consequently, they might not reflect nationwide patterns of drinking and riding. Of those who responded to the question, "Where have you been drinking?", 48 percent said they had been drinking in a bar, restaurant, or similar establishment (i.e., pool hall, bowling alley, lodge). Fewer than half this number, twenty-two percent, had been drinking at a friend or relative's house, or at a party; 16 percent had been drinking at home. The remaining 14 percent had been drinking at the other locations listed in the table.

ANALYSIS OF DWI ARREST REPORT DATA

The motorcycle DWI arrest data of greatest importance to the current study are the officers' narrative accounts. Officers' narratives describe the actions that provided the motivation to initiate enforcement stops that resulted in DWI arrests. Analysis of the information contained in narrative accounts of DWI motorcyclists' riding behavior provides an opportunity to determine what behavioral cues are being reported as used by law enforcement personnel, and the relative frequencies that specific cues are reported.

TABLE 11
LOCATION WHERE MOTORCYCLISTS
HAD BEEN DRINKING PRIOR TO DWI DETECTION

Location	Frequency	Percent
Bar, Restaurant, etc.	97	48
Friend's, Relative's, Party	45	22
Home, Hotel Room	33	16
Park, Beach, Lake	11	6
Sporting Event	7	4
Work	5	2
En Route	4	2
Total	202	

It is important to establish a distinction between frequency of cue reporting, and frequency of occurrence. As stated earlier, many officers are unaware that certain riding behaviors may be indicative of impaired motorcycle operation. Consequently, those behaviors might go undetected or mis-categorized by some law enforcement personnel. Thus, the relative frequency that a cue is reported in a sample of arrest reports is not necessarily the relative frequency of the cue's occurrence, or the best indicator of the cue's diagnostic utility.

With behavioral cues as the focus, the remainder of this chapter is presented in sections devoted to Cue Frequency, Cue Co-occurrence, and Relationships of Specific Cues to BAC Level.

Cue Frequency

The first measure to be applied to the database of 954 motorcycle DWI arrest reports was a frequency count of the cues identified during interviews and archival research. Table 12 provides a listing of all cues in descending order of the frequency of reporting on DWI arrest records. From this table it is apparent that *Weaving within a lane* is by far the most frequently-cited riding behavior associated with motorcycle DWI; this cue was reported a total of 209 times, appearing on 21.9 percent of all DWI reports in the database. Weaving was reported nearly twice as frequently as the next most common cue, *31+ miles per hour more than speed limit*. This most frequent speeding cue, also the most extreme speeding cue, was reported on 108 arrest reports, representing 11.3 percent of the sample. *Accident* is the third most common cue reported,

but this cue is of little value in developing a decision-aid regarding behaviors that might be useful in preventing accidents. The high occurrence of accidents in the database, however, underscores the need for improved DWI detection methods and strategies regarding motorcycles.

TABLE 12
FREQUENCY OF CUES RECORDED FROM MOTORCYCLE DWI ARREST REPORTS

Cue Description	Frequency	Percent of Reports
Weaving within a lane	209	21.9
31 +mph over speed limit	108	11.3
Accident	106	11.1
Rapid acceleration	95	10.0
Running light or stop sign	90	9.4
Excessive speed (no estimate provided)	78	8.2
21-25 mph over speed limit	76	8.0
11-15 mph over speed limit	75	7.9
Shifting weight repeatedly at stop	66	6.9
Unsteady at slow speed or during turn (e.g., wobbling)	65	6.8
16-20 mph over speed limit	65	6.8
Evasion	62	6.5
Failure to respond to officer's lights or hand signals	60	6.3
Recklessness (e.g., speed too great for conditions)	51	5.3
Erratic movements while going straight	51	5.3
Failing to turn left from left turn lane	50	5.2
Vehicle defects (lights, wheels, tires, etc.); illegal m/c for conditions	47	4.9
Weaving across center line	44	4.6
Expired registration tabs or no license plate	44	4.6
Riding or parking on sidewalk or similarly illegal location	42	4.4
Trouble with balance during dismount	34	3.6
Frequent lane changes	31	3.2
26-30 mph over speed limit	31	3.2
6-10 mph over limit	28	2.9
Following too closely	27	2.8
Drifting during turn or curve	27	2.8
Inattentive to surroundings	26	2.7
Loud motorcycle exhaust	25	2.6
Passing on left across double line	23	2.4
Operating without lights at night	21	2.2
Snaking through traffic	20	2.1
Facial expression	18	1.9
Passing on the right	17	1.8
Not wearing safety glasses (where req.); dark glasses at night	17	1.8
Jerky or abrupt stops	17	1.8
Erratic movements while turning	16	1.7
Display of speed	15	1.6
Failure to use turn signal	14	1.5
Jerky lane changes	13	1.4

Failure to stop at sign or red light before turning right	13	1.4
Unsafe lane change	12	1.3
Stopping beyond limit lines	12	1.3
Splitting traffic	12	1.3
Knocking motorcycle over accidentally	11	1.2
Jerky starts from stop	11	1.2
Difficulty with kickstand	11	1.2
Disorderly conduct	10	1.0
Substantial fluctuation in speed	9	.9
Not wearing helmet	9	.9
Failure to respond to green light	9	.9
11-15 mph under speed limit	9	.9
Wrong way on one-way street	8	.8
Seemingly unconcerned with detection	8	.8
Striking object with motorcycle	7	.7
Improper or missed gear shifts	7	.7
Foot dragging	7	.7
Difficulty starting motorcycle	7	.7
Revving engine at stop	6	.6
Carrying open container of alcohol	6	.6
Blocking traffic	6	.6
Abnormal coordination	6	.6
16-20 mph under speed limit	6	.6
Using motorcycle for support after stop	5	.5
6-10 mph under speed limit	5	.5
Wearing helmet while talking to officer	4	.4
Improper lean angle on a curve	4	.4
Abrupt response when officer signals rider to stop	4	.4
0-5 mph over speed limit	4	.4
Stopping at a location where kickstand cannot be deployed	3	.3
Pushing motorcycle (on or off road)	3	.3
Kicking motorcycle seat during dismount	3	.3
Dropping item from motorcycle	3	.3
Riding with kickstand deployed	2	.2
Rider urinating at roadside	2	.2
Operating motorcycle while holding object in hand	2	.2
Leaving motorcycle in gear when turning off engine	2	.2
Inappropriate behavior by rider or passenger	2	.2
Failure to pay toll	2	.2
31 +mph under speed limit	2	.2
0-5 mph under speed limit	2	.2
Wearing silly headgear	1	.1
Stopping too short of limit lines	1	.1
Stolen motorcycle (detected before stop)	1	.1
Not wearing protective gear	1	.1
Late foot placement	1	.1
Helmet attached to motorcycle rather than worn	1	.1
Early foot placement	1	.1
Wearing inappropriate clothing for conditions	0	0.0

Riding three-abreast in one lane	0	0.0
Leaning forward over tank for balance at stop	0	0.0
Late braking on a curve	0	0.0
Coasting downhill	0	0.0
23-30 mph under speed limit	0	0.0
21-25 mph under speed limit	0	0.0

NOTE: This list includes all cues originally identified from SME interviews, seven of which did not appear in the motorcycle DWI arrest reports

It is important to note that, excluding accidents, speeding cues account for six of the 10 most frequently-reported cues in the inventory. While exceeding the speed limit appears to be a category of riding behavior that will be useful when constructing a decision aid to assist officers in the detection of impaired motorcyclists, data concerning all stops involving speeding are necessary to calculate the predictive value of the cue. Further, it is clear that a large proportion of the cues contained in the inventory are reported infrequently by law enforcement personnel (several of the cues were not reported at all). However, the infrequent reporting of a cue does not imply that the cue is useless to the development of a decision aid or training materials. The question of relative frequency of cue reporting will be addressed in subsequent sections of this report.

A few tests were performed using cue frequency data to determine if regional differences were reflected in the frequency with which cues are reported by law enforcement personnel. One of those cues selected for this analysis was *Evasion. Evasion* is distinguished from *Failure to respond to an officer,* by a deliberate attempt to flee, rather than a failure to notice an officer or proceeding to a destination before stopping. Evasion was selected as a candidate for this test because it was believed that it might reflect regional differences in rider attitude, law enforcement procedures, or both. The results of this analysis are presented in Table 13. The table indicates that the percentage of all evasions reported by each participating agency corresponds with the agencies' contributions to the database. In other words, no significant regional differences were identified and where differences are apparent the numbers are too small for meaningful statistical comparisons.

Some cues do reflect regional differences. For example, *Not wearing a helmet,* and *Improper wearing of safety glasses,* are cues reported in jurisdictions in which laws requiring these items of equipment are enforced. Similarly, *Failure to pay toll,* is limited, as a DWI cue, to those areas in which toll bridges or toll roads are located. Although these cues might be useful indicators of impairment in specific areas, the absence of comparable requirements and conditions in all jurisdictions resulted in relatively low frequencies for these cues.

TABLE 13
FREQUENCY OF MOTORCYCLE DWI *EVASION* BY AGENCY

Agency	Number of Evasions	Percent of Evasions	Percent of Database
California			
CHP	35	56.5	52.3
Los Angeles PD	12	19.4	19.0
Florida			
Dade Co.	0	0	.2
Duval Co.	4	6.5	4.6
Hillsborough Co.	1	1.6	1.7
Orange Co.	1	1.6	2.3
New Mexico			
New Mexico	8	12.9	18.7
Virginia			
Norfolk PD	1	1.6	1.3

Co-occurrence of Cues

The motorcycle DWI arrest report database developed during the current project contains a total of 2,200 reported cues, drawn from the narrative sections of 954 arrest reports. This ratio results in an average of 2.3 cues per report; cue counts ranged from one to 12 per arrest (three reports contained no cue information–zero cues–but were retained in the database to preserve other data). Table 14 provides the distribution of motorcycle DWI arrests in terms of the number of cues reported. The table indicates that more than one-third of all arrests were based on the observation and reporting of just one behavioral cue, but approximately 100 of those cues were *Accidents,* with no co-occurring cues. Even when including accident as a cue, the bulk of all DWI arrests involved the reporting of two or more rider behaviors indicative of impairment.

Because an officer's narrative is usually presented as a chronological account of the events that preceded an arrest, it was possible to code the data to capture the sequence and co-occurrence of specific cues for most arrest reports; the cues printed on data-collection forms were marked with numbers corresponding to the order in which they were reported in the officers' narratives.

To perform co-occurrence analyses, it was necessary to reduce the number of cues in the inventory. It was found that by eliminating those cues that were reported with frequencies representing fewer than two percent, the cue inventory could be reduced from 94 to 30 cues. In other words, by disregarding cues that were reported fewer than 20 times in the 954 arrest reports, it is possible to focus on the 30 most common cues.

The results of the co-occurrence analysis are presented as Appendix C. Appendix C provides a listing of the 30 most frequently reported cues. Along with each cue are presented those cues that were reported most frequently with the primary cue (in bold). For example, *Weaving within a lane* was the most frequently cited cue in the inventory (209 times in 954 reports). The cue *Erratic movements while going straight*

occurred on 15.8 percent of the 209 occasions when *Weaving within a lane* was reported. *Unsteady at slow speeds or during turn* occurred 12.4 percent of the time that weaving within a lane was reported, and so forth. The criterion established for inclusion as a co-occurring cue was .05; that is, a cue had to occur with a primary cue at least 5 percent of the time to be listed as co-occurring.

TABLE 14
NUMBER OF CUES REPORTED PER MOTORCYCLE DWI ARREST

No. of Cues	Frequency	Percent	Percent Excluding Accident
0	3	0.3	0.4
1	333	34.9	26.8
2	290	30.4	34.2
3	174	18.2	20.5
4	102	10.7	12.0
5	27	2.8	3.2
6	11	1.2	1.3
7	6	0.6	0.7
8	2	0.2	0.2
9	2	0.2	0.2
10	2	0.2	0.2
11	1	0.1	0.1
12	1	0.1	0.1
Total	954		

Average 2.5 cues per DWI report, excluding accidents

At the risk of over-simplifying the issues involved, it is possible to categorize clusters of cues that tend to occur together. The "cue clusters" can be categorized as evidence of impairment in the realms of cognition (primarily judgment), psychomotor coordination (primarily balance), and an overlapping category in which both cognitive and psychomotor capabilities appear to be impaired.

Cue clusters become apparent when attention is focused on those secondary cues that occurred 10 or more percent of the time with a primary cue. For example, the primary cue *Weaving within a lane* was reported at least 10 percent of the time with *Erratic movements while going straight, Unsteady at slow speeds or during turn, Trouble with balance at stop,* or *Excessive speed;* with the exception of excessive speed, the most-frequently co-occurring cues are clearly balance-related. Similarly, the primary cue *31+ miles per hour more than the speed limit* was reported at least 10 percent of the time with *Rapid acceleration, Running light or stop sign, Failure to use turn signal,* or *Weaving within a lane;* all but weaving are primarily evidence of impaired judgment. An example of a cue that overlaps the boundaries of the categories is *Running light or stop sign*. This cue was reported at least 10 percent of the time with *31+ miles per hour more than the speed limit, Evasion, Weaving within a lane,* and *Unsteady at slow speeds or during turn*. The first two co-occurring cues are suggestive of impaired judgment, while the second two cues are suggestive of impaired balance.

Among other things, the co-occurrence analysis has indicated that while weaving within a lane is primarily a balance-related cue, it appears with great frequency and regularity, co-occurring with all of the 30 leading cues in the inventory, whether balance or judgment-related.

Relationship of BAC Level to Specific Cues

Appendix D presents the distribution of cue occurrence by BAC level; a separate table is provided for each of the 94 cues in the inventory. For the most part, these data confirm the opinions regarding alcohol effects offered by key experts interviewed at the beginning of the study; that is, at lower BACs judgment is impaired, and at higher BACs complex psychomotor coordination is degraded.

Data presented in Appendix D indicate that at lower BACs, behaviors suggesting impaired judgment dominated, such as riding between lanes of traffic, running stop lights and signs, and speeding; the greater the increment by which a motorcyclist's speed exceeds the posted limit, the more likely he or she has a BAC within the range of .10 to .19. Impaired judgment at lower BACs is illustrated by a statement made by a 22 year-old cafe racer, arrested with a BAC of .10 for traveling 105 miles per hour in a 55 zone: "The right way to ride a motorcycle is 90 miles an hour with the wind in your face."

While judgment is impaired at lower BACs, at higher BACs there is a pronounced tendency for motorcyclists to exhibit overt signs of degraded psychomotor skills and capabilities. For example, while *Weaving within a lane, Weaving across center line, Drifting during turn or curve,* and *Unsteady at slow speeds or during turn* occur at all BAC levels, they are disproportionately represented in categories above .20. Similarly, vigilance-related cues, such as *Inattentive to surroundings,* and *Failure to respond to officer's lights or hand signals* are reported disproportionately for motorcyclists with higher BACs.

The relationship between BAC and motorcycle riding behavior was summarized, in operational terms, by a highly-experienced police officer who has the responsibility of administering hundreds of breath tests each year at mobile DWI-booking stations. The officer mentioned that, at least on urban streets,

> It is not the really drunk drivers and motorcyclists that I worry about. It is usually pretty obvious when someone is above .20; you can detect them by their actions and they can be avoided [by motorists]. It's the .06 [i.e., lower BAC driver or motorcyclist] that I fear. An .06 driver or rider believes himself to be unimpaired, and there is frequently no indication of his impairment until he has a momentary lapse of attention and plows into someone.

CHAPTER 4:
PRELIMINARY FIELD STUDY OF MOTORCYCLIST RIDING BEHAVIOR

A preliminary field study was conducted to collect "real-time" data concerning motorcycle DWI behavior, and to further our understanding of operational conditions and the strategies used by expert law enforcement personnel in the detection of impaired motorcyclists. In short, the objective of this project task was to observe, first-hand, the process by which expert officers detect impaired motorcycle operators. It was understood that a relatively small number of DWI motorcyclists would likely be observed during the brief field study and that the ability to extrapolate probabilities of DWI from the resulting data would be limited. However, it was our belief that the "real-time" data that would be collected would be of sufficient detail to be extremely valuable to the overall analysis, and essential to any follow-on effort leading to the development of a decision aid for operational use by law enforcement personnel.

BACKGROUND

A review of industry marketing data indicated that the Los Angeles area has one of the highest *per capita* rates of motorcycle ownership in the country. High ownership rates, combined with the enormous population of the area, has resulted in Los Angeles having the highest "density" of motorcycle ridership in the U.S., and possibly the world. Density, defined as the number of motorcycles observed on the streets in a given period, was a critical variable to the selection of a site for this field research task. The greater the density, the greater the probability of observing impaired motorcyclists.

The Valley Traffic Division (VTD) of the Los Angeles Police Department is the jurisdiction with the highest density of motorcycles in the Los Angeles area. The VTD's commanding officer agreed to participate in a field study focusing on DWI motorcyclists. He offered to provide three special patrols on each Thursday, Friday, and Saturday night, for a period of six weeks. A total of nine DWI-specialist officers participated, sharing the duty among the 54 patrols during the study period. The officers' law enforcement experience ranged from 6 to 32 years. Each officer was accompanied during the special patrols by a research assistant. Research assistants were selected from a group of civilian law enforcement employees and volunteers who assist the police department.

The role of the officer during the preliminary field study was to conduct normal patrol activities until a motorcyclist was observed exhibiting behaviors that might be indicative of DWI. When a motorcyclist was observed violating traffic laws, or otherwise suggesting impairment, the officer began verbalizing the detection and decision-making processes for the research assistant to record on data-collection forms. Officers were encouraged to also provide information concerning detection strategies that they use, and to mention any other factors that are part of their decision-making processes.

For experienced officers, the detection and classification of behavioral cues is often a nearly nonconscious process. For example, when a motorcycle is observed weaving within a lane, that information might or might not be classified as evidence of

DWI–depending upon the road, traffic, or weather conditions, or perhaps the presence or absence of additional cues. For study purposes, the officer's role in this task was to verbalize the mental process of observation, classification of cues, and decision-making as it was experienced. The research assistant riding with the officer recorded this information on the data collection forms provided. When necessary, the research assistant probed the officer for clarification or additional information. It was emphasized during training and orientation sessions that the more detail the officers provide about operator behaviors, detection strategies, and decision-making processes, the more valuable the analysis will be.

The observers' role in the preliminary field study was to accurately record the information provided by the expert patrol officers with whom they were riding. When, for any reason, a motorcyclist "came to the attention" of an officer, the officer would begin to verbalize his thoughts. For example, he might say:

> I see a single tail light in the next block and it seems to be weaving within a lane. Let's get a little closer. Yes, it's a motorcycle. Now it is stopped for a red light. Notice how the tail light is swaying from left to right. That could be evidence that the operator is having trouble with his balance at the stop; it could also mean that the operator is inexperienced. The light just turned green, but the motorcyclist is still sitting there looking straight ahead. Now he notices that the light has changed and he is accelerating rapidly. Let's see if we can get a speed estimate... I am behind him now... there, 52 mph in a 35 zone. I believe that it is time to initiate a stop for the weaving and speed violations, and a possible DUI. I am turning on my red lights. It has been nearly a block... now, he finally sees us and is pulling over to the curb.

During the time that the officer was relating his observations and decision-making processes, the observer was recording notes. Each observer developed his or her own techniques for note-taking. Some used abbreviations, others recorded key words; some observers used shorthand or transcribed the officers' comments directly. In each case, the observer was able to reconstruct the sequence of events accurately on a data collection form. For example, the cues that the officer mentioned in the previous example would have been noted on a data collection form in this order: 1) weaving within a lane, 2) trouble with balance at a stop, 3) failure to respond to green light, 4) rapid acceleration, 5) speeding (52/35–17 mph more than limit), and 6) failure to respond to officer's lights. Following a stop, the observer would record additional information about the motorcyclist and traffic conditions.

DESCRIPTIVE STATISTICS

One-hundred and ninety-nine enforcement stops involving motorcycles were conducted during the course of the preliminary field study. Of these stops, 32–or, 16 percent– resulted in DWI arrests; 52 stops resulted in a traffic citation only; and, in 115 of the stops, no action was taken by the officer. Many of the "no action" stops were examples of standard officer discretion (e.g., when three "typical biker club-types" were stopped for illegal turns and it was learned that they were quite sober members of an alcoholics anonymous motorcycle club!). Table 15 summarizes the action taken in response to enforcement stops made during the preliminary field study.

Note that it is the preliminary field study that provides the first indications of *probabilities* of DWI. This is because during the field study it was possible to maintain a complete record of *all* stops involving motorcycles, not just those that resulted in DWI arrests. While the numbers of observations obtained during this preliminary field study are relatively small, and subject to the biases and errors associated with small samples, they *do* provide valuable indications, despite the inability to apply measures of statistical significance.

TABLE 15
RESULTS OF ENFORCEMENT STOPS MADE
DURING PRELIMINARY FIELD STUDY OF MOTORCYCLIST RIDING BEHAVIOR

Result	Frequency	Percent
No action	115	57.8
DWI arrest	32	16.1
Traffic citation	52	26.1
Total	199	

Table 16 and Table 17 provide background information concerning the 199 motorcyclists stopped during the preliminary field study. Table 16 indicates that five of the 199 motorcyclists stopped were women, and one of those women was arrested for DWI. The racial distribution of all motorcyclists stopped in the sample consisted of 74 percent white, 18 percent Hispanic, five percent black, and the remainder composed of motorcyclists reporting Native American, Oriental, or Polynesian descent, while the racial distribution of DWI motorcyclists actually arrested consisted of 78 percent white and 22 percent Hispanic, with no DWI arrests for other racial groups. Both gender and racial distributions obtained during the field study correspond, generally, to the proportions found during review of arrest reports.

TABLE 16
GENDER OF MOTORCYCLISTS STOPPED
AND DWI MOTORCYCLISTS ARRESTED DURING PRELIMINARY FIELD STUDY

Gender	Number All Stops	Percent All Stops	Number DWI	Percent DWI
Male	194	97.5	31	96.9
Female	5	2.5	1	3.1
Total	199		32	

Table 17 provides the age distributions of all motorcyclists stopped, and those arrested for DWI during the field study. The data summarized in the table and figures indicate 28.1 years as the average age of all motorcyclists stopped, and 31.1 years as the average for DWI motorcyclists. The average age of DWI motorcyclists obtained from archival review of arrest reports was 28.7 years.

TABLE 17
AGE DISTRIBUTION OF MOTORCYCLISTS STOPPED AND DWI MOTORCYCLISTS ARRESTED DURING PRELIMINARY FIELD STUDY

Age	Number All Stops	Percent All Stops	Number DWI	Percent DWI
15-17	4	2.08	0	0
18-20	25	13.02	2	6.25
21-24	46	23.96	7	21.87
25-34	77	40.10	12	37.50
35-44	31	16.15	9	28.12
45-54	7	3.65	1	3.13
55-65	2	1.04	1	3.13
Total	192		32	

Table 18 provides the distribution of BAC levels of the motorcyclists arrested for DWI during the preliminary field study. BACs ranged from the (then current) legal limit of .10 to a high of .25. The average of the 26 BACs obtained through breath testing is .15. Three of those arrested refused all tests, two requested blood tests, and one requested a urine test; only the results of breath tests were available. Table 19 provides the distribution of testing method.

TABLE 18
DISTRIBUTION OF BACs OF DWIs OBTAINED DURING PRELIMINARY FIELD STUDY

BAC	DWI Arrests	Percent
.10	5	19.2
.11	2	7.7
.13	2	7.7
.14	3	11.5
.15	3	11.5
.16	5	19.2
.17	1	3.9
.19	2	7.7
.20	1	3.9
.25	2	7.7
	26	
Refused All Tests	3	
Data Not Available	3	
Total	32	

TABLE 19
BAC TESTING METHOD DURING PRELIMINARY FIELD STUDY

Method	Frequency	Percent
Blood	2	6.2
Breath	26	81.3
Urine	1	3.1
Refused	3	9.4
Total	32	

DATA ANALYSES

Three-hundred and sixty-two cues were observed and recorded during the 167 motorcycle enforcement stops made during the preliminary field study that did not result in a DWI arrest (for an average of 2.2 cues per stop). In comparison, 115 cues were observed and recorded during the 32 enforcement stops that resulted in DWI arrests, for an average of 3.6 cues per DWI. Overall, 24.1 percent of all cues reported by officers during the field study were observed prior to stops that resulted in DWI arrests.

Table 20 provides a complete tabulation of cue reports obtained during the preliminary field study. The table presents data for all enforcement stops and for those stops that resulted in DWI arrests; the proportions of cue reports that were associated with DWI arrests are also provided. For example, the cue *Weaving within a lane* was reported during 28 of the 199 enforcement stops; 10 of those 28 stops resulted in DWI arrests, for a proportion of 35.7 percent. Similarly, the cue *Failure to respond to officer's lights or hand signals* was reported during 10 enforcement stops, and six of those, or 60 percent, resulted in DWI arrests. The most frequently-reported motorcycle cue was *Failure to use turn signals,* which was reported a total of 36 times, but only four of the enforcement stops involving that cue resulted in DWI arrests, for a proportion of only 11.1 percent.

TABLE 20
FREQUENCIES OF CUES REPORTED DURING PRELIMINARY FIELD STUDY AND CUES ASSOCIATED WITH DWI

Cue	DWIs	All Stops	Percent DWI of All Stops
Weaving within a lane	10	28	35.7
Failure to respond to officer's lights or hand signals	6	10	60.0
Drifting during turn or curve	5	9	55.6
Failure to use turn signal	4	36	11.1
Vehicle defects	4	25	16.0
6-10 mph over limit	4	12	33.3
Trouble with balance at stop	4	10	40.0
Difficulty with kickstand	4	8	50.0
Foot dragging	3	12	25.0
Early foot placement	3	9	33.3
Unsteady at slow speed or during turn (e.g., wobbling)	3	8	28.6
Recklessness (e.g., speed too great for conditions)	3	8	37.5
Erratic movements while going straight	3	8	37.5

31 + mph over speed limit	3	8	37.5
Seemingly unconcerned with detection	3	6	50.0
Trouble with balance during dismount	3	5	60.0
Rapid acceleration	2	18	11.1
16-20 mph over speed limit	2	16	12.5
Frequent lane changes	2	11	18.2
Jerky or abrupt stops	2	10	20.0
Snaking through traffic	2	9	22.2
Evasion	2	7	28.6
Operating motorcycle while holding object in hand	2	4	50.0
Inattentive to surroundings	2	4	50.0
Facial expression	2	4	50.0
Carrying open container of alcohol	2	3	66.7
Kicking motorcycle seat during dismount	2	2	100.0
Following too closely	1	10	10.0
Display of speed	1	10	10.0
Turning violation	1	9	11.1
Expired registration tabs or no license plate	1	9	11.1
Loud motorcycle exhaust	1	8	12.5
Running light or stop sign	1	7	14.3
Riding or parking on sidewalk or similarly illegal location	1	6	16.7
Jerky starts from stop	1	6	16.7
0-5 mph over speed limit	1	6	16.7
Erratic movements while turning	1	5	20.0
Unsafe lane change	1	3	33.3
Passing on the right	1	3	33.3
Operating without lights at night	1	3	33.3
Improper lean angle on a curve	1	3	33.3
Abrupt response when officer signals rider to stop	1	3	33.3
Wearing silly headgear	1	2	50.0
Stopping too short of limit lines	1	2	50.0
Passing on left across double line	1	2	50.0
Improper or missed gear shifts	1	2	50.0
Dropping item from motorcycle	1	2	50.0
Abnormal coordination	1	2	50.0
16-20 mph under speed limit	1	2	50.0
Accident	1	1	100.0
26-30 mph under speed limit	1	1	100.0
26-30 mph over speed limit	1	1	100.0
Excessive speed (no estimate provided)	0	9	0.0
11-15 mph under speed limit	0	6	0.0
11-15 mph over speed limit	0	6	0.0
Splitting traffic	0	5	0.0
Helmet attached to motorcycle rather than worn	0	5	0.0
21-25 mph under speed limit	0	5	0.0
6-10 mph under speed limit	0	4	0.0
Not wearing safety glasses (where req.); dark glasses at night	0	3	0.0
Failure to stop at sign or red light before turning right	0	3	0.0
Failure to respond to green light	0	3	0.0

Weaving across center line	0	2	0.0
Wearing inappropriate clothing for conditions	0	2	0.0
Substantial fluctuation in speed	0	2	0.0
Stopping beyond limit lines	0	2	0.0
Revving engine at stop	0	2	0.0
Wrong way on one-way street	0	1	0.0
Wearing helmet while talking to officer	0	1	0.0
Stopping at a location where kickstand cannot be deployed	0	1	0.0
Riding with kickstand deployed	0	1	0.0
Riding three-abreast in one lane	0	1	0.0
Leaving motorcycle in gear when turning off engine	0	1	0.0
Late foot placement	0	1	0.0
Difficulty starting motorcycle	0	1	0.0
0-5 mph under speed limit	0	1	0.0

While the numbers of observations obtained during the preliminary field study, and presented in Table 20, do not permit measures of statistical significance, they do provide some valuable indications of the likely usefulness of specific cues as predictors of DWI. For example, although it would be unwise, at this point, to assign a 40 percent probability of DWI to motorcyclists who are observed to be having *Trouble with balance at a stop,* there is evidence that trouble with balance suggests impairment. Similarly, it would be inappropriate to assume, because of the small number, that all operators who kick their motorcycle seat during a dismount are impaired, despite the indications provided during the field study, where both operators who kicked their seats were found to be DWI–one at BAC .16 and one at .25. Although the numbers are small, data concerning several of the cues provide strong suggestions for inclusion in a final Phase I cue list.

Just as it would be unwise to include cues in a final list on the basis of preliminary field study data alone, it is inadvisable to exclude cues on the same basis. Valuable predictors of DWI might be lost if we were to assume that the absence of an observation during this limited observational field study means that a cue is completely lacking in value as a predictor. For example, the cues *Rider urinating at roadside* and *Late braking on a curve* are behaviors that are intuitively and rationally predictive of DWI, but neither cue was observed–even once–during the preliminary field study. The point of this discussion is that the preliminary field study provided *preliminary* indications of likely probabilities of DWI associated with specific cues; however, the size of the sample is small. Therefore, while the brief Phase I field study provided clear indications of cues to be considered for inclusion in a final cue list and incorpo-

rated in a decision-aid, it was equally clear that Phase II of the research project would be required to refine the cue list and assign probabilities to specific cues.

CHAPTER 5:
PHASE I ANALYSIS AND RESULTS

The preceding chapters have described and presented the results of the three Phase I project tasks conducted to obtain data relevant to the detection of DWI motorcyclists. These chapters have summarized the results of interviews with law enforcement and civilian experts, archival research reviewing DWI arrest reports, and a preliminary field study of motorcyclist riding behavior. Significant differences in the three methods of data collection required an unorthodox approach to perform a combined analysis. The primary purpose of this section is to document and explain our approach to the required analysis, and to present the candidate list of cues that were used by law enforcement personnel in the detection of DWI motorcyclists during the full-scale Phase II field study.

ANALYSIS AND SYNTHESIS OF DATA FROM THREE SOURCES

Although the sources and forms of the data are varied, the primary objective of each task was to identify the behaviors exhibited by impaired motorcyclists. The focus on behavioral cues provides a "common denominator" that permits meaningful comparisons, and more important, a synthesis of data obtained from disparate sources.

It was mentioned in the introduction to this report that the inventory of DWI cues was developed by an evolutionary process during the sequential performance of the three Phase I data-collection tasks. Interviews with experts led to the identification of 83 cues. Subsequent archival research and the preliminary field study added 10 more. An additional cue was added during analysis, bringing the total inventory to 94 cues. But a decision-aid containing nearly 100 cues would be too cumbersome and impractical. It is important to reduce the size of the cue inventory to the smallest number of cues, with the highest probabilities, that account for the largest number of behaviors indicative of impairment.

The approach selected to combine the results of the three separate analyses involves both quantitative and qualitative components. The first step was to determine a cue criterion for each data-collection task in the evolutionary sequence. Because the three data collection tasks involved three separate sources of DWI cues, cues can be discussed as either one, two, or three-source cues. The criterion for a cue to be included in the first task was simply to be mentioned by at least one law enforcement or civilian expert during a personal interview. Thus, a total of 83 operator behaviors began the process as one-source cues.

The criterion established for a cue to be recognized by the archival analysis of arrest report data is slightly more complicated. Recall that for purposes of performing co-occurrence analyses it was necessary to reduce the cue list by eliminating cues that were reported on fewer than two percent of the 954 arrest reports reviewed. Inclusion on the resulting list of 30 behavioral cues derived from the arrest report data is the criterion for a cue to be designated a second-source cue at this hurdle in the process.

The Phase I (preliminary) field study represents the third hurdle for cues. Those cues on the list of 30, resulting from the co-occurrence analysis, were compared to the list of cues associated with DWI arrests made during the preliminary field study. If a cue was reported by an officer in association with a DWI arrest (even if it was only mentioned once), it received an additional source designation. The resulting list of 25 three-source cues is presented in Table 21

TABLE 21
CUES RESULTING FROM MULTIPLE-SOURCE ANALYSIS AND PROBABILITIES DERIVED FROM PRELIMINARY FIELD STUDY DATA ANALYSIS

Category Cue	DWIs	All Stops	Percent DWI of All Stops
Aggression Cues			
Rapid acceleration	2	18	11.1
16-20 mph more than speed limit	2	16	12.5
26-30 mph more than speed limit	1	1	100.0
31 + mph more than speed limit	3	8	37.5
Frequent lane changes	2	11	18.2
Snaking through traffic	2	9	22.2
"Recklessness" (e.g., speed too great for conditions, etc.)	3	8	37.5
Infraction Cues			
Failure to use turn signals	4	36	11.1
Parking or riding on sidewalk or other illegal location	1	6	16.7
Following too closely	1	10	10.0
Turning violation	1	9	11.1
Running stop light or sign	1	7	14.3
Evasion	2	7	28.6
Passing on left across double line	1	2	50.0
Equipment Cues			
Expired registration tabs or no license plate	1	9	11.1
Vehicle defects	4	25	16.0
Loud exhaust	1	8	12.5
Psychomotor Cues			
Weaving within a lane	10	28	35.7
Inattentive to surroundings (e.g., absence of scanning behavior)	2	4	50.0
Trouble with balance at stop	4	10	40.0
Trouble with balance during dismount	3	5	60.0
Unsteady at slow speeds or during turn	3	8	28.6
Erratic movements while going straight	3	8	37.5
Drifting during turn or curve	5	9	55.6
Accidents			
Accident	1	1	100.0

The operator behaviors listed in Table 21 are organized into five categories, based on the results of the co-occurrence analysis and a rational allocation of cues.

The cues are presented in these categories to facilitate the discussion, with the knowledge that the descriptive categories are not mutually exclusive. The category labeled "Aggression Cues" contains behaviors that are essentially speed-related, including three of the highest excessive speed categories in the cue inventory, recklessness, and two aggressive lane changing cues. Cues in this category can be interpreted as suggestive of impaired judgment, and they are consistent with the comments made by both law enforcement and civilian experts concerning the relationship between the mood-altering effects of alcohol and motorcycle riding behavior. The category labeled "Infraction Cues" includes those judgment-related cues that clearly involve vehicle code violations other than exceeding the speed limit or riding aggressively. The category "Equipment Cues" includes cues specifically related to the motorcycle being operated, such as, broken tail lights and turn indicators, bald tires, and the like. Separate cues are listed for loud exhaust and problems involving registration tags and license plates. The "Psychomotor Cues" are those behaviors, primarily balance and vigilance-related, that suggest overt evidence of impairment of mental and physical capabilities. Finally, the cue "Accident" represents a separate category.

Further examination of the list of three-source motorcycle DWI detection cues suggested that some of the cues within categories could be combined. Also, some two-source cues, considered to be particularly diagnostic, could be added or linked to three-source cues. This process is described in the following paragraphs. Incorporated in this discussion are the probabilities of cues predicting DWI, derived from the analysis of field study data. It is understood that those probabilities are based on the small samples of enforcement stops (199) and DWI arrests (32) presented in Table 20 in the preceding chapter. Probabilities were calculated by dividing the frequency that a cue was associated with a DWI stop by the total frequency of that cue's occurrence during the field study. Despite the relatively small number of observations involved in the field study, they were the only data available that can be used to calculate probabilities. The indications provided by the data appear to have merit to serve as a preliminary list, subject to modification as needed, until additional research can be completed.

Combining Three-Source Cues and Incorporating Two-Source Cues

Along with the three-source cues listed in Table 21 are the frequencies obtained during the Phase I field study from which preliminary probabilities can be calculated. Preliminary probabilities are "rounded-down" in the following discussion to provide conservative estimates. The three speeding cues in the "Aggression" category can be combined to form a single cue, labeled *Excessive speed (16+ mph more than limit*). The combined (and tentative) DWI-detection probability of the cues encompassed by this new cue is 24 percent. Similarly, *Frequent lane changes* (probability 18 percent) and *Snaking through traffic* (probability 22 percent) can be combined with the two-source cue, *Unsafe lane change* (probability 33 percent); the resulting single cue, *Unsafe lane change(s)* has a combined DWI probability of 21 percent.

In the "Infraction Cues" category, *Failure to use turn signals* and *Turning violations* can be combined; each has a probability of 11 percent, derived from the field study. The resulting single cue is labeled *Turning violations*. It must be mentioned that these turning-related cues, while associated with DWI, are such common actions by motorcyclists that additional research is required to determine their predictive value.

Similarly, the two-source cues *Display of speed* (probability 10 percent) and *Splitting traffic* (not observed in association with an enforcement stop during field study) are so frequently performed by motorcyclists that these four cues might be considered typical riding behavior of many sober motorcycle operators. Considering the small sample obtained in the field study, more evidence is needed to determine if the cues have predictive value for DWI.

Also in the "Infraction Cues" category, *Passing on the left across double line* (probability 50 percent) can be incorporated with the two-source cue, *Passing on the right* (probability 33 percent). The resulting single cue, labeled *Unsafe passing,* has a combined DWI probability of 40 percent.

To the "Equipment" category must be added the two-source cue *Operating without lights at night* (probability 33 percent). While this was an infrequently cited behavior in the review of arrest reports, it is known to be indicative of DWI among automobile drivers. Field study data suggest that the correlation may be extended to motorcyclists.

Several modifications are proposed for the category devoted to "Psychomotor" impairment. It is this category that contains some of the most discriminating cues in the inventory of riding behaviors. The data indicate that *Weaving within a lane* (probability 36 percent) should be combined with the two-source cue *Weaving across center line* (not observed during field study) to form a single *Weaving* cue, with an assigned probability of 35 percent. Although less frequently observed, weaving into opposing traffic must be considered more indicative of impairment than weaving within a lane. Similarly, *Trouble with balance during dismount* (probability 60 percent) can be combined with the two-source cues *Difficulty with kickstand* (probability 50 percent) and *Kicking motorcycle seat during dismount* (probability 100 percent). The resulting single cue, labeled *Trouble with dismount* has a combined probability of 60 percent. It must be noted that this cue combination is based on very few observations (9 DWIs out of 15 stops).

The cue *Drifting during turn or curve* (probability 56 percent) is both intuitively and empirically one of the most predictive of impaired motorcycle operation. Although it might be desirable to incorporate two-source turning cues with drifting, this temptation should be resisted to preserve the diagnostic integrity of this particular cue. For this reason, the two-source cues *Erratic movements while turning* (probability 20 percent), *Improper lean angle on a curve* (probability 33), and *Late braking on a turn or curve* (not observed during field study) are combined to form a single cue labeled *Turning problems*, with an assigned DWI probability of 25 percent.

Also concerning "Psychomotor Cues," it is suggested that the three-source cue *Inattentive to surrounding* (probability 50 percent) be combined with the two-source cues *Failure to respond to officer's lights or hand signals* (probability 60 percent), *Seemingly unconcerned with detection* (probability 50 percent), and *Failure to respond to green light* (not observed in association with DWI during field study). The resulting single cue, labeled *Vigilance problems*, has a combined probability of 39 percent. Recall that vigilance cues were operationally defined by expert patrol officers as an absence of scanning behavior that is typical of defensive riding practice.

It is further suggested that a few key one-source and two-source cues be combined to form a single cue labeled, *Inappropriate or unusual behaviors*. This single cue incorporates the unusual items from the inventory: *Operating motorcycle while holding object, Carrying open container of alcohol, Dropping item from motorcycle, Urinating at roadside, Disorderly or inappropriate behavior,* and *Facial expression*. Incorporating these cues in the preliminary decision-aid will permit the collection of additional data and possible validation of these cues.

Finally, the three-source cue *Accident* must be deleted from the cue list because it lacks predictive utility, despite the cue's apparent statistical validity. The high correlation between DWI and motorcycle accidents is well known; the highway safety literature and law enforcement sources indicate that between 50 and 75 percent of all fatal motorcycle accidents are alcohol-involved. It is this cause and effect relationship that has motivated NHTSA to sponsor the current research project.

Table 22 presents the modified list of 23 DWI motorcycle cues, derived from this analysis of information from three sources, in the form of a prototype decision-aid; nighttime DWI probabilities (BAC equal to or greater than .10), derived from field study data and rounded-down to the nearest "5," are included.

PHASE I RECOMMENDATIONS

A Phase II field study was recommended to collect the data necessary to identify the most predictive behavioral cues for discriminating between impaired and unimpaired motorcycle operation. The preliminary probabilities derived from the Phase I field test were not based on a sufficient number of observations to include probability values in the orientation materials used in the Phase II field study. Conduct of the Phase II field study would permit the calculation of probabilities that specific cues are predictive of DWI.

TABLE 22
PROTOTYPE DWI MOTORCYCLE
DETECTION GUIDE

Category	Behavioral Cue	DWI Probability*
Aggression Cues	Recklessness (e.g., speed too great for conditions, etc.)	**35**
	Excessive speed (16 + mph more than limit)	**24**
	Unsafe lane changes (frequent or snaking)	**21**
	Rapid acceleration	**10**
Infractions Cues	Unsafe passing (on left across double line & on right)	**40**
	Evasion	**25**
	Parking or riding on sidewalk or other illegal location	**15**
	Running stop light or sign	**10**
	Turning violation (including failure to use turn signals)	**10**
	Following too closely	**10**
Equipment Cues	Operating without lights at night	**30**
	Vehicle defects (e.g., broken tail light, bald tire, etc.)	**15**
	Loud exhaust	**10**
	Expired registration tabs or no license plate	**10**
Psychomotor Cues	Trouble with dismount (balance, kickstand, seat, etc.)	**60**
	Drifting during turn or curve	**55**
	Trouble with balance at stop	**40**
	Vigilance problems (inattentive to surroundings, etc.)	**39**
	Erratic movements while going straight (e.g., jerky corrections)	**35**
	Weaving (within a lane or across center line)	**35**
	Unsteady at slow speeds or during turn	**25**
	Turning problems (erratic movements, lean angle, braking)	**25**
Inappropriate/ Unusual	Carrying open container, Dropping item, Disorderly conduct, Urinating at roadside, Facial expression, etc	**?**

* NOTE: These are provisional probabilities based on limited sample sizes. Phase II research was required to establish firm and reliable probabilities Therefore, these preliminary probabilities were not included in the orientation materials used in the Phase II field study.

CHAPTER 6:
PHASE II FIELD STUDY

A major field study was conducted to collect the data necessary to refine the prototype motorcycle DWI detection guide, developed during Phase I. The field study involved the collection of data by law enforcement personnel concerning every enforcement stop they made of motorcyclists. The study was conducted during the 1990 motorcycle riding season.

BACKGROUND

There are only about 2.5 motorcycles for every 100 other motor vehicles in the United States. In addition, motorcycle riding is highly seasonal in much of the country, further limiting opportunities to obtain data about motorcyclists' riding behavior. For these reasons, a relatively low "data capture rate" was anticipated for the Phase II field study. To counter these conditions, the field study was designed to maximize the number of possible motorcycle stops made at participating law enforcement site. In this regard, reviews of industry data indicated that the five leading states, in numbers of registered motorcycles, account for approximately 35 percent of all registered motorcycles in the United States. Table 23 lists the five leading states, along with the numbers of registered motorcycles. The five states listed in Table 23 served as the focus for the effort to recruit law enforcement agencies to participate in the field study.

TABLE 23
FIVE LEADING STATES IN MOTORCYCLE REGISTRATIONS

State	Registered Motorcycles
California	647,488
Ohio	258,243
Illinois	242,000
Florida	234,498
Texas	225,997

Source: Motorcycle Industry Council (1989)

In addition to focusing on the five leading states in motorcycle registrations, other strategies might be used to obtain maximum data collection rates. For example, it was learned during Phase I interviews with SMEs that young Navy personnel might be disproportionately represented in motorcycle fatalities, due to a pattern of six-month ship deployment followed by drinking and motorcycle riding upon returning to home port. For this reason, the Norfolk, Virginia, Police Department was recruited to participate in the field study. (Norfolk is home to the largest U.S. Navy base–and several other naval facilities are located in the vicinity.) Similarly, Jacksonville, Florida, was invited to participate in the study because the city is located in one of the five leading states, and near a major Navy facility. The New Mexico State Police was recruited for its aggressive enforcement of traffic laws.

Table 24 lists the law enforcement agencies and sites that participated in the Phase II field study; Figure 2 illustrates the geographic distribution of the sites. A total of 26 separate sites, representing nine agencies and seven states, collected data on all motorcycle stops made within their jurisdictions.

TABLE 24
LAW ENFORCEMENT AGENCIES AND SITES
THAT PARTICIPATED IN THE PHASE II FIELD STUDY

State Agencies/Sites
California Highway Patrol, Bakersfield Area
California Highway Patrol, Contra Costa Area
California Highway Patrol, Fresno Area
California Highway Patrol, San Jose Area
Illinois State Police, East Moline, District 7
Illinois State Police, Pecatonica, District 16
Illinois State Police, La Salle, District 17
New Mexico State Police, Santa Fe, District 1
New Mexico State Police, Las Cruces, District 4
New Mexico State Police, Albuquerque, District 5
Ohio State Highway Patrol, Chardon Post
Ohio State Highway Patrol, Dayton Post
Ohio State Highway Patrol, Massillon Post
Texas Department of Public Safety, Waco Division
Texas Department of Public Safety, Austin Division
Texas Department of Public Safety, Austin
Texas Department of Public Safety, Bastrop
Texas Department of Public Safety, Bryan
Texas Department of Public Safety, Georgetown
Texas Department of Public Safety, Kerrville
Texas Department of Public Safety, Lampasas
Texas Department of Public Safety, San Marcos
Municipal Police Departments
Jacksonville (FL) Police Department/Sheriff's Office
Los Angeles (CA) Police Department, Valley Traffic Division
Norfolk (VA) Police Department
Santa Barbara (CA) Police Department

Figure 2. Geographic distribution of law enforcement sites participating in the Phase II field study.

The project director visited the participating agencies and field sites during the Spring of 1990 to provide orientation briefings to patrol officers and their managers. Printed orientation materials were distributed to all participating officers to augment the oral briefings; the materials summarized the project, presented complete field study procedures, and described possible motorcycle DWI cues in detail. Data collection forms were also distributed; Figure 3 presents the data collection form used during the Phase II field study. The 23 cues listed on the data collection form are the cues included on the prototype detection guide at the conclusion of Phase I (presented as Table 22). The data collection form was designed to minimize the time and effort required of officers to record the necessary information. (Note that no probabilities were included on the data collection form.)

Officers were instructed to complete a data collection form following each stop they made of a motorcyclist, regardless of the disposition of the stop. It was explained that by collecting data about the behavioral cues that motivated all stops, it would be possible to calculate the proportions of the stops in which specific cues were associated with DWI arrests; those proportions could then be expressed as p values, or probabilities that specific cues are *predictive* of DWI.

In addition to the behaviors observed, officers were asked to record the time and date of the stop, the disposition (i.e., warning, citation, or DWI arrest), and the BAC and testing method, if applicable. Officers were also encouraged to provide on the forms additional comments or descriptions of the cues, or any other information relevant to the stop (e.g., cues not listed on the form, suspected drug impairment, etc.).

Telephone calls and some return trips to selected sites were made throughout the field study to encourage active participation by patrol and liaison personnel. In addition, several project status reports were mailed to all sites during the field study to provide immediate "feedback" concerning the status of the research effort and to serve as reminders to participating officers that their contributions to the study were important and appreciated.

RESULTS

The nine participating law enforcement agencies submitted a total of 1,230 completed data collection forms for analysis. Contributions to the Phase II field study data base ranged from as few as four forms (from a small, remote district of the New Mexico State Police) to as many as 219 forms from the wide open spaces of the Waco Division of the Texas Highway Patrol (Texas Department of Public Safety). Table 25 presents a summary of the contributions of data collection forms by agency.

Of the 1,219 forms coded for disposition, 12 percent (n=144) represented DWI arrests; 80 percent were completed following traffic citations (n=978); and, 8 percent (n=97) were submitted in response to officers issuing written or verbal warnings to motorcyclists. Table 26 summarizes the action taken in response to enforcement stops made during the Phase II field study.

MOTORCYCLE DWI/DUI DETECTION GUIDE AND RECORD FORM

Agency:_____ Officer ID:_____

Month____Day____1990 Time of stop:_____

Disposition: ☐None ☐DWI Arrest ☐Traffic Citation

BAC:[ ] Test:☐Blood ☐Breath ☐Urine ☐Refused

Please record order in which cues were observed

(01) ☐ Excessive speed (speed_____ limit_____)
(02) ☐ Weaving (within a lane or across center line)
(03) ☐ Unsafe lane change (frequent or snaking)
(04) ☐ Rapid acceleration
(05) ☐ Unsafe passing (on left across double line or on right)
(06) ☐ Evasion
(07) ☐ Parking or riding on sidewalk or other illegal location
(08) ☐ Running stop light or sign
(09) ☐ Turning violation (including failure to signal--describe)
(10) ☐ Following too closely
(11) ☐ Operating without lights at night
(12) ☐ Vehicle defects (e.g., broken tail light, bald tire)
(13) ☐ Loud exhaust
(14) ☐ Expired registration tabs or no license plate
(15) ☐ Trouble with dismount (balance, kickstand, seat, etc.)
(16) ☐ Drifting during turn or curve
(17) ☐ Inattentive to surroundings (i.e., vigilance problems)
(18) ☐ Trouble with balance at stop
(19) ☐ Erratic movements while going straight
(20) ☐ Unsteady at slow speeds or during turn
(21) ☐ Turning problems (jerky, lean angle, braking)
(22) ☐ Recklessness (e.g., speed too great for conditions)
(23) ☐ Inappropriate or unusual behavior (e.g., open container, dropping item, disorderly conduct, facial expression, etc.--please specify)_____

(24) ☐ Other (please specify)_____

*Comments:*_____

Figure 3. Phase II data collection form.

TABLE 25
DATA COLLECTION FORMS RETURNED BY PARTICIPATING LAW ENFORCEMENT AGENCIES

Agency	Reports	Percent of Sample
California		
California Highway Patrol	440	35.7
Los Angeles Police Department	115	9.4
Santa Barbara Police Department	44	3.6
Florida		
Jacksonville PD/SO	106	8.6
Illinois		
Illinois State Police	95	7.7
New Mexico		
New Mexico State Police	19	1.6
Ohio		
Ohio Highway Patrol	85	6.9
Texas		
Texas Department of Public Safety	310	25.2
Virginia		
Norfolk Police Department	16	1.3
Total	1,230	100%

TABLE 26
RESULTS OF ENFORCEMENT STOPS MADE DURING FIELD STUDY OF MOTORCYCLIST RIDING BEHAVIOR

Result	Frequency	Percent
Warning	97	8.0
DWI arrest	144	11.8
Traffic citation	978	80.2
Total	1,219	

The data indicate that the peak period of traffic law enforcement occurred during the late afternoon and early evening hours (i.e., between 1500 and 1900 hours–3:00 and 7:00 PM), while the peak period for motorcycle DWI arrests was in the late night and early morning hours (i.e., 2300 to 0300 hours–11:00 PM to 3:00 AM). Figure 4 and Figure 5 illustrate the distributions by time of day for all stops and for DWI arrests, respectively. The distribution of DWI arrests by time is consistent with Phase I data.

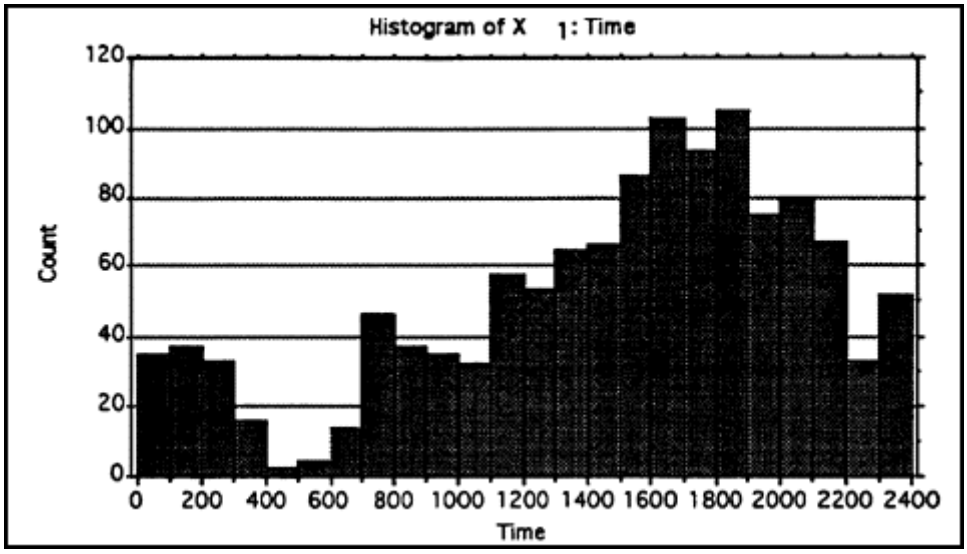

Figure 4. Distribution of all motorcycle stops by time.

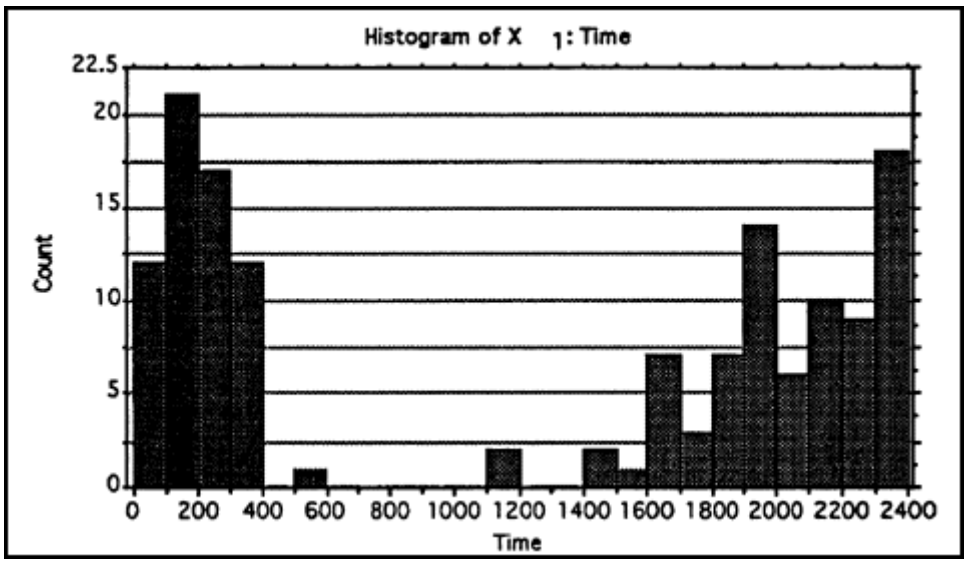

Figure 5. Distribution of motorcycle DWI arrests by time.

Table 27 presents the distribution of BAC levels of the motorcyclists arrested for DWI during the Phase II field study. BACs ranged from a low of .06 to a high of .23. The average of the known BACs is .145 (compared to .151 derived from the 1987 arrest report data base developed during Phase I). Figure 6 illustrates the distribution of the Phase II BACs. It must be noted that two of the seven states in which the field study was conducted (California and New Mexico) have established .05 as the legal limit for juvenile motor vehicle operators (i.e., under 21 years of age). California's limit for adults is .08 (as of January 1990); the DWI criterion for all other participating states is currently

.10 for both juveniles and adults. Only 11 of the 144 DWI arrests made during the Phase II field study resulted in BACs below the .10 level.

TABLE 27
DISTRIBUTION OF BACs OF DWIs OBTAINED DURING FIELD STUDY

BAC	DWI Arrests	Percent
.06	2	2.1
.07	2	2.1
.08	3	3.1
.09	4	4.3
.10	10	10.6
.11	3	3.1
.12	8	8.5
.13	5	5.3
.14	9	9.6
.15	8	8.5
.16	11	11.7
.17	9	9.6
.18	4	4.3
.19	7	7.4
.20	4	4.3
.21	1	1.1
.22	2	2.1
.23	2	2.1
	94	
Refused All Tests	22	
Data Not Available	28	
Total	144	

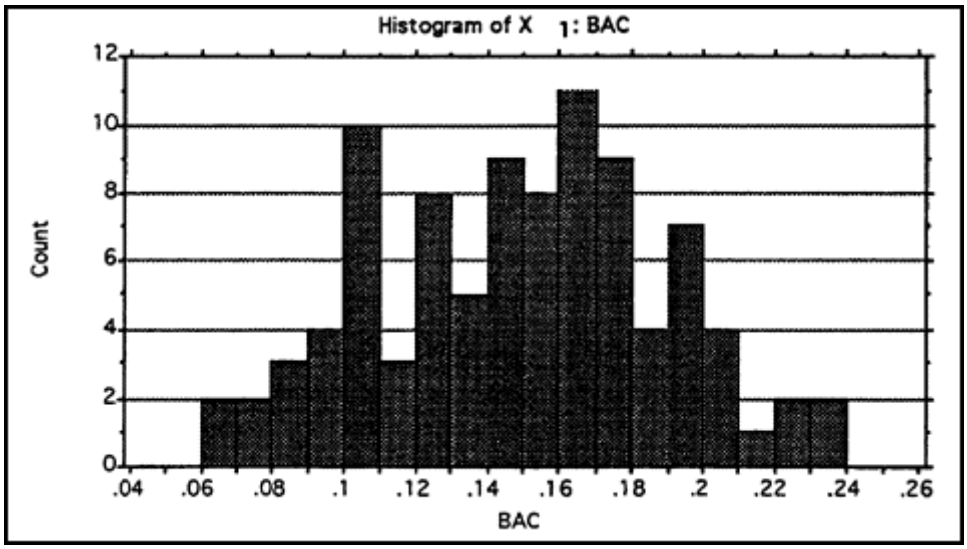

Figure 6. Distribution of DWI BACs obtained during Phase II field study.

A breath test was administered to sixty-one percent of the motorcyclists arrested for DWI (n=82), twenty-one percent (n=29) requested blood tests, and only one and one-half percent (two motorcyclists) requested urine tests; 16 percent of those arrested for DWI (n=22) refused all chemical tests. Table 28 presents the frequencies of the testing methods.

TABLE 28
BAC TESTING METHOD DURING FIELD STUDY

Method	DWI Arrests	Percent
Blood	29	21.5
Breath	82	60.7
Urine	2	1.5
Refused	22	16.3
Total	135	

DATA ANALYSES

Sixteen-hundred behavioral cues were observed and recorded during the 1,071 motorcycle enforcement stops made during the Phase II field study that did not result in a DWI arrest (for an average of 1.4 cues per stop). In comparison, 325 cues were observed and recorded during the 144 enforcement stops that resulted in DWI arrests, for an average of 2.3 cues per DWI. While approximately 12 percent of the stops resulted in a DWI arrest, 17.4 percent of the cues reported by officers during the field study were observed prior to stops that resulted in DWI arrests.

The difference between the average number of cues observed prior to a traffic citation versus prior to a DWI arrest is significant at the .05 level of confidence. This difference is attributable to a common patrol strategy: Officers typically respond promptly to clear violations of vehicle codes (e.g., excessive speed, vehicle defects, etc.), but when less articulable indications of DWI are observed, officers tend to watch for additional signs of impairment before initiating a stop. As a result, motorcyclists are stopped for "ticketable" offenses immediately after they are observed by an officer, but balance and vigilance problems (the behaviors that are the most predictive of DWI for motorcyclists) are usually followed by further scrutiny to add confirmation to an officer's initial suspicions.

Table 29 provides a complete tabulation of cue reports obtained during the Phase II field study. The table presents data for all enforcement stops and for those stops that resulted in DWI arrests; the proportions of cue reports that were associated with DWI arrests are also provided as p values. For example, the cue *Weaving within a lane* was reported during 57 of the 1,230 enforcement stops; 40 of those 57 stops resulted in DWI arrests, for a proportion of 70.2 percent (p=.702). Similarly, the cue *Erratic movements while going straight* was reported during 30 enforcement stops, and 20 of those, or 67 percent, resulted in DWI arrests (p=.667). The most frequently-reported motorcycle cue was *Excessive speed;* Excessive speed was reported a total of

656 times, but only 57 of the enforcement stops involving that cue resulted in DWI arrests, for a proportion of 8.7 percent (p=.087).

Four of the cues listed in Table 29 did not appear on the printed data collection forms provided to law enforcement officers during the Phase II field study (i.e., *Wrong way, Too slow, No eye protection when required, and No helmet when required*). Rather, the four cues were reported by officers in the "other" category, and coded separately during data entry.

TABLE 29
FINAL RANKING OF MOTORCYCLE DWI CUES FROM 1230 DATA COLLECTION FORMS OBTAINED DURING THE PHASE II FIELD STUDY

Rank	Cue	DWIs	Total	p Value
1	Unsteady at slow speeds or during turn	20	27	.741
2	Weaving	40	57	.702
3	Inappropriate or unusual behavior	17	25	.680
4	Erratic movements while going straight	20	30	.667
5	Wrong way	5	9	.556
6	Trouble with dismount	14	26	.538
7	Drifting during turn or curve	9	17	.529
8	Trouble with balance at stop	16	31	.516
9	Too slow	1	2	.500
10	Turning problems	4	9	.444
11	Operating without lights at night	6	14	.429
12	Inattentive to surroundings	7	18	.389
13	Evasion	10	30	.333
14	Running stop light or sign	19	69	.275
15	Recklessness	12	45	.267
16	Rapid acceleration	19	103	.184
17	Unsafe passing	7	43	.163
18	Parking or riding on sidewalk	2	13	.154
19	Turning violation	7	48	.146
20	Unsafe lane change	8	64	.125
21	Following too closely	2	21	.095
22	Excessive speed	57	656	.087
23	Vehicle defects	9	127	.071
24	Loud exhaust	8	124	.065
25	Expired registration tags or no plate	10	160	.063
26	No eye protection (when required)	1	29	.034
27	No helmet (when required)	1	74	.014

SELECTION OF CUES FOR DETECTION GUIDE AND TRAINING MATERIALS

The cue *Too slow,* while a likely indicator of operator impairment, was eliminated from further consideration for the detection guide and training materials because the behavior was only observed twice during the field study. In addition, the cue with the highest p value, *Unsteady at slow speeds or during a turn,* was combined with *Turning*

problems (which consisted of improper lean angle, late braking, and erratic movements during a turn). A composite p value of .67 was obtained by combining the 26 observations of the four related examples of turning problems.

As a result of these analyses it was recommended to NHTSA that all cues with p values greater than .25 be included on the motorcycle DWI detection guide and in other training materials concerning the detection of impaired motorcyclists. The .25 criterion was selected as a rationally appropriate level of predictive utility, even though p values below the criterion would be useful to some officers.

Confidence intervals were calculated for each of the behavioral cues. Appendix E presents the results of those calculations, and Figure 7 illustrates the p values of the cues with 95 percent confidence intervals. Although some of the recommended cues' confidence intervals appear to be relatively large, it must be understood that the p values calculated for the cues represent the best statistical estimates of probability. In addition, only one of the confidence intervals has a lower limit below .16 (i.e., *Recklessness*), and most are above .34 (the four most predictive cues have lower limits at .50 and above). Recall that all of the cues listed on the Phase II data collection form passed the qualitative and quantitative hurdles of Phase I. In other words, the correlation of the cues with DWI has been established–the only question concerns the assignment of valid p values. The fact that some of the cues have relatively small n's must not automatically eliminate them from consideration.

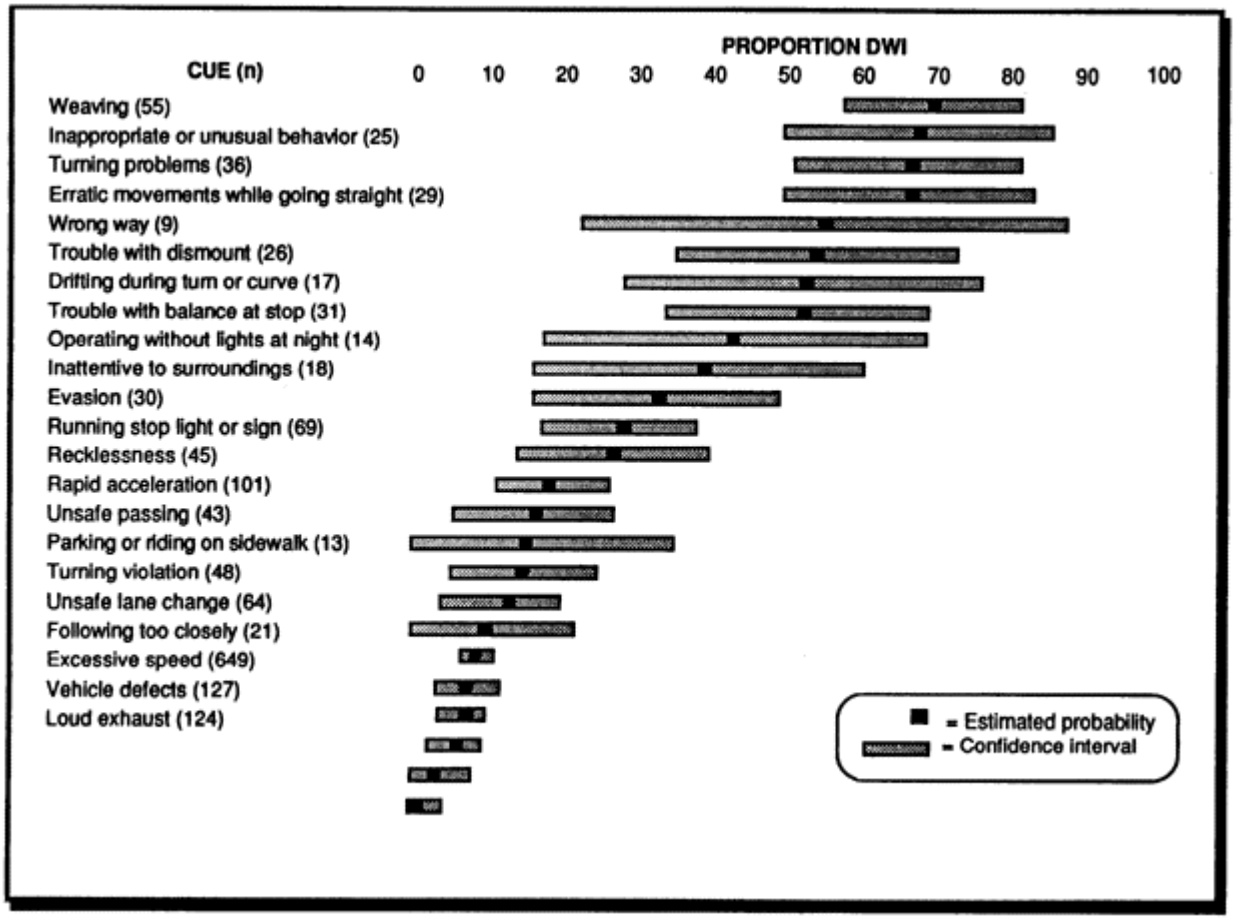

Figure 7. Illustration of sample p values with 95% confidence intervals.

CHAPTER 7 :
DEVELOPMENT OF PRELIMINARY TRAINING MATERIALS

DWI DETECTION GUIDE

A motorcycle DWI detection guide for use by traffic law enforcement was developed based on the results of the Phase II field study; the guide is presented as Figure 8. Thirteen cues were included on the detection guide, along with the estimated probabilities that those cues were predictive of DWI. It was intended that the detection guide be used in training (e.g., roll call or specialized DWI training programs) and as a decision aid during patrols to alert officers to the behaviors that are the most indicative of impaired motorcycle operation. The preliminary DWI guide, and associated training video and booklet, were designed to be evaluated during the validation study, the next and final step of the research and development project.

MOTORCYCLE DWI DETECTION GUIDE

Percentage of motorcyclists with BAC equal to or greater than the legal limit.

Observed Behaviors	Probabilities DWI
Weaving	70
Inappropriate or unusual behavior (e.g., carrying or dropping object, urinating at roadside, disorderly conduct, etc.)	68
Turning problems (e.g., unsteady, sudden corrections, late braking, improper lean angle, etc.)	67
Erratic movements while going straight	67
Wrong way	56
Trouble with dismount	54
Drifting during turn or curve	53
Trouble with balance at stop	52
Operating without lights at night	43
Inattentive to surroundings	39
Evasion	33
Running stop light or sign	28
Recklessness	27

Apply the higher or highest percentage when two or more cues are observed.

Figure 8. Preliminary motorcycle DWI detection guide.

Excessive speed was not included on the DWI detection guide because the predictive value of speeding as a cue to DWI was found to be relatively low; only 8.5

percent of speeding motorcyclists during the Phase II study were likely to be legally impaired. However, speeding motorcyclists who *are* DWI tend to ride significantly faster than speeding motorcyclists who *are not* impaired (24.4 miles per hour over the limit, compared to 19.3 miles per hour, on average). But even when focusing on relatively high speeds, the predictive value of speeding is limited. For example, speeding 24 miles per hour (and more) over the limit was associated with DWI about 15 percent of the time, and at 38 miles per hour (and more) over the limit, one full standard deviation above the mean for DWI speeders, only 20 percent were found to be DWI.

The irony of this analysis is that *Excessive speed* is the behavioral cue that results in the greatest number of DWI arrests, not because of its relatively low predictive value but due to the large numbers of speeding motorcyclists who are stopped by law enforcement officers. An extremely large number of stops with low probabilities of DWI will generate more arrests than a small number of stops made in response to cues with high DWI probabilities.

It must be understood that the absence of *Excessive speed* on the detection guide does not mean that officers should ignore speeding motorcyclists. To the contrary, one would expect that all violations of established vehicle codes should be enforced, and some of those enforcement stops will lead to DWI arrests. It must be understood that the purpose of the DWI detection guide is to sensitize patrol personnel to the behaviors that are the *most* indicative of operator impairment. Additionally, it is important to note that most of the cues on the guide are not infractions, and consequently, would possibly remain undetected as signs of impairment by untrained officers. By providing officers with knowledge about the predictive value of these additional behaviors (in particular, the balance and vigilance cues), law enforcement personnel are better equipped to accurately detect impaired motorcyclists.

Multiple Cue Analysis

An analysis was performed to determine the relationship between the number of cues observed by an officer and DWI probabilities. For each cue, p values were calculated for enforcement stops involving observations of one, two, and three or more cues. It was found that cues with relatively low probabilities (when observed alone) increased in probability when combined with other cues as two-cue and multiple-cue stops. Conversely, the probabilities of highly predictive (single) cues were diluted when combined with additional cues with lower (single) probabilities. As a result of the multiple cue analysis, the preliminary DWI detection guide contained simple instructions to officers to use the higher probability when two cues are observed, and when three or more cues are detected to focus on the observed cue with the highest probability. This procedure provided officers with the best estimate of probability that a motorcyclist is DWI.

Preliminary Evaluation of DWI Detection Guide

A form containing the motorcycle DWI detection guide was sent to a sample of the law enforcement agencies that participated in the Phase II field study. The purpose of the form was to provide immediate “feedback” to the participants of the study concerning their efforts, and to ask a few questions of the officers regarding the likely

use of the guide. Officers were also invited to offer suggestions about the guide and to comment on the field study.

Three-hundred and fifteen of the 500 forms distributed were returned for analysis. Of those officers who participated in the Phase II field study and who completed the evaluation, 23 percent responded that the cues listed on the data collection form helped them to detect an impaired motorcyclist, while 77 percent reported that they were not assisted by the cues on the form. Nine percent of the officers mentioned that the detection guide suggested cues that they had not previously considered. The cues identified by those officers are listed in Table 30. All but one of the cues are balance and vigilance-related.

TABLE 30
CUES IDENTIFIED BY OFFICERS AS "NEW"

Behavioral Cue	Frequency Mentioned
Trouble with dismount	8
Turning problems	6
Trouble with balance at stop	4
Inattentive to surroundings	3
Erratic movements while going straight	3
Wrong way	2
Inappropriate or unusual behavior	2

Law enforcement personnel were asked which category of officer might benefit from the motorcycle DWI detection guide and training materials? Of the 302 officers who responded to this question, 49 percent believed that the guide and training materials would be beneficial to both experienced personnel and new recruits; 48 percent believed the materials would be helpful only to new recruits; and, three percent responded that the materials would probably not help anyone.

The interviews conducted with law enforcement personnel early in the current research project strongly suggested that motorcycle DWI training materials would be useful even to experienced patrol personnel (i.e., approximately one-third of those interviewed believed it difficult if not impossible to detect an impaired motorcyclist from riding behavior). The suggestion that experienced personnel might benefit from a detection guide and training materials was confirmed by the evaluation exercise described above: About half of the officers who were asked the question believe that the materials developed during this project will assist *both* experienced personnel and those new to law enforcement; the other half responded that the benefit of the materials would be limited to new recruits.

Many officers were enthusiastic about the results of the study and offered suggestions to assist the development of training materials (i.e., use motorcycle officers to demonstrate cues in the video, laminate and distribute the detection guide for easy reference, etc.).

TRAINING VIDEO

A training video was produced, with the assistance of the Santa Barbara Police Department. The 12-minute video, narrated by an experienced police motorcycle officer, summarizes the research project and describes the cues listed on the detection guide. Motorcycle officers and other expert motorcyclists demonstrate the 13 behavioral cues under operational patrol conditions.

PRINTED TRAINING MATERIALS

A 12-page training booklet, *The Detection of DWI Motorcyclists,* was developed to accompany the detection guide and training video. The booklet contained a copy of the Motorcycle DWI Detection Guide, a summary of the research that led to the guide, and descriptions of the 13 cues listed on the guide. Each cue description was illustrated by an associated drawing.

CHAPTER 8:
VALIDATION STUDY AND
DEVELOPMENT OF FINAL TRAINING MATERIALS

A follow-up study was conducted to validate the Phase II cues and the motorcycle DWI detection training program developed at the conclusion of the Phase II field study. The hypotheses to be tested by the validation study were, 1) that the cues identified at the conclusion of the Phase II study were the best discriminators of impaired motorcycle operation, and 2) that the training program, consisting of training videotape, brochure, and detection guide, would improve the effectiveness of patrol officers in detecting impaired motorcyclists.

PROCEDURES

The procedures followed during the validation study were the same as those followed during the Phase II field study, with the few exceptions discussed below. Officers used the same data-collection form to record information about every enforcement stop made of motorcyclists; the data-collection form was presented previously as Figure 3–only the year was different on the forms used during the validation study. As in the Phase II field study, collecting information about all enforcement stops, regardless of disposition, permitted the calculation of probabilities that specific cues are predictive of DWI.

Some of the same law enforcement agencies that participated in the Phase II field study participated again in the validation study and additional agencies were recruited. A total of 50 law enforcement sites, representing 19 separate agencies and eleven states, participated by collecting data about every stop made of motorcyclists in those jurisdictions. Table 31 lists the law enforcement agencies and sites that participated in the validation study; Figure 9 illustrates the geographic distribution of the sites.

The validation study was conducted during the 1991 motorcycle riding season. Unlike the Phase II study conducted during the previous riding season, the depressed economic conditions during the validation study resulted in significant diversions or reductions of traffic patrol effort by many of the participating law enforcement agencies. Law enforcement managers explained that declining operating budgets, caused by the recession, had forced their agencies to reduce or redirect traffic enforcement effort to other concerns; some managers reported that the number of traffic citations issued by their agencies had declined by as much as 30 percent from the same period in 1990. These conditions resulted in the submission of 740 data-collection forms during the validation study: a 40 percent drop from the 1,230 forms returned during the Phase II field study.

The manner in which participating officers were introduced to the motorcycle DWI cues was the most important difference between the conduct of the Phase II field study and the validation study. During the Phase II study, the project director visited each agency to brief liaison personnel; usually only the agency's liaison officer and a small proportion of the patrol officers from the agency were present during these roll call

meetings. Printed orientation materials that included brief descriptions of all 23 cues listed on the data-collection forms were provided for all participating officers, but the liaison officers were responsible for describing the cues and study procedures to all other patrol officers who did not meet personally with the project director.

TABLE 31
LAW ENFORCEMENT AGENCIES AND SITES THAT PARTICIPATED IN THE VALIDATION STUDY

State Agencies/Sites
Arizona State Police (5 districts) California Highway Patrol (4 area offices) Maryland State Police, North East Barracks (3 sites) Massachusetts State Police (3 sites) Ohio State Highway Patrol (3 posts) Texas Department of Public Safety, Waco Division (8 Sites) Texas Department of Public Safety, Austin Division (8 Sites)
Municipal Police Departments
Albuquerque (NM) Police Department Dallas (TX) Police Department Eau Claire (WI) County Sheriff's Office Eau Claire (WI) Police Department Jacksonville (FL) Police Department/Sheriff's Office Lake Charles (LA) Police Department Sulphur (LA) Police Department DeRidder (LA) Police Department Los Angeles (CA) Police Department, (4 divisions) Marlborough (MA) Police Department Metro Dade (FL) Police Department Santa Barbara (CA) Police Department Tucson (AZ) Police Department

Figure 9. Geographic distribution of law enforcement sites participating in the validation study.

In contrast, during the validation study all participating law enforcement personnel viewed a 12-minute training video that described the 13 most discriminating cues identified during the Phase II Study. The probabilities derived from the Phase II study were included in the training materials. The cues were demonstrated in the video in realistic contexts by expert motorcyclists. In addition to the training videotape, each officer received a training brochure that provided detailed descriptions and drawings illustrating the cues, as well as information about the study and how to use the cues to detect impaired motorcyclists. Finally, each participating officer received a laminated detection guide to serve as a job aid–a handy reminder of the cues–designed to be carried in a pocket or citation book for easy reference.

To summarize, the training materials and detection guide were developed following the Phase II field study as drafts of the final materials that are the ultimate products of the research project. The validation study was designed as a test of the detection cues and associated training materials.

DATA ANALYSIS

Table 32 presents the results of the validation study and compares those results to the results of the Phase II effort. Ninety-five percent confidence intervals were calculated for every cue and for both field studies (i.e., Phase II study and validation study). Confidence intervals are illustrated by the horizontal bars in Figure 10; p values are indicated by black squares. T tests (two-tailed) were performed to identify any significant differences between the validation study and Phase II field study results. Appendix E presents a discussion of the method and the results of the calculations.

The data summarized in Table 32 and Figure 10 appear to reject the null hypothesis. In the validation study, five cues resulted in p values outside the Phase II 95 percent confidence intervals. A plausible and logical explanation exists for these results. In the Phase II study these cues were behaviors that were not traffic law violations, but still emerged from the data as predictive of DWI (i.e., primarily the balance and vigilance-related cues). The Phase II orientation materials merely mentioned the cues along with the other behaviors that may have been associated with DWI. In contrast, the draft training materials, to which all officers were exposed in the validation study, emphasized these highly discriminating cues and taught officers to look for the behaviors, even though they were (still) not actual violations. It might be expected that officers would more frequently see and respond to these cues when on patrol as a result of the training provided. Indeed, a Chi Square test of the data summarized in Table 33 revealed that officers disproportionately observed and reported cues on which they were trained during the validation study; differences from the expected values were significant at the .001 level of confidence. Thus, it is reasonable to conclude that the additional training provided during the Validation Study accounts for the increased reporting of DWI above the Phase II levels.

A review of Table 32 and Figure 10 will indicate that nine of the top 13 cues listed had higher p values in the validation study than in the Phase II study; of those nine p values, seven were significantly higher (i.e., greater than the upper limits of the Phase II confidence intervals). In particular, the cues *Trouble with dismount, Trouble with balance at a stop, Drifting during turn or curve,* and *Inattentive to surroundings* all

displayed validation study p values significantly greater than obtained during the Phase II study. It is important to note that these cues are evidence of balance and vigilance impairment. It is believed that higher validation study p values for these cues suggests successful transfer of detection skills to other officers by the DWI detection training program. (This is consistent with observations made at the beginning of the research project that attention to subtle balance and vigilance cues is what distinguished the relatively small proportion of sophisticated DWI detectors from all other officers who were interviewed.)

TABLE 32
COMPARISON OF OFFICERS' DWI ARRESTS BY CUES DURING THE PHASE II AND VALIDATION STUDIES

		Phase II Study		***Validation Study***		***Change in P Value***
	Cue	**n**	**p value**	**n**	**p value**	
Cues Used in Validation Study Training	Weaving	40	.70	37	.60	-.10
	I/U behavior	17	.68	17	.65	-.03
	Turning problems	24	.67	17	.68	+.01
	Erratic movements	20	.67	5	.46	**-.21***
	Wrong way	5	.56	1	1.0	–.–
	Trouble with dismount	14	.54	20	.80	**+.26***
	Drifting during turn or curve	9	.53	12	.92	**+.39***
	Trouble with balance at stop	16	.52	19	.76	**+.24***
	No lights at night	6	.43	3	.43	0
	Inattentive to surroundings	7	.39	6	.67	**+.28***
	Evasion	10	.33	8	.36	+.03
	Running stop light or sign	19	.28	23	.39	+.11
	Recklessness	12	.27	14	.40	+.13
Cues *Not* Used in Validation Study Training	Rapid acceleration	19	.18	25	.30	+.12
	Unsafe passing	7	.16	9	.32	+.16
	Parking/riding on sidewalk	2	.15	3	.27	+.12
	Turning violation	7	.15	9	.16	+.01
	Unsafe lane change	8	.13	15	.32	+.19
	Following too closely	2	.10	4	.40	–.–
	Excessive speed	57	.09	55	.15	+.06
	Vehicle defects	9	.07	4	.05	-.02
	Loud exhaust	8	.07	4	.07	0
	Expired tabs or plates	10	.06	13	.15	+.09
	No eye protection	1	.03	3	.2	–.–
	No helmet (where req.)	1	.01	1	.07	–.–
	Total Cues Reported DWI Arrests Total Stops Made	330 144 1230	*2.29 cues per DWI*	327 120 740	*2.73 cues per DWI*	
	Proportion DWI of all Stops	.117		.162		

*Indicates difference in p value exceeds Phase II 95 percent confidence interval.
Difference in p values for balance and vigilance cues indicated by bold type.

TABLE 33
RESULTS OF CHI SQUARE ANALYSIS OF OFFICERS' REPORTING OF CUES DURING THE PHASE II AND VALIDATION STUDIES

	Phase II Study	Validation Study	Total Actual Observations
Cues Used in Validation Study Training	Expected Observations: 446 Actual Observations: 407 Chi Value: 3.41	Expected Observations: 282 Actual Observations: 321 Chi Value: 5.39	728
Cues *Not* Used in Validation Study Training	Expected Observations: 1423 Actual Observations: 1462 Chi Value: 1.07	Expected Observations: 899 Actual Observations: 860 Chi Value: 1.69	2322
Total Actual Observations	1869	1181	3050

Critical value of Chi Square = 11.56 (significant at the .01 level).

Only three of the top 13 cues declined in p value from Phase II to the validation study, and only one of those cues declined significantly. All three cues with lower p values were among the highest four p values on the list. In particular, *Weaving* and *Inappropriate or unusual behavior,* the two top cues, declined slightly. The declines fell within Phase II confidence intervals and can be explained as the results of chance. Alternatively, those slight declines may be explained as a result of the cues' extremely high predictive, or discriminating, values. It is possible that these clear and traditional

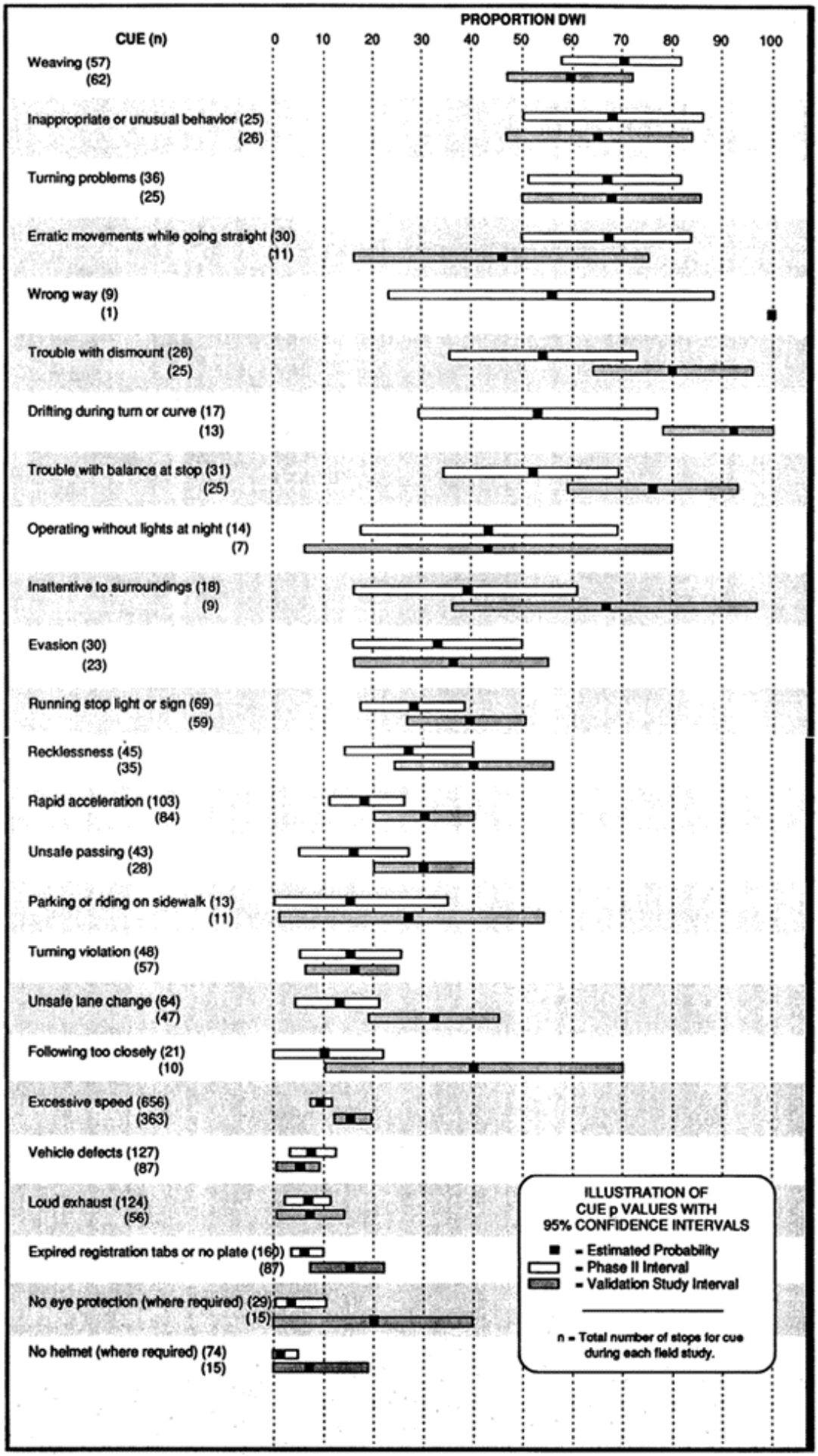

Figure 10. Illustration of Phase II and Validation Study p values with 95% confidence intervals.

indicators of impairment were used to good effect by officers during the Phase II study. When further encouraged to respond to the cues by the validation study training program, officers might have made more stops for *Weaving* and *Inappropriate and unusual behavior* than they would have made during the Phase II study, resulting in a slightly lower proportion of DWI arrests for these cues in the validation study. Anecdotal accounts from officers and reviewers of the training video support this interpretation for *Weaving*. It appears that some reviewers interpreted the cue description to include *all* weaving, including the normal movement within a lane practiced by motorcyclists to avoid pavement imperfections and as standard defensive riding technique. Final versions of the training materials further explain these exceptions concerning weaving.

Erratic movements while going straight was the only cue among the top 13 that exhibited a significantly lower p value in the validation study than during Phase II. However, the small number of observations of this cue during the validation study explains this slightly out-of-bounds p value.

It is also interesting to note the cue with a p value that was the same in both the Phase II and validation studies. That cue is *Operating without lights at night*. All but one of the cues with p values greater than that of "no lights" are behaviors indicative of impairment, rather than infractions of vehicle codes. As mentioned previously, it is these subtle indicators of balance and vigilance impairment that have emerged from the study as the most discriminating cues. *Operating without lights at night,* however, is an infraction that is also indicative of impaired vigilance. But more important to this analysis, the cue is unambiguous; that is, the cue or behavior is not subject to misinterpretation or debate. A motorcycle's head light is either on or it is not. Presumably, officers would respond to this cue by stopping motorcyclists whether or not they had the benefit of the DWI training provided during the validation study. Because it is an unambiguous infraction, the p value of this cue should be expected to remain the same, and it did. NOTE: Motorcycles sold in the U.S. today are hard-wired to ensure that headlights are automatically illuminated when the engine is on to improve conspicuity. Despite this feature on motorcycles sold since 1978, there are still many older motorcycles on the road, and some owners disable the automatic headlight on their bikes.

No new cues were identified during the validation study, and the cues remained in approximately the same order that emerged from the Phase II effort. Some of the cues that fell below the 25 percent cut-off during Phase II (i.e., to be included on the detection guide) did receive slightly higher p values during the validation study, but in most cases the number of observations was quite small. Further, most DWI arrests were preceded by the display of multiple cues, including cues that had not made the 25 percent cut-off. In other words, the effectiveness of the highly predictive cues may have increased p values of the less predictive cues.

DISCUSSION OF THREATS TO INTERNAL VALIDITY

Introduction

The results of the validation study have prompted us to explore alternative explanations of the differences displayed in DWI cue p values between the Phase II and validation studies. Our conclusion was that the observed differences between the Phase II and validation studies were indeed attributable to the exposure to the training materials officers experienced during the validation study. Cook and Campbell's (1979) classic

volume on the subject of field study design and data analysis provides the equivalent of a handy checklist of 13 possible threats to internal validity in field research, i.e., alternative explanations to the observed results need to be considered and discarded, as appropriate. In the context of the current study, the possible threats can be summarized as uncontrolled changes that might have occurred in:

- The data-collection procedures,
- The population of participating patrol officers,
- The drinking and riding behavior of motorcyclists,
- The DWI detection abilities of participating patrol officers.

Each category of threat to validity is discussed in the following paragraphs.

Data-Collection Procedures

Data-collection procedures become a threat to internal validity when there is a change in the measuring instrument between the pre- and post-test conditions. The implication of this threat is that different data-collection procedures could produce different results.

The data-collection procedures were the same during the Phase II and validation studies. The same data-collection form was used, and officers received the same instructions regarding procedures for completing a form following all stops made of motorcyclists. The same type of self-addressed envelope was provided to the liaison officers with the same instructions for returning completed forms to the project director. In short, the data-collection procedures ("instrumentation" in Cook and Campbell's terms) were identical during the Phase II and validation studies.

Identical procedures do not *ensure* that officers followed the procedures identically during both studies. For example, it is possible that some officers did not submit a data-collection form for every stop they made of motorcyclists–perhaps some submitted forms disproportionately for DWIs. However, it must be assumed that any differences in officer behavior regarding procedures during the validation study would be balanced by similar differences or departures from the established procedures during the Phase II study, because the instructions were identical.

Population Of Participating Patrol Officers

Cook and Campbell warn us about two possible threats to validity that concern the populations of those being tested in a pre- versus post-test research design: selection and mortality. Selection is a threat due to possible differences between the kinds of people in the two groups. Mortality is a threat when the same population is used before and after the treatment condition, but some members of the population (selected nonrandomly) drop out before the post-test is conducted.

Our study is definitely subject to both selection and mortality threats to validity. This is because 25 law enforcement sites participated in the Phase II study and 50 sites participated in the validation study–18 Phase II sites were among the 50 sites participating in the validation study. Accordingly, it is possible that the officers "selected" to participate in the validation study, who did not participate during Phase II, were better

detectors of motorcycle DWI behavior prior to their involvement in the project. Similarly, it is possible that among the agencies that participated during both field studies, only the better detectors remained to participate during the validation study. Selection and mortality threats are addressed separately below.

Selection. While neither of these threats can be ruled out completely, it is believed that the very large sample sizes in both studies eliminate the threat of selection as an explanation of the reported differences (1500 and 3000 officers at the participating sites for the Phase II and validation studies, respectively). Presumably, samples of these magnitudes represent a normal distribution of patrol officer skill.

Mortality. The liaison officers of key sites that participated in both field studies were contacted to evaluate the possibility of selective mortality changing the population of participating officers at those sites. It was found that the same officers participated in both studies, with only minor turnover in personnel (at a rate of approximately three percent). Liaison officers explained that while the same people participated in both studies, it is a natural progression for officers' skill levels to improve in response to the training they receive while on the job, such as the training provided by the NHTSA/Anacapa motorcycle DWI training program.

The Drinking And Riding Behavior Of Motorcyclists

It is possible that the behavior of motorcyclists changed between the 1990 and 1991 riding seasons, which could result in differential displays of cues making it easier to detect impaired motorcyclists during the validation study (conducted during the 1991 riding season).

Descriptive statistics about the BAC levels of DWI motorcyclists were calculated to evaluate the possibility that motorcyclists' behavior changed in a manner that would render them easier to detect during the validation study. The results of those calculations are provided below.

	Mean BAC	SD	Range
Phase II Study	.143	.041	.06-.23
Validation Study	.146	.044	.06-.31

Again, while subtle changes might have occurred in the drinking and riding population between the two field studies, the data clearly suggest that the behaviors indicative of impairment did not change, as determined from the nearly identical BAC levels of DWI motorcycle operators during the two field studies.

In addition, no new cues were identified during the validation study that had not been identified by the end of Phase II of the project. And, the relative order of the cues, in terms of descending p values, remained virtually the same. In other words, the cue list has internal validity, and motorcyclist behavior did not appear to change.

DWI Detection Abilities Of Participating Officers

Cook and Campbell suggest "history" and "maturation" as possible explanations of differences obtained in pre- versus post-test research designs. History is a possible explanation of differences when some critical event takes place between the pretest and post-test that might cause a change to occur. Maturation is a possible explanation when an observed difference could be attributable to changes in the respondents, for example, growing older, wiser, or obtaining additional experience. History and maturation are threats to internal validity when their influences on respondents are not the treatments of research interest.

In the context of the current study, however, an event *was* intentionally inserted in the research design prior to the post test; that event was formal training concerning the detection of DWI motorcyclists. Further, it is hypothesized that the training resulted in a change in the respondents (maturation), and improvements in their DWI detection abilities during the validation study. Table 34 presents the results of a Chi Square test of officers' performance in detecting DWI motorcyclists during the Phase II and validation studies. Results of the test indicate that officer performance clearly improved following training; differences from the expected values were significant at the .01 level of confidence.

Another test of officer DWI-detection performance is to compare the proportions of DWI motorcyclists among all motorcyclists who were stopped during the Phase II and validation studies. The proportion of stops that resulted in a DWI arrest during the Phase II study was 11.7 percent, compared to 16.2 percent during the validation study. A test of proportion differences using the z statistic indicates that this difference is significant at the .01 level, again clearly suggesting that officers' DWI detection abilities were better during the validation study; that is, officers' DWI detection abilities appear to have improved significantly following training ($z = 2.8397$).

In addition, if motorcycle DWI detection skills improved during the validation study we would expect to find a disproportionate reporting of the most discriminating cues in the validation study, compared to the Phase II data. This would be expected because the 13 most discriminating cues were described in detail in the training materials and listed on the detection guide along with their significant probabilities that the cues are predictive of impairment. No cue received this special treatment during the Phase II study; that is, during Phase II the cues were not "prioritized" in any way, nor were probabilities associated with any cue, as in the validation study.

We received approximately 40 percent fewer data-collection forms during the validation study than during Phase II. However, the 13 most discriminating cues declined at about half that rate, and the two most discriminating cues actually increased in incidence: *Weaving* increased by nine percent and *Inappropriate or unusual behavior* increased by four percent during the validation study, despite the 40 percent decline in total stops made of motorcyclists. Other cues, such as *Turning problems, Trouble with dismount,* and *Trouble with balance at a stop,* declined but at about half the rate that would be expected if officers had not been sensitized to these cues by the training program. It must be understood that these cues are *not* traffic violations that would normally motivate a stop by an officer, unless the officer were aware of the behaviors as

indicators of DWI. (Four of the top 13 cues *did* decline in proportion, or greater, to the decline in data-collection forms, but three of them are traffic violations, and each of the four had fewer than 11 observations during the validation study.)

TABLE 34
RESULTS OF CHI SQUARE ANALYSIS OF OFFICERS' DETECTION OF DWI DURING THE PHASE II AND VALIDATION STUDIES

	Phase II Study	Validation Study	Total Actual Observations
DWI	Expected Observations: 165 Actual Observations: 144 Chi Value: 2.67	Expected Observations: 99 Actual Observations: 120 Chi Value: 4.45	264
Non-DWI	Expected Observations: 1065 Actual Observations: 1086 Chi Value: .41	Expected Observations: 641 Actual Observations: 620 Chi Value: .69	1706
Total Actual Observations	1230	740	1970

Critical value of Chi Square = 8.22 (significant at the .01 level).

Conclusions

This discussion and elimination of alternative explanations of the obtained results strengthens our conclusion that the shift in probabilities for some cues from the Phase II to the validation study is attributable to the training program implemented during the validation study.

CONCLUSIONS AND RECOMMENDATIONS

The results of the validation study clearly suggest that the draft training materials and detection guide significantly improved the detection effectiveness of patrol officers. The previous section provides a methodological discussion that examines the rationale for drawing this conclusion. In addition, there is evidence that exposure to the training materials sensitized officers to balance- and vigilance-related behaviors, rather than just traffic violations. Further, the cues included in the draft materials were confirmed by the validation study as the behaviors that best discriminate between impaired and normal operation of a motorcycle.

The p values obtained during the validation study provide the best estimates that the observed motorcyclist behaviors are predictive of DWI. In other words, exposure to the Phase II Training Program resulted in improvements to officers' DWI detection abilities for some cues. The p values used in the final training materials should reflect the validation study values. The final version of the training materials has been modified by arranging the cues in descending order of the p values obtained in the validation study. In addition, the cue *Following too closely,* which did not make the 25 percent criterion at the conclusion of Phase II, was included on the final list of cues, based on validation study data.

It appeared that use of the DWI detection guide would be facilitated by categorizing the cues into two classes (Excellent and Good), rather than assigning specific probabilities to them (as in the preliminary training materials). Cues that were categorized as *Excellent* were those with p values of .50 or greater, and cues that were categorized as *Good* were those with p values of .30 to .49. The final version of the Motorcycle DWI Detection Guide is presented as Figure 11. The training video and booklets were modified to conform to the changes made to the detection guide. Appendix F presents a copy of the final training brochure.

FINAL COMMENTS

The validation study data and anecdotal reports from participants in the validation study suggest that exposure to the preliminary Motorcycle DWI Detection training program resulted in officers' increased sensitivity to motorcyclists as possible DWI suspects. One liaison officer, in particular, reported that previous to the study, most of his department's DWI arrests were made at the scenes of motorcycle crashes, rather than through enforcement stops. But, following exposure to the training program, the number of arrests resulting from enforcement stops increased dramatically–surpassing the number from crashes. The officers concluded that they were now probably stopping the motorcyclists for DWI *before* they crashed. Future study of the effect of using these training materials may provide data supporting these observations.

The traffic officers described above were asked to identify what aspect of motorcycle enforcement, in fact, had changed. They reported that it was their increased sensitivity to motorcyclists, in general, that was the biggest difference from their previous approach to traffic patrol–they had been focusing on automobiles to the exclusion of all other vehicles.

Additional data will be necessary to evaluate the impact of the Motorcycle DWI Detection training program on DWI arrests. Study data, and the anecdotal reports of participating officers, suggest that the program will sensitize all patrol personnel to motorcycles, in general, and to the specific behaviors that are the most indicative of operator impairment.

MOTORCYCLE DWI DETECTION GUIDE

NHTSA has found that the following cues predicted impaired motorcycle operation.

Excellent Cues (50% or greater probability)

- Drifting during turn or curve
- Trouble with dismount
- Trouble with balance at a stop
- Turning problems (e.g., unsteady, sudden corrections, late braking, improper lean angle)
- Inattentive to surroundings
- Inappropriate or unusual behavior (e.g., carrying or dropping object, urinating at roadside, disorderly conduct, etc.)
- Weaving

Good Cues (30 to 50% probability)

- Erratic movements while going straight
- Operating without lights at night
- Recklessness
- Following too closely
- Running stop light or sign
- Evasion
- Wrong way

Figure 11. Final version of the Motorcycle DWI Detection Guide.

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APPENDIX A

EXAMPLES OF NARRATIVE SECTIONS OF DWI MOTORCYCLE ARREST REPORTS

NARRATIVE/SUPPLEMENTAL

DATE OF OCCURRENCE	TIME OCCURRED	REPORT NUMBER	OFFICER ID	NUMBER
11-28-88	0155	9326	11595	

FORM	FORM	TYPE SUPPLEMENTAL/FOLLOW-UP APPLICABLE
[X] NARRATIVE	[ ] COLLISION REPORT	[ ] DA UPDATE [ ] FATAL [ ] HIT & RUN UPDATE
[ ] SUPPLEMENTAL	[X] OTHER 702	[ ] HAZARDOUS MATERIALS [ ] SCHOOL BUS [ ] OTHER

CITY/COUNTY/JUDICIAL DISTRICT	REPORTING DISTRICT/BEAT	DEFENDANT'S NAME
SAN BRUNO / SAN MATEO / SAN FRANCISCO	18	[redacted]

[redacted] [X] YES [ ] NO

1. FIRST OBSERVATIONS:

2. AT APPROX 0145 HRS MY ATTENTION WAS DRAWN TO THE SUBJECT
3. VEHICLE (U/V) AS IT WAS S/B US-101 IN THE S-2 LANE IN THE VICINITY OF SAN
4. BRUNO AV. AT A SLOW RATE OF SPEED (ESTIMATED 30 MPH). THE MARKED CHP UNIT
5. (# 7326) WAS S/B ON THE COLLECTOR RD. THE U/V PASSED THE CHP UNIT AND A PACE
6. WAS STARTED ON THE U/V. THE U/V WAS PACED IN EXCESS OF 80 MPH. THE U/V WAS
7. ALSO UNSTEADY AND ERRATIC IN ITS MOVEMENTS AS IF THE DRIVER WAS ATTEMPTING
8. TO MAINTAIN BALANCE OF THE M/C. THE 4-WAY RED SAT LIGHT WAS TURNED ON
9. AT THE SFO ON RAMP TO S/B US-101 THE U/V DID NOT RESPOND AT FIRST, UTILIZING
10. THE OUTSIDE P.A. SPEAKER AND BURSTS FROM THE SIREN, THE U/V FINALLY SLOWED
11. AND PULLED TO THE R/ SHOULDER @ MILLBRAE AVE.
12.
13. OBSERVATIONS AFTER STOP:
14. I APPROACHED THE U/V ON THE R/SIDE, SPOKE TO THE DRIVER AND RE-
15. QUESTED THE DRIVER OF THE REASON FOR THE STOP. THE DRIVER SEEMED STUNNED OR
16. IN WHAT APPEARED TO BE A STATE OF DEEPER CONFUSION. WHEN ASKED TO STEP FROM
17. THE U/V, THE SUBJECT MOVED SLOW AND DELIBERATELY IN A ROBOTIC MANNER. WHEN REQUEST
18. THE SUBJECT PRODUCED A DRIVERS LICENSE BUT DID HAVE DIFFICULTY REMOVING IT FROM
19. HIS WALLET. AS I SPOKE WITH THE SUBJECT, I COULD SMELL THE STRONG ODOR OF AN
20. ALCOHOLIC BEVERAGE EMITTING FROM HIS BREATH + PERSON. (SUBJECT STILL WEARING HIS
21. FULL FACED MOTORCYCLE HELMET.) ONCE HIS HELMET WAS TAKEN OFF, I NOTICED THE
22. SUBJECTS EYES TO BE RED + WATERY. AS I ASKED THE SUBJECT BASIC QUESTIONS, HE
23. WAS SLOW TO RESPOND HE HAD A LIMITED SPAN OF ATTENTION. HIS SPEECH WAS SLOW,
24. THICK AND SLURRED BUT UNDERSTANDABLE. I THEN EXPLAINED, DEMONSTRATED AND AD-
25. MINISTERED A SERIES OF FIELD SOBRIETY TESTS (FST'S) TO THE SUBJECT. BASED ON HIS
26. DRIVING THAT I OBSERVED, THE SUBJECTS OBVIOUS SYMPTOMS OF INTOXICATION, AND
27. HIS INABILITY TO PROPERLY PERFORM THE FST'S AS I PREDEMONSTRATED, I FORMED
28. THE OPINION THAT THE SUBJECT WAS DRIVING UNDER THE INFLUENCE OF AN AL-
29. COHOLIC BEVERAGE.
30.
31. (BAC = .21 + .20)
32.

PRINTED NAME	ID NUMBER	DATE/TIME	REVIEWER'S NAME	DATE/TIME
[redacted]	11595	08-29-88		

CHP 556 (Rev. 7-87) OPI 042

NARRATIVE/SUPPLEMENTAL

DATE	TIME	CASE NUMBER	OFFICER NO.	NUMBER
5-23-88	2125	9-246	7586	—

☒ NARRATIVE ☐ SUPPLEMENTAL ☐ COLLISION REPORT ☒ OTHER 202 ARREST ☐ SUPPLEMENTAL ☐ NATAL ☐ SCHOOL BUS

UNINC/ELDO/ELDOMAIN/896/24 — KVJ611

[redacted]

1 FIRST OBSERVATIONS:
2 5-23-88 @ 2125 HRS. I OBSERVED SUBJ R/C VE S.O IN MAYHAS W/OF SANTA FE ST.
3 S/V A MOTORCYCLE TURN DRIFTED 1' TO 2' INTO THE L TURN LN - BACK I
4 FOLLOWED IT. IT WAS @ ≈5 MPH IN THE 40 ZONE, GENTLY DRIFTING SLR WITH
5 THE R/C LN. AT PIONEER TRAIL IT SIGNALLED + MADE A R. TURN. IT DRIFTED
6 LEFT JUST CROSSING THE C/L + THEN CONTINUED @ 25 MPH IN THE 45 ZONE
7 DRIVING AS BEFORE. IT SIGNALLED FOR A L TURN TO SOUTHERN PINES. AT
8 THE I/S IT CAME TO A JERKY STOP + WAITED APPROX 15 SEC'S FOR A GOLD
9 W/O VEH. TO PASS WHEN IT COULD EASILY HAVE TURNED FIRST. SUBJ. MADE A
10 JERKY START + MADE HIS L TURN OFF THE ROAD IN THE DIRT, WOBBLED BUT BACK
11 ON THE ROAD + PROCEEDED ON SOUTHERN PINES. I WAS DIRECTLY BEHIND S/V
12 UPON TURNING ON E'GY LIGHTS + HONKING THE HORN SUBJ. STOPPED; IN THE MIDDLE
13 OF THE ROAD. IT TOOK HIM A FULL 30 SEC'S TO ALIGHT HIS M/C + PUT IT ON ITS STAND
14 OBSERVATIONS AFTER STOP:
15 UPON CONTACT WITH SUBJ. HE DISPLAYED SYMPTOMS OF ALCOHOLIC INTOX-
16 ICATION. WHICH ASKED, HE SAID HE'D BEEN DRINKING A FEW BEERS - HAVING
17 A LITTLE PARTY AT THE FREELPEAT, A LOCAL BAR. HE PROVIDED A DRIVER'S LIC.
18 WHICH PROVED TO BE VALID HOWEVER RESTRICTED TO EMPLOYMENT + ALCOHOLIC
19 REHABILITATION. SAME IS NOT ENDORSED FOR MOTORCYCLE OPERATION. HE HAD
20 NO EVIDENCE OF INSURANCE IN PASS. SUBJ. WAS GIVEN SOBRIETY TESTS WHICH
21 HE FAILED MISERABLY TO PERFORM AS DEMONSTRATED. IN OBSERVING - CONVERS-
22 ING WITH SUBJ. IT BECAME OBVIOUS THAT HE WAS HIGHLY INTOXICATED
23 ARREST:
24 AT LOCATION OF STOP I PLACED SUBJ UNDER ARREST FOR 23152 A/B VC
25 OUT. 10% BAC LEVEL, 12500 VC DRIVING OUT OF CLASSIFICATION 14601.2 VC
26 [illegible] 14601.1 VC. NO EVIDENCE OF INSURANCE
27 WHEN ADVISED OF CHEMICAL TEST REQUIREMENTS, SUBJ CHOSE A BREATH TEST
28 WHEN ADVISED OF HIS LEGAL RIGHTS HE CHOSE TO REMAIN SILENT. SUBJ
29 WAS TRANSPORTED TO ALCOSA JAIL, SLT SUR AT ≈ 2140-2152 HRS. I CONDU-
30 CTED A BREATH TEST WHICH SHOWED .16-.17 RESULTS. AT ≈ 0015 HRS. SUBJ
31 WAS TURNED OVER TO JAIL STAFF FOR FORMAL BOOKING AS CHARGED
32

PRINTED NAME	BADGE NUMBER	MONTH/DAY/YEAR	REVIEWER'S NAME	DATE REVIEWED
J. L. Lark CT.O	7586	5-23-88	MW	5-24-88

CHP 556 (Rev. 7-87) OPI 042

STATE OF CALIFORNIA
NARRATIVE/SUPPLEMENTAL

DATE OF ORIGINAL INCIDENT	TIME (24HR)	BEAT NUMBER	OFFICER'S ID	NUMBER
8-14-88	0340	9590	12111	

☒ NARRATIVE	☐ COLLISION REPORT	☐ DA UPDATE	☐ FATAL	☐ HIT & RUN UPDATE
☐ SUPPLEMENTAL	☒ OTHER: 202	☐ HAZ. MATERIALS	☐ SCHOOL BUS	☐ OTHER:

CITY/COUNTY/JUDICIAL DISTRICT | APP. DISTRICT/BEAT | CITATION NUMBER

LOCATION/JURISDICT | STATE HIGHWAY RELATED ☐ YES ☐ NO

FIRST OBSERVATIONS

I WAS IN A MARKED CHP UNIT N/B ON US101 (HOF) IN THE N-3 LANE AT 55 MPH S/OF SILVERLAKE BL. I OBSERVED THE S/U AT A HIGH RATE OF SPEED IN THE N-2 LANE APPROX 400' AHEAD OF THE PATROL CAR. THE PATROL WAS POSITIONED IN THE N-2 LANE APPROX 150' BEHIND THE S/U. THE S/U WAS PACED AT APPROX 70 MPH FROM SILVERLAKE BL TO APPROX ½ MILE S/OF MELROSE AVE. AS I PACED THE S/U, I NOTICED IT WEAVING SIDE TO SIDE USING THE ENTIRE N-2 LANE. AN ENFORCEMENT STOP WAS INITIATED APPROX ½ MILE S/OF MELROSE AVE. THE DRIVER OF THE S/U WAS INSTRUCTED TO EXIT THE FWY AT THE MELROSE AVE OFFRAMP USING THE P.A. THE S/U COMPLIED AND STOPPED ALONG THE RIGHT CURB OF MELROSE AVE JUST E/OF ALEXANDRIA.

OBSERVATIONS AFTER STOP

THE DRIVER GOT OFF OF THE M/C AND I CONTACTED HIM ON THE SIDEWALK NEAR THE FRONT OF THE PATROL CAR. I NOTICED THAT HE WALKED SLOWLY AND SLIGHTLY OFF BALANCE. I TOLD HIM THE REASON FOR THE STOP AND ASKED FOR HIS DRIVERS LICENSE. HE SAID HE LEFT IT AT HOME. I SMELLED THE STRONG ODOR OF AN ALCOHOLIC BEVERAGE ON HIS BREATH. I NOTICED THAT HIS EYES WERE RED AND WATERY AND THAT HIS SPEECH WAS SLIGHTLY SLOW. I GAVE HIM A SERIES OF F.S.T.'S WHICH HE FAILED TO PERFORM AS DEMONSTRATED. BASED UPON THE ABOVE OBSERVATIONS I FORMED THE OPINION THE DRIVER WAS UNDER THE INFLUENCE OF AN ALCOHOLIC BEVERAGE.

ARREST

I ARRESTED SUBJ. [redacted] FOR 23152(A) V.C. D.U.I. SUBJ. WAS ADVISED OF IMPLIED CONSENT. SUBJ CHOSE AND COMPLETED A BREATH TEST AT PARKER CENTER. (.14/.15) SUBJ. REFUSED FURTHER TESTING PER TRONETTA AND WAS ADVISED MIRANDA. SUBJ. WAS BOOKED AT PARKER CENTER FOR 23152(A) V.C. D.U.I.

PREPARED BY NAME	I.D. NUMBER	DATE	REVIEWED BY NAME	DATE
[redacted]	12111	8-14-88		

APPENDIX B

DATA COLLECTION FORM–
MOTORCYCLE DWI ARCHIVAL RECORDS

Data Collection Form - Motorcycle DWI Archival Records

Arrest Report Data

Form No.: _____

ARREST RECORD

Date of Collection ..... ☐☐☐☐☐☐

Agency ..... ☐

AZHP (0) Duval Co (3) Norfolk (6)
CHP (1) Hillsborough (4) Orange Co (7)
Dade Co (2) LAPD (5) New Mexico 8
Virginia Beach 9

Report No. ... ☐☐☐☐☐☐☐☐☐☐

SITUATION

Time (24 hr) ..... ☐☐☐☐

Date (mo/day/yr) ... ☐☐☐☐☐☐

Day of Week

Monday ..... ☐(0) Thursday ..... ☐(3)
Tuesday ..... ☐(1) Friday ..... ☐(4)
Wednesday ... ☐(2) Saturday ..... ☐(5)
Sunday ..... ☐(6)

Stopped in Lane:

1 ..... ☐ 3 ..... ☐
2 ..... ☐ 4 ..... ☐

Cycle Type: _____

Passenger?

No ..... ☐(0) Yes ..... ☐(1)

RIDER

Sex

Male ..... ☐(0) Female ..... ☐(1)

Age ..... ☐☐

Race

White ..... ☐(0) Hispanic ..... ☐(2)
Black ..... ☐(1) Oriental ..... ☐(3)
Polynesian.... ☐4
Amer. Indian... ☐5

Drugs/Medication

No ..... ☐(0) Yes ..... ☐(1)

Type: _____

BAC ..... ☐☐

How Determined:

Blood ... ☐(0) Breath ... ☐(1) Urine ... ☐(2)

DWI Behavioral Cues (*Check all the behaviors that apply*)

Aggressive/Reckless Behavior

☐ 1. Display of speed (e.g., wheelies and burnouts)
☐ 2. Rapid acceleration

Excessive speed (over speed limit)

- ☐ 3. 0-5
- ☐ 4. 6-10
- ☐ 5. 11-15
- ☐ 6. 16-20
- ☐ 7. 21-25
- ☐ 8. 26-30
- ☐ 9. 31 & over

☐ 10. Splitting traffic
☐ 11. Running light or stop sign
☐ 12. Revving engine at stop

Cue Number	Explanation
_____	_____
_____	_____
_____	_____
_____	_____

☐ 13. Passing on left across double line
☐ 14. Passing on the right
☐ 15. Snaking through traffic (passing on both sides)
☐ 16. Frequent lane changes
☐ 17. Turning violation (e.g., turning left in front of oncoming traffic; illegal U-turn; turning left from right lane)
☐ 18. Recklessness (e.g., speed to great for turn given conditions)
☐ 19. Seemingly unconcerned with detection
☐ 20. Evasion
☐ 21. Abnormal Coordination
☐ 22. Difficulty starting motorcycle
☐ 23. Weaving (frequent crossing of center "oil" line within lane or weaving over lane lines)
☐ 24. Weaving (across double yellow line (into opposing traffic lane)
☐ 25. Erratic movements of motorcycle while going straight (e.g., sudden corrections)
☐ 26. Unsteady at slow speed or during turn (e.g., wobbling of front wheel or handlebars)
☐ 27. Jerky or abrupt stops
☐ 28. Jerky starts from stop
☐ 29. Jerky lane changes
☐ 30. Early foot placement (too soon when coming to stop)
☐ 31. Late foot placement (too late when coming to stop)
☐ 32. Foot dragging
☐ 33. Substantial fluctuation in speed (i.e., difficulty maintaining constant speed)
☐ 34. Stopping beyond the stop limit lines
☐ 35. Stopping too short of the stop limit lines
☐ 36. Following too closely
☐ 37. Late braking on a curve (failure to brake prior to entering a curve, requiring braking during the curve)
☐ 38. Improper lean angle on a curve
☐ 39. Erratic movements of motorcycle while turning (e.g., sudden corrections)
☐ 40. Drifting during turn or curve (not necessarily out of the lane)
☐ 41. Leaning forward over tank to maintain balance at a stop
☐ 42. Knocking motorcycle over accidentally
☐ 43. Kicking motorcycle seat during dismount
☐ 44. Difficulty with kickstand (cannot find or trouble deploying)
☐ 45. Trouble w/ balance at stop (e.g., shifting weight repeatedly-from a distance, taillight seems to move side to side)
☐ 46. Trouble with balance during dismount

Cue Number	**Explanation**
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Attention/Vigilance Decrement

Insufficient speed (under speed limit)

- ☐ 47. 0-5
- ☐ 48. 6-10
- ☐ 49. 11-15
- ☐ 50. 16-20
- ☐ 51. 21-25
- ☐ 52. 26-30
- ☐ 53. 31 & under

☐ 54. Inattentive to surroundings (lack of monitoring behavior)
☐ 55. Failure to stop at light or sign before turning right
☐ 56. Failure to respond to green light
☐ 57. Failure to use turn signal
☐ 58. Failure to respond to officer's lights or hand signals
☐ 59. Improper gear shifts (e.g., missing shift)
☐ 60. Riding with kickstand deployed
☐ 61. Operating without lights at night
☐ 62. Leaving motorcycle in gear when turning off engine

Inappropriate/Unusual/Bizarre Behavior

☐ 63. Abrupt response when officer signals rider to stop
☐ 64. Operating motorcycle while holding an object in one hand (e.g., a case of beer)
☐ 65. Carrying open container of alcohol
☐ 66. Female passenger exposing herself or other socially inappropriate behavior
☐ 67. Riding three abreast within the lane (when only two abreast is legal)
☐ 68. Rider urinating at roadside
☐ 69. Stopping at a location where the kickstand cannot be safely or effectively deployed
☐ 70. Riding or parking on sidewalk or similarly illegal location.

Cue Number	**Explanation**
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Equipment Cues

- ☐ 71. Not wearing helmet
- ☐ 72. Wearing helmet while talking to officer
- ☐ 73. Helmet attached to motorcycle rather than being worn
- ☐ 74. Improper wearing of safety glasses (for states with appropriate laws)
- ☐ 75. Not wearing protective gear (other than helmet, e.g., gloves, shoes, and leathers)
- ☐ 76. Wearing silly headgear (e.g., cap on backwards)
- ☐ 77. Wearing inappropriate clothing for conditions (e.g., T-shirt in cold weather)
- ☐ 78. Vehicle defects (e.g., missing turn signals, no vehicle license, etc.)

Other Cues

- ☐ 79. Accident
- ☐ 80. Facial expression (i.e., appearing to be drunk)
- ☐ 81. Coasting downhill
- ☐ 82. Loud motorcycle exhaust
- ☐ 83. Uses motorcycle for support while waiting for officer to approach
- ☐ 84. Dropped item from motorcycle
- ☐ 85. Disorderly conduct
- ☐ 86. Failed to pay toll
- ☐ 87. Stolen motorcycle
- ☐ 88. Wrong way on one-way street
- ☐ 89. Blocking traffic
- ☐ 90. Excessive speed
- ☐ 91. Striking object (e.g., curb, auto, etc.) with motorcycle
- ☐ 92. Pushing motorcycle (either on or off road)
- ☐ 93. Unsafe lane change

Cue Number	Explanation
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

APPENDIX C

RESULTS OF MOTORCYCLE DWI CUE CO-OCCURRENCE ANALYSIS

RESULTS OF MOTORCYCLE DWI
CUE CO-OCCURRENCE ANALYSIS

Cue Name	Frequency	Percent of Total
Weaving within lane	**209**	
Erratic movements while going straight		15.8
Unsteady at slow speeds or during turn		12.4
Excessive speed		11.0
Trouble with balance at a stop		10.0
Failure to use turn signal		9.6
Rapid acceleration		8.8
Running light or stop sign		8.1
31 mph & over		7.2
16-20 mph over limit		6.7
Vehicle defects		6.7
Has trouble with balance during dismount		6.2
Drifting during turn or curve		6.2
Weaving across center line		5.7
Failing to turn left from left turn lane		5.7
Following too closely		5.3
21-25 mph over limit		5.3

31 mph & over	**108**	
Rapid acceleration		19.4
Running light or stop sign		17.6
Weaving within lane		13.9
Failure to use turn signal		12.0
Unsteady at slow speeds or during turn		7.4
Failing to turn left from left turn lane		7.4
Frequent lane changes		7.4
Snaking through traffic		7.4
Passing on left across double line		7.4
Has trouble with balance during dismount		5.6
Recklessness		5.6
21-25 mph over limit		5.6

Accident	**106**	
NONE		

Cue Name	Frequency	Percent of Total
Rapid acceleration	**95**	
31 mph & over		22.1
Weaving within lane		16.8
16-20 mph over limit		15.8
21-25 mph over limit		14.7
Excessive speed		9.5
Failure to use turn signal		9.5
Evasion		9.5
6-10 mph over limit		8.4
Weaving across center line		7.4
Running light or stop sign		7.4
11-15 mph over limit		7.4
Frequent lane changes		6.3
Unsteady at slow speeds or during turn		5.3
Vehicle defects		5.3

Running light or stop sign	**90**	
31 mph & over		21.1
Evasion		20.0
Weaving within lane		18.9
Unsteady at slow speeds or during turn		12.2
Failure to use turn signal		8.9
Failing to turn left from left turn lane		8.9
21-25 mph over limit		8.9
11-15 mph over limit		8.9
Excessive speed		7.8
Rapid acceleration		7.8
Erratic movements while going straight		6.7
Weaving across center line		6.7
Drifting during turn or curve		5.6
Recklessness		5.6

RESULTS OF MOTORCYCLE DWI
CUE CO-OCCURRENCE ANALYSIS (Continued)

Cue Name	Frequency	Percent of Total
Excessive speed	**78**	
Weaving within lane		29.5
Evasion		11.5
Rapid acceleration		11.5
Running light or stop sign		9.0
Vehicle defects		7.7
Failure to use turn signal		7.7
Unsteady at slow speeds or during turn		6.4
Weaving across center line		6.4
Recklessness		6.4
Passing on left across double line		6.4
31 mph & over		5.1
21-25 mph over limit	**76**	
Rapid acceleration		18.4
Failure to use turn signal		15.8
Weaving within lane		14.5
Frequent lane changes		10.5
Running light or stop sign		10.5
Evasion		7.9
31 mph & over		7.9
Inattentive to surroundings		5.3
Recklessness		5.3
Failing to turn left from left turn lane		5.3
Snaking through traffic		5.3
11-15 mph over limit	**75**	
Weaving within lane		12.0
Failure to use turn signal		10.7
Running light or stop sign		10.7
Rapid acceleration		9.3
Registration/license		9.3
Vehicle defects		9.3
Trouble with balance at a stop		5.3
Failing to turn left from left turn lane		5.3
Frequent lane changes		5.3

Cue Name	Frequency	Percent of Total
Trouble with balance at a stop	**66**	
Weaving within lane		31.8
Erratic movements while going straight		15.2
Weaving across center line		10.6
Has trouble with balance during dismount		7.6
Drifting during turn or curve		7.6
Failing to turn left from left turn lane		7.6
31 mph & over		7.6
11-15 mph over limit		6.1
Rapid acceleration		6.1
16-20 mph over limit	**65**	
Rapid acceleration		23.1
Weaving within lane		21.5
Failure to use turn signal		9.2
Following too closely		6.2
Vehicle defects		6.2
Unsteady at slow speeds or during turn	**65**	
Weaving within lane		40.0
Running light or stop sign		16.9
Trouble with balance at a stop		15.4
Weaving across center line		12.3
31 mph & over		12.3
Failure to use turn signal		10.8
Erratic movements while going straight		9.2
Excessive speed		7.7
Evasion		7.7
Rapid acceleration		7.7
Vehicle defects		7.7
Riding/parking on sidewalk or other illegal place		6.2
Drifting during turn or curve		6.2
Recklessness		6.2
Failing to turn left from left turn lane		6.2
Registration/license		6.2

RESULTS OF MOTORCYCLE DWI
CUE CO-OCCURRENCE ANALYSIS (Continued)

Cue Name	Frequency	Percent of Total
Evasion	**62**	
31 mph & over		43.5
Running light or stop sign		29.3
Excessive speed		14.5
Rapid acceleration		14.5
Failure to use turn signal		12.9
Weaving within lane		12.9
Recklessness		11.3
Passing on left across double line		9.7
21-25 mph over limit		9.7
Unsteady at slow speeds or during turn		8.1
Accident		6.5
Vehicle defects		6.5
Riding/parking on sidewalk or other illegal place		6.5
Failing to turn left from left turn lane		6.5
Snaking through traffic		6.5

Failure to use turn signal	**60**	
Weaving within lane		33.3
31 mph & over		21.7
21-25 mph over limit		20.0
Erratic movements while going straight		15.0
Rapid acceleration		15.0
Evasion		13.3
Running light or stop sign		13.3
11-15 mph over limit		13.3
Unsteady at slow speeds or during turn		11.7
Excessive speed		10.0
Vehicle defects		10.0
Weaving across center line		10.0
Recklessness		10.0
16-20 mph over limit		10.0
Passing on left across double line		8.3
Inattentive to surroundings		6.7
Riding/parking on sidewalk or other illegal place		5.0
Has trouble with balance during dismount		5.0
Drifting during turn or curve		5.0
Failing to turn left from left turn lane		5.0
Frequent lane changes		5.0

RESULTS OF MOTORCYCLE DWI
CUE CO-OCCURRENCE ANALYSIS (Continued)

Cue Name	Frequency	Percent of Total
Erratic movements while going straight	**51**	
Weaving within lane		64.7
Failure to use turn signal		17.7
Trouble with balance at a stop		13.7
Unsteady at slow speeds or during turn		11.8
Running light or stop sign		11.8
Has trouble with balance during dismount		9.8
Following too closely		7.8
Weaving across center line		7.8
31 mph & over		7.8
Rapid acceleration		7.8

Failing to turn left from left turn lane	**50**	
Weaving within lane		24.0
Running light or stop sign		16.0
31 mph & over		16.0
Riding/parking on sidewalk or other illegal place		10.0
Unsteady at slow speeds or during turn		8.0
Evasion		8.0
21-25 mph over limit		8.0
11-15 mph over limit		8.0
Rapid acceleration		8.0
Failure to use turn signal		6.0
Has trouble with balance during dismount		6.0
Trouble with balance at a stop		6.0
Recklessness		6.0
16-20 mph over limit		6.0

Recklessness	**50**	
Evasion		14.0
Failure to use turn signal		12.0
31 mph & over		12.0
Excessive speed		10.0
Trouble with balance at a stop		10.0
Running light or stop sign		10.0
Accident		8.0
Unsteady at slow speeds or during turn		8.0
Weaving within lane		8.0
21-25 mph over limit		8.0
Failing to turn left from left turn lane		6.0
Rapid acceleration		6.0

RESULTS OF MOTORCYCLE DWI
CUE CO-OCCURRENCE ANALYSIS (Continued)

Cue Name	Frequency	Percent of Total
Vehicle defects	**47**	
Weaving within lane		29.8
11-15 mph over limit		14.9
Failure to use turn signal		12.8
Unsteady at slow speeds or during turn		10.6
Rapid acceleration		10.6
Evasion		8.5
16-20 mph over limit		8.5
Running light or stop sign		8.5
Excessive speed		6.4
6-10 mph over speed limit		6.4
31+ mph over speed limit		6.3
Weaving across center line	**44**	
Weaving within lane		27.3
Unsteady at slow speeds or during turn		18.2
Rapid acceleration		15.9
Failure to use turn signal		13.6
Drifting during turn or curve		13.6
Running light or stop sign		13.6
Excessive speed		11.4
31 mph & over		11.4
Erratic movements while going straight		9.1
Evasion		6.8
Registration/License	**44**	
Weaving within lane		18.2
11-15 mph over limit		15.9
Vehicle defect		13.6
Trouble with balance at stop		6.8
Unsteady at slow speed or during turn		9.1
Riding/parking on sidewalk/other Illegal place	**42**	
Weaving within lane		23.8
31 mph & over		19.9
Failing to turn left from left turn lane		11.9
Unsteady at slow speeds or during turn		9.5
Evasion		9.5
Running light or stop sign		9.5
Excessive speed		7.1
Failure to use turn signal		7.1
Trouble with balance at a stop		7.1

RESULTS OF MOTORCYCLE DWI
CUE CO-OCCURRENCE ANALYSIS (Continued)

Cue Name	Frequency	Percent of Total
Has trouble with balance during dismount	**34**	
Weaving within lane		38.2
31 mph & over		17.6
Trouble with balance at a stop		14.7
Erratic movements while going straight		14.7
Failure to use turn signal		8.8
Failing to turn left from left turn lane		8.8
21-25 mph over limit		8.8
16-20 mph over limit		8.8
Riding/parking on sidewalk or other illegal place		5.9
Inattentive to surroundings		5.9
Drifting during turn or curve		5.9
Following too closely		5.9
Unsteady at slow speeds or during turn		5.9
Weaving across center line		5.9
Evasion		5.9
Running light or stop sign		5.9
11-15 mph over limit		5.9

Frequent lane changes	**31**	
31 mph & over		25.8
21-25 mph over limit		25.8
Rapid acceleration		19.4
Snaking through traffic		16.1
11-15 mph over limit		12.9
Failure to use turn signal		9.7
Inattentive to surroundings		9.7
Weaving within lane		9.7
26-30 mph over limit		9.7
Excessive speed		6.5
Following too closely		6.5
Evasion		6.5
16-20 mph over limit		6.5

26-30 mph over limit	**31**	
Rapid acceleration		12.9
Weaving within lane		9.7
Frequent lane changes		9.7
Riding/parking on sidewalk or other illegal place		6.5
Failure to use turn signal		6.5
Trouble with balance at a stop		6.5
31 mph & over		6.5

RESULTS OF MOTORCYCLE DWI
CUE CO-OCCURRENCE ANALYSIS (Continued)

Cue Name	Frequency	Percent of Total
6-10 mph over limit	**28**	
Weaving within lane		32.1
Rapid acceleration		28.6
Vehicle defects		10.7
Failure to use turn signal		7.1
Inattentive to surroundings		7.1
Trouble with balance at a stop		7.1
Unsteady at slow speeds or during turn		7.1
Recklessness		7.1
Running light or stop sign		7.1
Following too closely	**27**	
Weaving within lane		40.7
Erratic movements while going straight		14.8
16-20 mph over limit		14.8
21-25 mph over limit		11.1
11-15 mph over limit		11.1
Failure to use turn signal		7.4
Has trouble with balance during dismount		7.4
Trouble with balance at a stop		7.4
Drifting during turn or curve		7.4
Frequent lane changes		7.4
Running light or stop sign		7.4
Vehicle defects		7.4
Drifting during turn or curve	**27**	
Weaving within lane		48.1
Weaving across center line		22.2
Trouble with balance at a stop		18.5
Running light or stop sign		18.5
Accident		14.8
Unsteady at slow speeds or during turn		14.8
Failure to use turn signal		11.1
31 mph & over		11.1
Vehicle defects		7.4
Has trouble with balance during dismount		7.4
Following too closely		7.4
Erratic movements while going straight		7.4
Evasion		7.4
21-25 mph over limit		7.4
11-15 mph over limit		7.4
Rapid acceleration		7.4

RESULTS OF MOTORCYCLE DWI
CUE CO-OCCURRENCE ANALYSIS (Continued)

Cue Name	Frequency	Percent of Total
Inattentive to surroundings	**26**	
Weaving within lane		19.2
31 mph & over		19.2
Failure to use turn signal		15.4
21-25 mph over limit		15.4
Frequent lane changes		11.5
16-20 mph over limit		11.5
11-15 mph over limit		11.5
Excessive speed		7.7
Has trouble with balance during dismount		7.7
Trouble with balance at a stop		7.7
Unsteady at slow speeds or during turn		7.7
Erratic movements while going straight		7.7
Failing to turn left from left turn lane		7.7
6-10 mph over limit		7.7
Registration/license		7.7
Loud motorcycle exhaust	**25**	
Weaving within lane		16.0
Rapid acceleration		16.0
11-15 mph over limit		12.0
Vehicle defects		8.0
Evasion		8.0
Failing to turn left from left turn lane		8.0
Snaking through traffic		8.0
31 mph & over		8.0
21-25 mph over limit		8.0
Passing on left across double line	**23**	
31 mph & over		34.8
Evasion		26.1
Excessive speed		21.7
Failure to use turn signal		21.7
Running light or stop sign		17.4
Rapid acceleration		17.4
Accident		13.0
Weaving within lane		13.0
Riding/parking on sidewalk or other illegal place		8.7
Unsteady at slow speeds or during turn		8.7
Recklessness		8.7
Failing to turn left from left turn lane		8.7
16-20 mph over limit		8.7

RESULTS OF MOTORCYCLE DWI
CUE CO-OCCURRENCE ANALYSIS (Continued)

Cue Name	Frequency	Percent of Total
Snaking through traffic	**20**	
31 mph & over		40.0
Frequent lane changes		25.0
Evasion		20.0
21-25 mph over limit		20.0
Weaving within lane		15.0
Loud motorcycle exhaust		10.0
Recklessness		10.0
Running light or stop sign		10.0
11-15 mph over limit		10.0
Excessive speed		5.0
Failure to use turn signal		5.0
Has trouble with balance during dismount		5.0
Trouble with balance at a stop		5.0
Drifting during turn or curve		5.0
Following too closely		5.0
Passing on left across double line		5.0
26-30 mph over limit		5.0
16-20 mph over limit		5.0
Rapid acceleration		5.0

APPENDIX D

CUES BY BAC LEVEL FROM ARREST REPORTS

	Display of speed n=15			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.77	1	6.67
0.05 up to 0.09	67	7.14	1	6.67
0.10 up to 0.14	220	23.45	4	26.67
0.15 up to 0.19	189	20.15	7	46.67
0.20 up to 0.24	88	9.38	.	.
0.25 up to 0.29	34	3.62	1	6.67
0.30 or greater	6	0.64	.	.
Refused Test.	95	10.13	1	6.67
Data Not Available	213	22.17	.	.

	Rapid acceleration n=95			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	25	2.91	2	2.11
0.05 up to 0.09	60	6.99	8	8.42
0.10 up to 0.14	195	22.73	29	30.53
0.15 up to 0.19	185	21.56	11	11.58
0.20 up to 0.24	80	9.32	8	8.42
0.25 up to 0.29	34	3.96	1	1.05
0.30 or greater	6	0.70	.	.
Refused Test.	91	10.61	5	5.26
Data Not Available	182	21.21	31	32.63

	0-5 mph over limit n=4			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.85	.	.
0.05 up to 0.09	68	7.17	.	.
0.10 up to 0.14	223	23.50	1	25.00
0.15 up to 0.19	196	20.65	.	.
0.20 up to 0.24	87	9.17	1	25.00
0.25 up to 0.29	35	3.69	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	95	10.01	1	25.00
Data Not Available	212	22.34	1	25.00

	6-10 mph over limit n=28			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.92	.	.
0.05 up to 0.09	63	6.81	5	17.86
0.10 up to 0.14	220	23.78	4	14.29
0.15 up to 0.19	193	20.86	3	10.71
0.20 up to 0.24	83	8.97	5	17.86
0.25 up to 0.29	35	3.78	.	.
0.30 or greater	6	0.65	.	.
Refused Test.	91	9.84	5	17.86
Data Not Available	207	22.38	6	21.43

	11-15 mph over limit n=75			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	3.08	.	.
0.05 up to 0.09	62	7.06	6	8.00
0.10 up to 0.14	204	23.23	20	26.67
0.15 up to 0.19	173	19.70	23	30.67
0.20 up to 0.24	85	9.68	3	4.00
0.25 up to 0.29	32	3.64	3	4.00
0.30 or greater	5	0.57	1	1.33
Refused Test.	90	10.25	6	8.00
Data Not Available	200	22.78	13	17.33

	16-20 mph over limit n=65			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	3.04	.	.
0.05 up to 0.09	64	7.21	4	6.15
0.10 up to 0.14	201	22.64	23	35.38
0.15 up to 0.19	185	20.83	11	16.92
0.20 up to 0.24	83	9.35	5	7.69
0.25 up to 0.29	33	3.72	2	3.08
0.30 or greater	6	0.68	.	.
Refused Test.	93	10.47	3	4.62
Data Not Available	196	22.07	17	26.15

	21-25 mph over limit n=76			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	25	2.85	2	2.63
0.05 up to 0.09	62	7.07	6	7.89
0.10 up to 0.14	207	23.60	17	22.37
0.15 up to 0.19	179	20.41	17	22.37
0.20 up to 0.24	84	9.58	4	5.26
0.25 up to 0.29	32	3.65	3	3.95
0.30 or greater	6	0.68	.	.
Refused Test.	91	10.38	5	6.58
Data Not Available	191	21.78	22	28.95

	26-30 mph over limit n=31			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.82	1	3.23
0.05 up to 0.09	67	7.27	1	3.23
0.10 up to 0.14	216	23.43	8	25.81
0.15 up to 0.19	189	20.50	7	22.58
0.20 up to 0.24	87	9.44	1	3.23
0.25 up to 0.29	34	3.69	1	3.23
0.30 or greater	6	0.65	.	.
Refused Test.	94	10.20	2	6.45
Data Not Available	203	22.02	10	32.26

	31 mph & over limit n=108			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	3.08	1	0.93
0.05 up to 0.09	57	6.75	11	10.19
0.10 up to 0.14	192	22.72	32	29.63
0.15 up to 0.19	179	21.18	17	15.74
0.20 up to 0.24	82	9.70	6	5.56
0.25 up to 0.29	32	3.79	3	2.78
0.30 or greater	6	0.71	.	.
Refused Test.	87	10.30	9	8.33
Data Not Available	184	21.78	29	26.85

	Splitting traffic n=12			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.87	.	.
0.05 up to 0.09	65	6.91	3	25.00
0.10 up to 0.14	221	23.49	3	25.00
0.15 up to 0.19	195	20.72	1	8.33
0.20 up to 0.24	87	9.25	1	8.33
0.25 up to 0.29	35	3.72	.	.
0.30 or greater	6	0.64	.	.
Refused Test.	95	10.10	1	8.33
Data Not Available	210	22.32	3	25.00

	Running light or stop sign n=90			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	3.01	1	1.11
0.05 up to 0.09	65	7.53	3	3.33
0.10 up to 0.14	198	22.94	26	28.89
0.15 up to 0.19	183	21.21	13	14.44
0.20 up to 0.24	77	8.92	11	12.22
0.25 up to 0.29	33	3.82	2	2.22
0.30 or greater	6	0.70	.	.
Refused Test.	83	9.62	13	14.44
Data Not Available	192	22.25	21	23.33

	Revving engine at stop n=6			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.75	1	16.67
0.05 up to 0.09	68	7.18	.	.
0.10 up to 0.14	223	23.55	1	16.67
0.15 up to 0.19	196	20.70	.	.
0.20 up to 0.24	87	9.19	1	16.67
0.25 up to 0.29	34	3.59	1	16.67
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.14	.	.
Data Not Available	211	22.28	2	33.33

	Passing on left across double line n=23			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.90	.	.
0.05 up to 0.09	67	7.20	1	4.35
0.10 up to 0.14	219	23.55	5	21.74
0.15 up to 0.19	196	21.08	.	.
0.20 up to 0.24	86	9.25	2	8.70
0.25 up to 0.29	34	3.66	1	4.35
0.30 or greater	6	0.65	.	.
Refused Test.	90	9.68	6	26.09
Data Not Available	205	22.04	8	34.78

	Passing on the right n=17			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.88	.	.
0.05 up to 0.09	66	7.05	2	11.76
0.10 up to 0.14	221	23.61	3	17.65
0.15 up to 0.19	196	20.94	.	.
0.20 up to 0.24	86	9.19	2	11.76
0.25 up to 0.29	34	3.63	1	5.88
0.30 or greater	6	0.64	.	.
Refused Test.	94	10.04	2	11.76
Data Not Available	206	22.01	7	41.18

	Snaking through traffic n=20			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.89	.	.
0.05 up to 0.09	67	7.18	1	5.00
0.10 up to 0.14	220	23.58	4	20.00
0.15 up to 0.19	193	20.69	3	15.00
0.20 up to 0.24	87	9.32	1	5.00
0.25 up to 0.29	35	3.75	.	.
0.30 or greater	6	0.64	.	.
Refused Test.	93	9.97	3	15.00
Data Not Available	205	21.97	8	40.00

	Frequent lane changes n=31			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.93	.	.
0.05 up to 0.09	66	7.16	2	6.45
0.10 up to 0.14	215	23.32	9	29.03
0.15 up to 0.19	189	20.50	7	22.58
0.20 up to 0.24	86	9.33	2	6.45
0.25 up to 0.29	33	3.58	2	6.45
0.30 or greater	6	0.65	.	.
Refused Test.	95	10.30	1	3.23
Data Not Available	205	22.23	8	25.81

	Turning Violation n=50			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	25	2.77	2	4.00
0.05 up to 0.09	61	6.76	7	14.00
0.10 up to 0.14	209	23.15	15	30.00
0.15 up to 0.19	185	20.49	11	22.00
0.20 up to 0.24	85	9.41	3	6.00
0.25 up to 0.29	34	3.77	1	2.00
0.30 or greater	6	0.66	.	.
Refused Test.	93	10.30	3	6.00
Data Not Available	205	22.70	8	16.00

	Recklessness n=51			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.88	1	1.96
0.05 up to 0.09	65	7.21	3	5.88
0.10 up to 0.14	212	23.50	12	23.53
0.15 up to 0.19	181	20.07	15	29.41
0.20 up to 0.24	84	9.31	4	7.84
0.25 up to 0.29	33	3.66	2	3.92
0.30 or greater	6	0.67	.	.
Refused Test.	88	9.76	8	15.69
Data Not Available	207	22.95	6	11.76

	Seemingly unconcerned with detection n=8			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.86	.	.
0.05 up to 0.09	67	7.09	1	12.50
0.10 up to 0.14	221	23.39	3	37.50
0.15 up to 0.19	194	20.53	2	25.00
0.20 up to 0.24	88	9.31	.	.
0.25 up to 0.29	35	3.70	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.16	.	.
Data Not Available	211	22.33	2	25.00

	Evasion n=62			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.92	1	1.61
0.05 up to 0.09	66	7.41	2	3.23
0.10 up to 0.14	208	23.34	16	25.81
0.15 up to 0.19	181	20.31	15	24.19
0.20 up to 0.24	84	9.43	4	6.45
0.25 up to 0.29	34	3.82	1	1.61
0.30 or greater	6	0.67	.	.
Refused Test.	84	9.43	12	19.35
Data Not Available	202	22.67	11	17.74

	Abnormal Coordination n=6			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.85	.	.
0.05 up to 0.09	68	7.18	.	.
0.10 up to 0.14	223	23.55	1	16.67
0.15 up to 0.19	192	20.27	4	66.67
0.20 up to 0.24	88	9.29	.	.
0.25 up to 0.29	35	3.70	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	95	10.03	1	16.67
Data Not Available	213	22.49	.	.

	Difficulty starting motorcycle n=7			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.85	.	.
0.05 up to 0.09	68	7.19	.	.
0.10 up to 0.14	223	23.57	1	14.29
0.15 up to 0.19	194	20.51	2	28.57
0.20 up to 0.24	87	9.20	1	14.29
0.25 up to 0.29	34	3.59	1	14.29
0.30 or greater	6	0.63	.	.
Refused Test.	94	9.94	2	28.57
Data Not Available	213	22.52	.	.

	Weaving within lane n=208			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	18	2.42	9	4.33
0.05 up to 0.09	54	7.25	14	6.73
0.10 up to 0.14	187	25.10	37	17.79
0.15 up to 0.19	161	21.61	35	16.83
0.20 up to 0.24	64	8.59	24	11.54
0.25 up to 0.29	27	3.62	8	3.85
0.30 or greater	3	0.40	3	1.44
Refused Test.	73	9.80	23	11.06
Data Not Available	158	21.21	55	26.44

	Weaving across center line n=44			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	25	2.75	2	4.55
0.05 up to 0.09	66	7.26	2	4.55
0.10 up to 0.14	216	23.76	8	18.18
0.15 up to 0.19	190	20.90	6	13.64
0.20 up to 0.24	82	9.02	6	13.64
0.25 up to 0.29	31	3.41	4	9.09
0.30 or greater	6	0.66	.	.
Refused Test.	93	10.23	3	6.82
Data Not Available	200	22.00	13	29.55

	Erratic movements while going straight n=50			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.88	1	2.00
0.05 up to 0.09	65	7.20	3	6.00
0.10 up to 0.14	216	23.92	8	16.00
0.15 up to 0.19	186	20.60	10	20.00
0.20 up to 0.24	76	8.42	12	24.00
0.25 up to 0.29	35	3.88	.	.
0.30 or greater	5	0.55	1	2.00
Refused Test.	88	9.75	8	16.00
Data Not Available	206	22.81	7	14.00

	Unsteady at Slow Speeds or During Turn n=65			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	25	2.82	2	3.08
0.05 up to 0.09	65	7.32	3	4.62
0.10 up to 0.14	212	23.87	12	18.46
0.15 up to 0.19	186	20.95	10	15.38
0.20 up to 0.24	75	8.45	13	20.00
0.25 up to 0.29	32	3.60	3	4.62
0.30 or greater	4	0.45	2	3.08
Refused Test.	89	10.02	7	10.77
Data Not Available	200	22.52	13	20.00

	Jerky or abrupt stops n=17			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.88	.	.
0.05 up to 0.09	66	7.05	2	11.76
0.10 up to 0.14	220	23.50	4	23.53
0.15 up to 0.19	192	20.51	4	23.53
0.20 up to 0.24	88	9.40	.	.
0.25 up to 0.29	35	3.74	.	.
0.30 or greater	6	0.64	.	.
Refused Test.	93	9.94	3	17.65
Data Not Available	209	22.33	4	23.53

	Jerky starts from stop n=11			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.87	.	.
0.05 up to 0.09	67	7.11	1	9.09
0.10 up to 0.14	222	23.57	2	18.18
0.15 up to 0.19	193	20.49	3	27.27
0.20 up to 0.24	87	9.24	1	9.09
0.25 up to 0.29	33	3.50	2	18.18
0.30 or greater	6	0.64	.	.
Refused Test.	95	10.08	1	9.09
Data Not Available	212	22.51	1	9.09

	Jerky lane changes n=13			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.87	.	.
0.05 up to 0.09	68	7.23	.	.
0.10 up to 0.14	219	23.30	5	38.46
0.15 up to 0.19	196	20.85	.	.
0.20 up to 0.24	85	9.04	3	23.08
0.25 up to 0.29	35	3.72	.	.
0.30 or greater	5	0.53	1	7.69
Refused Test.	94	10.00	2	15.38
Data Not Available	211	22.45	2	15.38

	Early foot placement n=1			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.14	.	.
0.10 up to 0.14	224	23.53	.	.
0.15 up to 0.19	196	20.59	.	.
0.20 up to 0.24	88	9.24	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	95	9.98	1	100.00
Data Not Available	213	22.37	.	.

	Late foot placement n=1			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.14	.	.
0.10 up to 0.14	223	23.42	1	100.00
0.15 up to 0.19	196	20.59	.	.
0.20 up to 0.24	88	9.24	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.08	.	.
Data Not Available	213	22.37	.	.

	Foot dragging n=7			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.75	1	14.29
0.05 up to 0.09	66	6.98	2	28.57
0.10 up to 0.14	224	23.68	.	.
0.15 up to 0.19	196	20.72	.	.
0.20 up to 0.24	87	9.20	1	14.29
0.25 up to 0.29	34	3.59	1	14.29
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.15	.	.
Data Not Available	211	22.30	2	28.57

	Substantial fluctuation in speed n=9			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.75	1	11.11
0.05 up to 0.09	68	7.20	.	.
0.10 up to 0.14	222	23.52	2	22.22
0.15 up to 0.19	196	20.76	.	.
0.20 up to 0.24	87	9.22	1	11.11
0.25 up to 0.29	35	3.71	.	.
0.30 or greater	6	0.64	.	.
Refused Test.	96	10.17	.	.
Data Not Available	208	22.03	5	55.56

	Stopping beyond the stop limit lines n=12			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.76	1	8.33
0.05 up to 0.09	67	7.12	1	8.33
0.10 up to 0.14	223	23.70	1	8.33
0.15 up to 0.19	193	20.51	3	25.00
0.20 up to 0.24	85	9.03	3	25.00
0.25 up to 0.29	33	3.51	2	16.67
0.30 or greater	6	0.64	.	.
Refused Test.	96	10.20	.	.
Data Not Available	212	22.53	1	8.33

	Stopping too short of stop limit lines n=1			
	no		yes	
	N	PCTN	N	PCTN
BAC Level 0.05				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.14	.	.
0.10 up to 0.14	224	23.53	.	.
0.15 up to 0.19	196	20.59	.	.
0.20 up to 0.24	88	9.24	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.08	.	.
Data Not Available	212	22.27	1	100.00

	Following too closely n=27			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.92	.	.
0.05 up to 0.09	66	7.13	2	7.41
0.10 up to 0.14	221	23.87	3	11.11
0.15 up to 0.19	189	20.41	7	25.93
0.20 up to 0.24	86	9.29	2	7.41
0.25 up to 0.29	34	3.67	1	3.70
0.30 or greater	6	0.65	.	.
Refused Test.	94	10.15	2	7.41
Data Not Available	203	21.92	10	37.04

	Late braking on a curve	
	no	
	N	PCTN
BAC Level		
Less than 0.05	27	2.83
0.05 up to 0.09	68	7.14
0.10 up to 0.14	224	23.50
0.15 up to 0.19	196	20.57
0.20 up to 0.24	88	9.23
0.25 up to 0.29	35	3.67
0.30 or greater	6	0.63
Refused Test.	96	10.07
Data Not Available	213	22.35

	Improper lean angle on a curve n=4			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.85	.	.
0.05 up to 0.09	68	7.17	.	.
0.10 up to 0.14	223	23.50	1	25.00
0.15 up to 0.19	195	20.55	1	25.00
0.20 up to 0.24	87	9.17	1	25.00
0.25 up to 0.29	35	3.69	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.12	.	.
Data Not Available	212	22.34	1	25.00

	Erratic motorcycle movements while tuleanngrning n=16			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.88	.	.
0.05 up to 0.09	68	7.26	.	.
0.10 up to 0.14	224	23.91	.	.
0.15 up to 0.19	192	20.49	4	25.00
0.20 up to 0.24	87	9.28	1	6.25
0.25 up to 0.29	35	3.74	.	.
0.30 or greater	6	0.64	.	.
Refused Test.	93	9.93	3	18.75
Data Not Available	205	21.88	8	50.00

	Drifting during turn or curve n=27			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.92	.	.
0.05 up to 0.09	68	7.34	.	.
0.10 up to 0.14	219	23.65	5	18.52
0.15 up to 0.19	191	20.63	5	18.52
0.20 up to 0.24	85	9.18	3	11.11
0.25 up to 0.29	34	3.67	1	3.70
0.30 or greater	6	0.65	.	.
Refused Test.	92	9.94	4	14.81
Data Not Available	204	22.03	9	33.33

	Leaning forward over tank maintain balance at stop	
	no	
	N	PCTN
BAC Level		
Less than 0.05	27	2.83
0.05 up to 0.09	68	7.14
0.10 up to 0.14	224	23.50
0.15 up to 0.19	196	20.57
0.20 up to 0.24	88	9.23
0.25 up to 0.29	35	3.67
0.30 or greater	6	0.63
Refused Test.	96	10.07
Data Not Available	213	22.35

	Knocking motorcycle over accidentally n=11			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.87	.	.
0.05 up to 0.09	67	7.11	1	9.09
0.10 up to 0.14	223	23.67	1	9.09
0.15 up to 0.19	194	20.59	2	18.18
0.20 up to 0.24	87	9.24	1	9.09
0.25 up to 0.29	34	3.61	1	9.09
0.30 or greater	6	0.64	.	.
Refused Test.	94	9.98	2	18.18
Data Not Available	210	22.29	3	27.27

	Kicking motorcycle seat during dismount n=3			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.16	.	.
0.10 up to 0.14	223	23.47	1	33.33
0.15 up to 0.19	195	20.53	1	33.33
0.20 up to 0.24	88	9.26	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	95	10.00	1	33.33
Data Not Available	213	22.42	.	.

	Difficulty with kickstand n=11			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.87	.	.
0.05 up to 0.09	68	7.22	.	.
0.10 up to 0.14	222	23.57	2	18.18
0.15 up to 0.19	194	20.59	2	18.18
0.20 up to 0.24	88	9.34	.	.
0.25 up to 0.29	34	3.61	1	9.09
0.30 or greater	6	0.64	.	.
Refused Test.	93	9.87	3	27.27
Data Not Available	210	22.29	3	27.27

	Trouble with Balance at Stop n=66			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	25	2.82	2	3.03
0.05 up to 0.09	66	7.44	2	3.03
0.10 up to 0.14	212	23.90	12	18.18
0.15 up to 0.19	177	19.95	19	28.79
0.20 up to 0.24	80	9.02	8	12.12
0.25 up to 0.29	31	3.49	4	6.06
0.30 or greater	5	0.56	1	1.52
Refused Test.	90	10.15	6	9.09
Data Not Available	201	22.66	12	18.18

	Has trouble with balance during dismount n=34			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.83	1	2.94
0.05 up to 0.09	67	7.29	1	2.94
0.10 up to 0.14	218	23.72	6	17.65
0.15 up to 0.19	190	20.67	6	17.65
0.20 up to 0.24	82	8.92	6	17.65
0.25 up to 0.29	32	3.48	3	8.82
0.30 or greater	6	0.65	.	.
Refused Test.	94	10.23	2	5.88
Data Not Available	204	22.20	9	26.47

	0-5 mph under limit n=2			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.15	.	.
0.10 up to 0.14	224	23.55	.	.
0.15 up to 0.19	196	20.61	.	.
0.20 up to 0.24	88	9.25	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	95	9.99	1	50.00
Data Not Available	212	22.29	1	50.00

	6-10 mph under limit n=5			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.85	.	.
0.05 up to 0.09	68	7.17	.	.
0.10 up to 0.14	223	23.52	1	20.00
0.15 up to 0.19	195	20.57	1	20.00
0.20 up to 0.24	87	9.18	1	20.00
0.25 up to 0.29	35	3.69	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.13	.	.
Data Not Available	211	22.26	2	40.00

	11-15 mph under limit n=9			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.75	1	11.11
0.05 up to 0.09	68	7.20	.	.
0.10 up to 0.14	223	23.62	1	11.11
0.15 up to 0.19	193	20.44	3	33.33
0.20 up to 0.24	86	9.11	2	22.22
0.25 up to 0.29	35	3.71	.	.
0.30 or greater	6	0.64	.	.
Refused Test.	95	10.06	1	11.11
Data Not Available	212	22.46	1	11.11

	16-20 mph under limit n=6			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.85	.	.
0.05 up to 0.09	68	7.18	.	.
0.10 up to 0.14	224	23.65	.	.
0.15 up to 0.19	195	20.59	1	16.67
0.20 up to 0.24	87	9.19	1	16.67
0.25 up to 0.29	35	3.70	.	.
0.30 or greater	5	0.53	1	16.67
Refused Test.	96	10.14	.	.
Data Not Available	210	22.18	3	50.00

	21-25 mph under limit	
	no	
	N	PCTN
BAC Level		
Less than 0.05	27	2.83
0.05 up to 0.09	68	7.14
0.10 up to 0.14	224	23.50
0.15 up to 0.19	196	20.57
0.20 up to 0.24	88	9.23
0.25 up to 0.29	35	3.67
0.30 or greater	6	0.63
Refused Test.	96	10.07
Data Not Available	213	22.35

	26-30 mph under limit	
	no	
	N	PCTN
BAC Level		
Less than 0.05	27	2.83
0.05 up to 0.09	68	7.14
0.10 up to 0.14	224	23.50
0.15 up to 0.19	196	20.57
0.20 up to 0.24	88	9.23
0.25 up to 0.29	35	3.67
0.30 or greater	6	0.63
Refused Test.	96	10.07
Data Not Available	213	22.35

	31 mph under limit n=2			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.15	.	.
0.10 up to 0.14	224	23.55	.	.
0.15 up to 0.19	196	20.61	.	.
0.20 up to 0.24	87	9.15	1	50.00
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	5	0.53	1	50.00
Refused Test.	96	10.09	.	.
Data Not Available	213	22.40	.	.

	Inattentive to surroundings n=26			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.91	.	.
0.05 up to 0.09	67	7.23	1	3.85
0.10 up to 0.14	217	23.41	7	26.92
0.15 up to 0.19	194	20.93	2	7.69
0.20 up to 0.24	83	8.95	5	19.23
0.25 up to 0.29	34	3.67	1	3.85
0.30 or greater	5	0.54	1	3.85
Refused Test.	95	10.25	1	3.85
Data Not Available	205	22.11	8	30.77

	Failre to stp at lght/sgn bfr trnng rght n=13			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.87	.	.
0.05 up to 0.09	67	7.13	1	7.69
0.10 up to 0.14	219	23.30	5	38.46
0.15 up to 0.19	194	20.64	2	15.38
0.20 up to 0.24	88	9.36	.	.
0.25 up to 0.29	35	3.72	.	.
0.30 or greater	5	0.53	1	7.69
Refused Test.	96	10.21	.	.
Data Not Available	209	22.23	4	30.77

	Failure to respond to green light n=9			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.86	.	.
0.05 up to 0.09	67	7.10	1	11.11
0.10 up to 0.14	221	23.41	3	33.33
0.15 up to 0.19	195	20.66	1	11.11
0.20 up to 0.24	86	9.11	2	22.22
0.25 up to 0.29	35	3.71	.	.
0.30 or greater	6	0.64	.	.
Refused Test.	96	10.17	.	.
Data Not Available	211	22.35	2	22.22

	Failure to use turn signal n=14			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.88	.	.
0.05 up to 0.09	67	7.14	1	7.14
0.10 up to 0.14	218	23.22	6	42.86
0.15 up to 0.19	193	20.55	3	21.43
0.20 up to 0.24	88	9.37	.	.
0.25 up to 0.29	34	3.62	1	7.14
0.30 or greater	5	0.53	1	7.14
Refused Test.	94	10.01	2	14.29
Data Not Available	213	22.68	.	.

	Failre to rspnd to cops lghts/hnd sgnls n=60			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	25	2.80	2	3.33
0.05 up to 0.09	64	7.17	4	6.67
0.10 up to 0.14	219	24.52	5	8.33
0.15 up to 0.19	183	20.49	13	21.67
0.20 up to 0.24	82	9.18	6	10.00
0.25 up to 0.29	33	3.70	2	3.33
0.30 or greater	4	0.45	2	3.33
Refused Test.	88	9.85	8	13.33
Data Not Available	195	21.84	18	30.00

	Improper gear shifts (e.g., missing shft) n=7			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.85	.	.
0.05 up to 0.09	68	7.19	.	.
0.10 up to 0.14	222	23.47	2	28.57
0.15 up to 0.19	194	20.51	2	28.57
0.20 up to 0.24	88	9.30	.	.
0.25 up to 0.29	35	3.70	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.15	.	.
Data Not Available	210	22.20	3	42.86

	Riding with kickstand deployed n=2			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.15	.	.
0.10 up to 0.14	223	23.45	1	50.00
0.15 up to 0.19	195	20.50	1	50.00
0.20 up to 0.24	88	9.25	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.09	.	.
Data Not Available	213	22.40	.	.

	Operating without lights at night n=21			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.79	1	4.76
0.05 up to 0.09	66	7.08	2	9.52
0.10 up to 0.14	220	23.61	4	19.05
0.15 up to 0.19	196	21.03	.	.
0.20 up to 0.24	85	9.12	3	14.29
0.25 up to 0.29	33	3.54	2	9.52
0.30 or greater	6	0.64	.	.
Refused Test.	94	10.09	2	9.52
Data Not Available	206	22.10	7	33.33

	Leaving cycle in gear when turning off n=2			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.15	.	.
0.10 up to 0.14	223	23.45	1	50.00
0.15 up to 0.19	196	20.61	.	.
0.20 up to 0.24	88	9.25	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	95	9.99	1	50.00
Data Not Available	213	22.40	.	.

	Abrupt rspnse whn cop sgnls rider to stp n=4			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.85	.	.
0.05 up to 0.09	68	7.17	.	.
0.10 up to 0.14	223	23.50	1	25.00
0.15 up to 0.19	195	20.55	1	25.00
0.20 up to 0.24	88	9.27	.	.
0.25 up to 0.29	35	3.69	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.12	.	.
Data Not Available	211	22.23	2	50.00

	Operating cycle whle hldng objct in hand n=2			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.15	.	.
0.10 up to 0.14	224	23.55	.	.
0.15 up to 0.19	196	20.61	.	.
0.20 up to 0.24	88	9.25	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.09	.	.
Data Not Available	211	22.19	2	100.00

	Carrying open container of alcohol n=6			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.85	.	.
0.05 up to 0.09	68	7.18	.	.
0.10 up to 0.14	221	23.34	3	50.00
0.15 up to 0.19	193	20.38	3	50.00
0.20 up to 0.24	88	9.29	.	.
0.25 up to 0.29	35	3.70	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.14	.	.
Data Not Available	213	22.49	.	.

	Exposed passengr or other inappro bhvior n=1			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.15	.	.
0.10 up to 0.14	224	23.55	.	.
0.15 up to 0.19	196	20.61	.	.
0.20 up to 0.24	88	9.25	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	95	9.99	1	50.00
Data Not Available	212	22.29	1	50.00

	Riding three abreast within the lane	
	no	
	N	PCTN
BAC Level		
Less than 0.05	27	2.83
0.05 up to 0.09	68	7.14
0.10 up to 0.14	224	23.50
0.15 up to 0.19	196	20.57
0.20 up to 0.24	88	9.23
0.25 up to 0.29	35	3.67
0.30 or greater	6	0.63
Refused Test.	96	10.07
Data Not Available	213	22.35

	Rider urinating at roadside n=2			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.15	.	.
0.10 up to 0.14	224	23.55	.	.
0.15 up to 0.19	196	20.61	.	.
0.20 up to 0.24	88	9.25	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.09	.	.
Data Not Available	211	22.19	2	100.00

	Stop location w/ kickstand deploy problm n=3			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.16	.	.
0.10 up to 0.14	223	23.47	1	33.33
0.15 up to 0.19	195	20.53	1	33.33
0.20 up to 0.24	88	9.26	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.11	.	.
Data Not Available	212	22.32	1	33.33

	Riding/prkng on sdewlk or othr illgl plc n=42			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	25	2.74	2	4.76
0.05 up to 0.09	64	7.03	4	9.52
0.10 up to 0.14	219	24.04	5	11.90
0.15 up to 0.19	192	21.08	4	9.52
0.20 up to 0.24	81	8.89	7	16.67
0.25 up to 0.29	32	3.51	3	7.14
0.30 or greater	6	0.66	.	.
Refused Test.	91	9.99	5	11.90
Data Not Available	201	22.06	12	28.57

	Not wearing helmet n=9			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.86	.	.
0.05 up to 0.09	66	6.99	2	22.22
0.10 up to 0.14	224	23.73	.	.
0.15 up to 0.19	195	20.66	1	11.11
0.20 up to 0.24	87	9.22	1	11.11
0.25 up to 0.29	33	3.50	2	22.22
0.30 or greater	6	0.64	.	.
Refused Test.	93	9.85	3	33.33
Data Not Available	213	22.56	.	.

	Wearing helmet while talking to cop n=4			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.85	.	.
0.05 up to 0.09	68	7.17	.	.
0.10 up to 0.14	222	23.39	2	50.00
0.15 up to 0.19	196	20.65	.	.
0.20 up to 0.24	86	9.06	2	50.00
0.25 up to 0.29	35	3.69	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.12	.	.
Data Not Available	213	22.44	.	.

	Helmet attached to cycle instd of worn n=1			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.14	.	.
0.10 up to 0.14	224	23.53	.	.
0.15 up to 0.19	196	20.59	.	.
0.20 up to 0.24	88	9.24	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.08	.	.
Data Not Available	212	22.27	1	100.00

	Improper wearing of safety glasses n=17			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.88	.	.
0.05 up to 0.09	67	7.16	1	5.88
0.10 up to 0.14	218	23.29	6	35.29
0.15 up to 0.19	194	20.73	2	11.76
0.20 up to 0.24	86	9.19	2	11.76
0.25 up to 0.29	35	3.74	.	.
0.30 or greater	6	0.64	.	.
Refused Test.	91	9.72	5	29.41
Data Not Available	212	22.65	1	5.88

	Not wearing protective gear n=1			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.14	.	.
0.10 up to 0.14	224	23.53	.	.
0.15 up to 0.19	196	20.59	.	.
0.20 up to 0.24	88	9.24	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	95	9.98	1	100.00
Data Not Available	213	22.37	.	.

	Wearing silly headgear n=1			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.14	.	.
0.10 up to 0.14	223	23.42	1	100.00
0.15 up to 0.19	196	20.59	.	.
0.20 up to 0.24	88	9.24	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.08	.	.
Data Not Available	213	22.37	.	.

	Wearing inappropriate clothing for conditions	
	no	
	N	PCTN
BAC Level		
Less than 0.05	27	2.83
0.05 up to 0.09	68	7.14
0.10 up to 0.14	224	23.50
0.15 up to 0.19	196	20.57
0.20 up to 0.24	88	9.23
0.25 up to 0.29	35	3.67
0.30 or greater	6	0.63
Refused Test.	96	10.07
Data Not Available	213	22.35

	Vehicle defects n=47			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	24	2.65	3	6.38
0.05 up to 0.09	62	6.84	6	12.77
0.10 up to 0.14	211	23.29	13	27.66
0.15 up to 0.19	188	20.75	8	17.02
0.20 up to 0.24	86	9.49	2	4.26
0.25 up to 0.29	35	3.86	.	.
0.30 or greater	5	0.55	1	2.13
Refused Test.	94	10.38	2	4.26
Data Not Available	201	22.19	12	25.53

	Accident n=106			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	24	2.83	3	2.83
0.05 up to 0.09	63	7.44	5	4.72
0.10 up to 0.14	204	24.09	20	18.87
0.15 up to 0.19	167	19.72	29	27.36
0.20 up to 0.24	78	9.21	10	9.43
0.25 up to 0.29	31	3.66	4	3.77
0.30 or greater	6	0.71	.	.
Refused Test.	82	9.68	14	13.21
Data Not Available	192	22.67	21	19.81

	Facial expression n=18			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.78	1	5.56
0.05 up to 0.09	68	7.27	.	.
0.10 up to 0.14	222	23.74	2	11.11
0.15 up to 0.19	193	20.64	3	16.67
0.20 up to 0.24	88	9.41	.	.
0.25 up to 0.29	33	3.53	2	11.11
0.30 or greater	6	0.64	.	.
Refused Test.	91	9.73	5	27.78
Data Not Available	208	22.25	5	27.78

	Coasting downhill	
	no	
	N	PCTN
BAC Level		
Less than 0.05	27	2.83
0.05 up to 0.09	68	7.14
0.10 up to 0.14	224	23.50
0.15 up to 0.19	196	20.57
0.20 up to 0.24	88	9.23
0.25 up to 0.29	35	3.67
0.30 or greater	6	0.63
Refused Test.	96	10.07
Data Not Available	213	22.35

	Loud motorcycle exhaust n=25			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.91	.	.
0.05 up to 0.09	67	7.22	1	4.00
0.10 up to 0.14	216	23.28	8	32.00
0.15 up to 0.19	190	20.47	6	24.00
0.20 up to 0.24	88	9.48	.	.
0.25 up to 0.29	35	3.77	.	.
0.30 or greater	5	0.54	1	4.00
Refused Test.	94	10.13	2	8.00
Data Not Available	206	22.20	7	28.00

	Uses cycle for support while waiting n=5			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.85	.	.
0.05 up to 0.09	68	7.17	.	.
0.10 up to 0.14	223	23.52	1	20.00
0.15 up to 0.19	193	20.36	3	60.00
0.20 up to 0.24	88	9.28	.	.
0.25 up to 0.29	35	3.69	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	95	10.02	1	20.00
Data Not Available	213	22.47	.	.

	Dropped item from motorcycle n=3			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.16	.	.
0.10 up to 0.14	224	23.58	.	.
0.15 up to 0.19	195	20.53	1	33.33
0.20 up to 0.24	88	9.26	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	95	10.00	1	33.33
Data Not Available	212	22.32	1	33.33

	Disorderly conduct n=10			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.86	.	.
0.05 up to 0.09	68	7.21	.	.
0.10 up to 0.14	222	23.54	2	20.00
0.15 up to 0.19	193	20.47	3	30.00
0.20 up to 0.24	88	9.33	.	.
0.25 up to 0.29	35	3.71	.	.
0.30 or greater	6	0.64	.	.
Refused Test.	95	10.07	1	10.00
Data Not Available	209	22.16	4	40.00

	Failed to pay toll n=2			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	67	7.05	1	50.00
0.10 up to 0.14	224	23.55	.	.
0.15 up to 0.19	196	20.61	.	.
0.20 up to 0.24	88	9.25	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.09	.	.
Data Not Available	212	22.29	1	50.00

	Stolen motorcycle n=1			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.84	.	.
0.05 up to 0.09	68	7.14	.	.
0.10 up to 0.14	224	23.53	.	.
0.15 up to 0.19	196	20.59	.	.
0.20 up to 0.24	87	9.14	1	100
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.08	.	.
Data Not Available	213	22.37	.	.

	Wrong way on one-way street n=8			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.86	.	.
0.05 up to 0.09	68	7.20	.	.
0.10 up to 0.14	222	23.49	2	25.00
0.15 up to 0.19	194	20.53	2	25.00
0.20 up to 0.24	86	9.10	2	25.00
0.25 up to 0.29	35	3.70	.	.
0.30 or greater	5	0.53	1	12.50
Refused Test.	96	10.16	.	.
Data Not Available	212	22.43	1	12.50

	Blocking traffic n=6			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.85	.	.
0.05 up to 0.09	68	7.18	.	.
0.10 up to 0.14	224	23.65	.	.
0.15 up to 0.19	191	20.17	5	83.33
0.20 up to 0.24	88	9.29	.	.
0.25 up to 0.29	35	3.70	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	95	10.03	1	16.67
Data Not Available	213	22.49	.	.

	Excessive speed n=78			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	25	2.86	2	2.56
0.05 up to 0.09	65	7.43	3	3.85
0.10 up to 0.14	204	23.31	20	25.64
0.15 up to 0.19	180	20.57	16	20.51
0.20 up to 0.24	78	8.91	10	12.82
0.25 up to 0.29	32	3.66	3	3.85
0.30 or greater	6	0.69	.	.
Refused Test.	87	9.94	9	11.54
Data Not Available	198	22.63	15	19.23

	Striking object with motorcycle n=7			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.85	.	.
0.05 up to 0.09	68	7.19	.	.
0.10 up to 0.14	222	23.47	2	28.57
0.15 up to 0.19	196	20.72	.	.
0.20 up to 0.24	88	9.30	.	.
0.25 up to 0.29	35	3.70	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	95	10.04	1	14.29
Data Not Available	209	22.09	4	57.14

	Pushing motorcycle (on or off road) n=3			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	26	2.74	1	33.33
0.05 up to 0.09	68	7.16	.	.
0.10 up to 0.14	222	23.37	2	66.67
0.15 up to 0.19	196	20.63	.	.
0.20 up to 0.24	88	9.26	.	.
0.25 up to 0.29	35	3.68	.	.
0.30 or greater	6	0.63	.	.
Refused Test.	96	10.11	.	.
Data Not Available	213	22.42	.	.

	Unsafe lane change n=12			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	27	2.87	.	.
0.05 up to 0.09	67	7.12	1	8.33
0.10 up to 0.14	220	23.38	4	33.33
0.15 up to 0.19	193	20.51	3	25.00
0.20 up to 0.24	86	9.14	2	16.67
0.25 up to 0.29	34	3.61	1	8.33
0.30 or greater	6	0.64	.	.
Refused Test.	96	10.20	.	.
Data Not Available	212	22.53	1	8.33

	Registration/license n=36			
	no		yes	
	N	PCTN	N	PCTN
BAC Level				
Less than 0.05	25	2.75	2	4.55
0.05 up to 0.09	60	6.60	8	18.18
0.10 up to 0.14	210	23.10	14	31.82
0.15 up to 0.19	188	20.68	8	18.18
0.20 up to 0.24	84	9.24	4	9.09
0.25 up to 0.29	34	3.74	1	2.27
0.30 or greater	6	0.66	.	.
Refused Test.	95	10.45	1	2.27
Data Not Available	207	22.77	6	13.64

APPENDIX E

STATISTICAL NOTE CONCERNING THE USE OF CONFIDENCE INTERVALS WITH PROPORTIONS

STATISTICAL NOTE CONCERNING THE USE OF CONFIDENCE INTERVALS WITH PROPORTIONS

Confidence intervals were computed for all 23 cues included on the data collection form and the two cues added during data collection (no helmet and no eye protection). This statistical procedure was performed for the Phase II data and the validation study data.

We computed the confidence intervals for the p values using a t test, assuming an underlying normal distribution. This procedure is also known as the normal approximation to the binomial.

The practice of computing confidence intervals for proportions is a common statistical procedure. For example, we might read in a newspaper that, "candidate X is expected to receive 55 percent of the votes in an impending election, *plus or minus four percent*, based on our sample of 1200 voters." The plus or minus four percent is an expression of the confidence interval surrounding the estimated proportion, .55.

There are several ways to compute confidence intervals for proportions. The statistical choice to be made is what underlying distribution we assume for the population being sampled. It must be understood that a proportion (i.e., p value), like a mean, is a point estimate of the true population parameter p-value (in our case, of all motorcycle stops in the US).

We typically assume a normal distribution. But it is not a distribution in the conventional sense because we are dealing, in the current case, with a binomial event: a stop results in a DWI arrest, or it does not. The distribution in question (the one we assume is normal) is the distribution of p values that would be obtained as a result of repeated conduct of a study. The p values obtained would rarely be the same, but it is assumed that they would fall in a normally distributed fashion around the best estimate. That distribution is called the sampling distribution of the statistic. That sampling distribution is almost always hypothetical because studies are usually conducted only once. In contrast, we have the benefit of two studies upon which to base our sampling distributions and inferences about actual p values.

It is understood that sample size affects the sampling distribution; that is, if the n is small, the underlying (hypothesized) sampling distribution will have a larger spread of variance. Thus, variance is a function of sample size, but variance is also a function of the assumed underlying sampling distribution. The only problem with this approach is that the n might be too small, or the proportions might be skewed from .50, which actually flairs the tails of the hypothetical distribution, creating slightly broader confidence intervals for extreme p values and p values based on n's fewer than 30 observations. This approach does not affect the p values obtained. Most statisticians would agree that the appropriate procedure to follow in this particular case is the normal (or more precisely, a t-distribution) approximation to the binomial.

Phase II Confidence Intervals for Cue Probabilities of DWI

Phase II Field Study Data					
All Hours/1230 Forms					
95% Confidence Intervals					
Cue	**P**	**N**	**Con. Interval**	**Lower Limit**	**Upper Limit**
Weaving	0.702	57	0.118739532	0.583260468	0.820739532
I/U behavior	0.68	25	0.182858651	0.497141349	0.862858651
Turning problems	0.667	36	0.153953602	0.513046398	0.820953602
Erratic movements	0.667	30	0.168647721	0.498352279	0.835647721
Wrong way	0.556	9	0.324611348	0.231388652	0.880611348
Trouble w/ dismount	0.538	26	0.191637953	0.346362047	0.729637953
Drifting during turn or curve	0.529	17	0.23728479	0.29171521	0.76628479
Trouble w/ balance at stop	0.516	31	0.175923054	0.340076946	0.691923054
Too slowly	0.5	2	0.692964646	-0.192964646	1.192964646
No lights at night	0.429	14	0.259261932	0.169738068	0.688261932
Inattentive to surroundings	0.389	18	0.225224289	0.163775711	0.614224289
Evasion	0.333	30	0.168647721	0.164352279	0.501647721
Running stop light or sign	0.275	69	0.105357844	0.169642156	0.380357844
Recklessness	0.267	45	0.129258	0.137742	0.396258
Rapid acceleration	0.184	103	0.074832706	0.109167294	0.258832706
Unsafe passing	0.163	43	0.110402364	0.052597636	0.273402364
Parking/riding on sidewalk	0.154	13	0.196213976	-0.042213976	0.350213976
Turning violation	0.146	48	0.099894325	0.046105675	0.245894325
Unsafe lane change	0.125	64	0.081026134	0.043973866	0.206026134
Following too closely	0.095	21	0.125410101	-0.030410101	0.220410101
Excessive speed	0.087	656	0.021567468	0.065432532	0.108567468
Vehicle defects	0.071	127	0.044667458	0.026332542	0.115667458
Loud exhaust	0.065	124	0.043391805	0.021608195	0.108391805
Expired tabs or plates	0.063	160	0.037647501	0.025352499	0.100647501
No eye protection (where req)	0.034	29	0.065960675	-0.031960675	0.099960675
No helmet (where req)	0.014	74	0.02676965	-0.01276965	0.04076965

Validation Study Confidence Intervals for Cue Probabilities of DWI

Validation Study Data					
All Hours/740 Forms					
95% Confidence Intervals					
Cue	**P**	**N**	**Con. Interval**	**Lower Limit**	**Upper Limit**
Weaving	0.597	62	0.122095572	0.474904428	0.719095572
I/U behavior	0.654	26	0.182850571	0.471149429	0.836850571
Turning problems	0.68	25	0.182858651	0.497141349	0.862858651
Erratic movements	0.455	11	0.294281986	0.160718014	0.749281986
Wrong way	1	1	0	1	1
Trouble w/ dismount	0.8	25	0.1568	0.6432	0.9568
Drifting during turn or curve	0.923	13	0.144920762	0.778079238	1.067920762
Trouble w/ balance at stop	0.76	25	0.167416587	0.592583413	0.927416587
Too slowly	0.333	3	0.533310922	-0.200310922	0.866310922
No lights at night	0.429	7	0.366651741	0.062348259	0.795651741
Inattentive to surroundings	0.667	9	0.307907204	0.359092796	0.974907204
Evasion	0.358	23	0.195930109	0.162069891	0.553930109
Running stop light or sign	0.39	59	0.124459281	0.265540719	0.514459281
Recklessness	0.4	35	0.16230342	0.23769658	0.56230342
Rapid acceleration	0.298	84	0.09781222	0.20018778	0.39581222
Unsafe passing	0.321	28	0.172927658	0.148072342	0.493927658
Parking/riding on sidewalk	0.273	11	0.263274173	0.009725827	0.536274173
Turning violation	0.158	57	0.094689807	0.063310193	0.252689807
Unsafe lane change	0.319	47	0.133252707	0.185747293	0.452252707
Following too closely	0.4	10	0.303641894	0.096358106	0.703641894
Excessive speed	0.152	363	0.036933671	0.115066329	0.188933671
Vehicle defects	0.046	87	0.04401995	0.00198005	0.09001995
Loud exhaust	0.071	56	0.06726654	0.00373346	0.13826654
Expired tabs or plates	0.149	87	0.074826315	0.074173685	0.223826315
No eye protection (where req)	0.2	15	0.20242793	-0.00242793	0.40242793
No helmet (where req)	0.067	15	0.126528589	-0.059528589	0.193528589

APPENDIX F

COPY OF TRAINING BROCHURE

Introduction

There are approximately four million street-legal motorcycles registered in the United States. Each year one out of every 35 of those motorcycles is involved in a crash, and one out of every 1,200 or so is involved in a fatal crash.

When fatalities per miles travelled are considered, motorcyclists are killed at about 19 times the rate of drivers and passengers of other motor vehicles. The National Highway Traffic Safety Administration (NHTSA) estimates that alcohol is a contributing factor in nearly half of all motorcycle fatalities.

Clearly, enforcement of DWI laws is a key to reducing the number of alcohol-related motorcyclist fatalities. *But what are the clues that we should use to detect impaired motorcyclists*?

NHTSA sponsored the research necessary to develop a set of behavioral cues that can be used by law enforcement personnel to accurately detect motorcyclists who are operating their vehicles while intoxicated. The researchers began by interviewing expert patrol officers from across the country to determine what behavioral cues have been used to detect impaired motorcyclists. Most officers recalled at least a few cues that they use to discriminate between DWI and normal riding. A few, primarily motorcycle officers, suggested cues that reflected considerable understanding of the mental and physical requirements of riding a motorcycle. Others believed the cues to be identical to those used to detect impaired drivers. But some officers, even those with many years experience, reported that they believe there to be no cues that can be used to distinguish DWI from unimpaired motorcycle operation.

In addition to interviewing law enforcement personnel, the research team developed a data base of 1,000 motorcycle DWI arrest reports. They focused on the officer's narratives and the behaviors that motivated the stops, and correlated those behaviors with blood alcohol concentrations, or BACs. Analysis of the interviews and arrest report data resulted in an inventory of about 100 cues that have been observed by officers in association with impaired motorcycle operation.

The researchers, working closely with the law enforcement personnel, conducted two major field studies involving more than 50 sites throughout the

United States. Officers recorded information about every enforcement stop they made of a motorcyclist. Those field studies permitted the researchers to identify the most effective cues and to calculate the probabilities that those cues are predictive of DWI. This training document presents the results of the research.

Fourteen cues were identified that best discriminate between DWI and unimpaired operation of a motorcycle. The cues have been labeled as "Excellent Predictors" and "Good Predictors," based on study results. The *excellent* cues predicted impaired motorcycle operation 50 percent or more of the time. The *good* cues predicted impaired motorcycle operation 30 to 49 percent of the time. The special coordination and balance requirements of riding a two-wheeled vehicle provided most of the behaviors in the excellent category of cues.

Important Information

The cues described in the following pages have been used by law enforcement officers from across the United States to help detect impaired motorcycle operators. The cues can be used at all hours of the day and night, and they apply to all two-wheeled motor vehicles.

The cues described and illustrated in this document (and on the accompanying detection guide and training video) are the behaviors that are most likely to discriminate between impaired and normal operation of a motorcycle. However, the special case of "speeding" requires elaboration. Motorcyclists stopped for excessive speed are likely to be DWI only about 10 percent of the time (i.e., ten times out of 100 stops for speeding). But because motorcyclists tend to travel in excess of speed limits, speeding is associated with a large portion of all motorcycle DWI arrests. In other words, while only a small proportion of speeding motorcyclists are likely to be DWI, the large number of speeding motorcyclists results in a large number of DWIs, despite the relatively small probability.

The research suggests that these training materials, and the Motorcycle DWI Detection Guide, will be helpful to officers in:

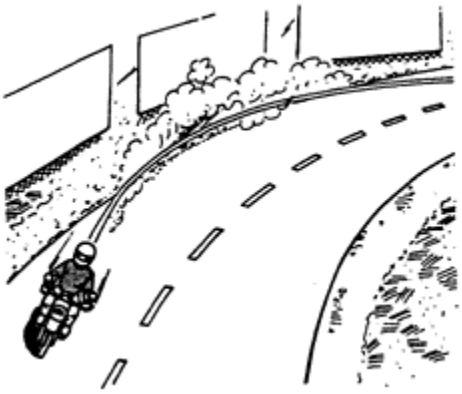
*Detecting impaired motorcyclists,

*Articulating observed behaviors on arrest reports, and

*Supporting officer's expert testimony.

Drifting During Turn or Curve

Earlier studies have shown that the most common cause of single-vehicle, fatal motorcycle crashes is for the road to curve and the motorcycle and rider to continue in a straight line until they strike a stationary object: this type of crash is usually caused by alcohol-impaired balance and coordination abilities. In less extreme cases, the motorcycle's turn radius expands during the maneuver. The motorcycle appears to drift to the outside of the lane, or into another lane, through the curve or while turning a corner. If you see a motorcycle drifting during a turn or curve, do the rider a favor and pull him over — our study showed there is an *excellent* chance that he is DWI.



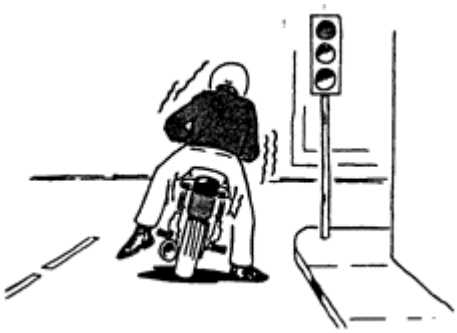
Trouble with Dismount

Parking and dismounting a motorcycle can be a helpful field sobriety test. The motorcyclist must turn off the engine, and locate and deploy the kickstand. He must then balance his weight on one foot while swinging the other foot over the seat to dismount. But first, the operator must decide upon a safe place to stop his bike. Problems with any step in this sequence can be evidence of alcohol impairment

Not every motorcyclist that you see having some form of trouble with a dismount is under the influence, but study results indicated that more than 50 percent of them are. In other words, trouble with dismount is an *excellent* cue.

Trouble with Balance at Stop

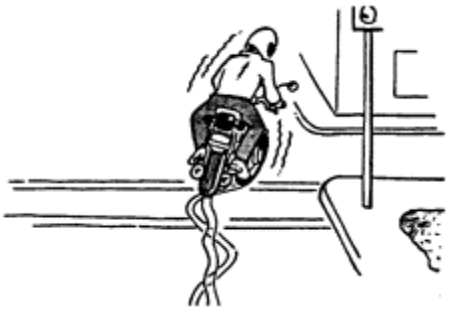
The typical practice at a stop is for the motorcyclist to place one foot on the ground to keep the bike upright, while leaving the other foot on the peg nearest the gear shift lever. Some riders favor placing both feet on the ground for stability. Riders whose balance has been impaired by alcohol often have difficulty with this task. They might be observed to shift their weight from side-to-side, that is from one foot to another to maintain balance at a stop. From a block away, an officer might notice a single tail light moving from side to side in a gentle rocking motion. If you observe a motorcyclist to be having trouble with balance at a stop, there is an *excellent* chance that he or she is DWI.



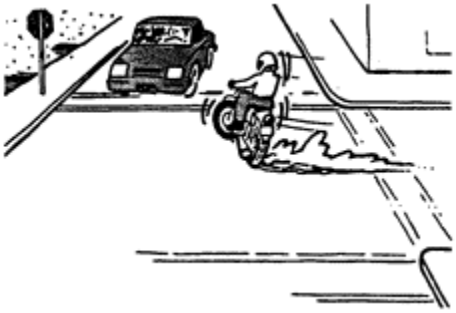
Turning Problems

The research identified four turning problems that are indicative of rider impairment. Each of the problems is described separately in the following paragraphs.

Unsteady During Turn or Curve. The gyroscopic effects of a motorcycle's wheels tend to keep a motorcycle "on track" as long as speed is maintained. As a motorcycle's speed decreases, the demands placed on the operator's balance capabilities increase. As a result, an officer might observe a motorcycle's front wheels or handlebars to wobble as an impaired operator attempts to maintain balance at slow speeds or during a turn.

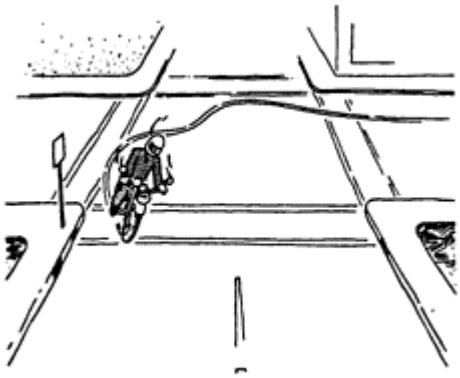


Late Braking During Turn. The next turning problem is "late braking during a turn or on a curve." A motorcyclist normally brakes prior to entering a turn or curve, so the motorcycle can accelerate through the maneuver for maximum control. An impaired motorcyclist might misjudge his speed or distance to the corner or curve, requiring him to apply the brakes during the maneuver.



Improper Lean Angle During Turn. Third, a motorcyclist normally negotiates a turn or curve by leaning into the turn. However, when balance or speed judgment are impaired, the operator frequently attempts to sit upright through the maneuver. An "improper lean angle" can be detected by the trained observer.

Erratic Movements During Turn. The fourth turning problem is "erratic movements". An erratic movement or sudden correction of a motorcycle during a turn or curve can also indicate impaired operator ability.



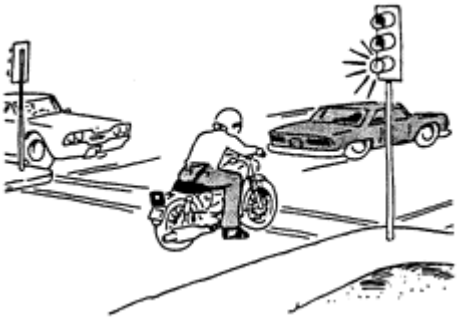
If you observe a motorcyclist to be unsteady during a turn or curve, brake late, assume an improper lean angle, or make erratic movements during a turn or curve, there is an *excellent* chance that the motorcyclist is DWI

Inattentive to Surroundings

Vigilance concerns a person's ability to pay attention to a task or notice changes in surroundings. A motorcyclist whose vigilance has been impaired by alcohol might fail to notice that the light that he has been waiting for has changed to green.

A vigilance problem is also evident when a motorcyclist is inattentive to his surroundings or seemingly unconcerned with detection. For example, there is cause for suspicion of DWI when a motorcyclist fails to periodically scan the area around his bike when in traffic, a wise defensive riding procedure to guard against potential encroachment by other vehicles. There is further evidence of impairment if a motorcyclist fails to respond to an officer's emergency lights or hand signals.

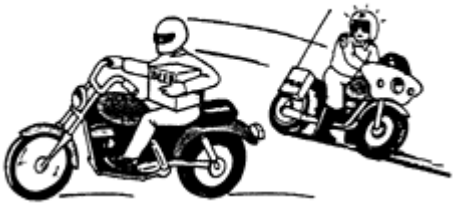
If you observe a motorcyclist to be inattentive to his or her surroundings, there is an *excellent* chance that the motorcyclist is DWI.



Inappropriate or Unusual Behavior

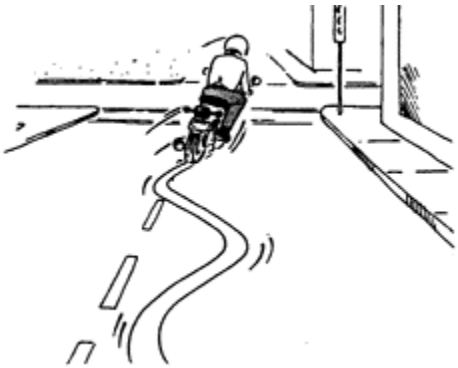
There is a category of cues that we call "inappropriate or unusual behavior." This category of cues includes behaviors such as operating a motorcycle while holding an object with one hand or under an arm, carrying an open container of alcohol, dropping an item from a motorcycle, urinating at the roadside, arguing with another motorist or otherwise being disorderly. If you

observe inappropriate or unusual behavior by a motorcyclist, there is an *excellent* probability that the motorcyclist is DWI.



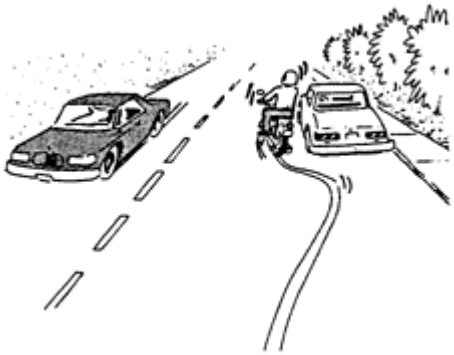
Weaving

You are probably familiar with weaving as a predictor of DWI. If you see an automobile weaving there is a good chance that the driver has exceeded the legal limits on alcohol, but if you observe a motorcycle to be weaving, the probability of DWI is even greater—weaving is an *excellent* cue. Weaving includes weaving within a lane and weaving across lane lines, but does not include the movements necessary to avoid road hazards.



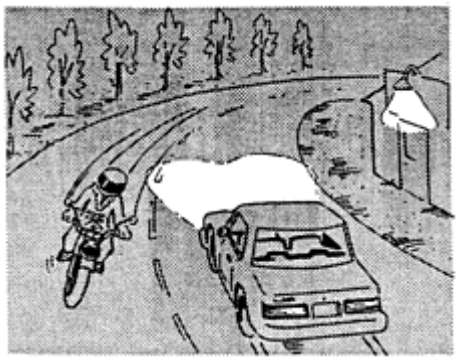
Erratic Movements While Going Straight

If you observe a motorcyclist making erratic movements or sudden corrections while attempting to ride in a straight line, study results indicated there is a *good* probability that the rider is DWI. In other words, during the study between 30 and 49 percent of the time erratic movements while going straight were observed in association with impaired operation.



Operating without Lights at Night

Operating a motorcycle without lights at night is very dangerous and can indicate operator-impairment. Study results showed that if you detect a motorcyclist riding at night without lights, there is a *good* chance that the operator is DWI.



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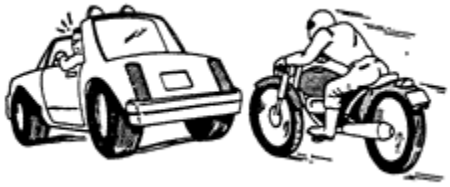
Recklessness

Motorcyclists tend to ride faster than autos, so speeding is not necessarily a good predictor of DWI for motorcyclists. However, recklessness, or riding too fast for the conditions, *was* found to be a *good* indicator of operator impairment.

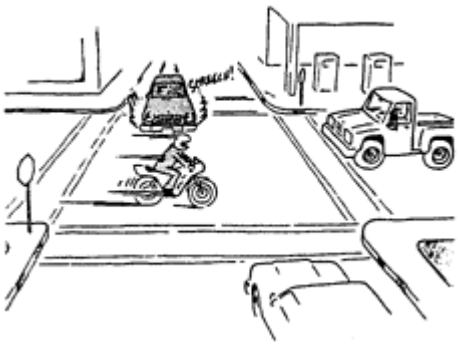
Following Too Closely

Following too closely, an unsafe following distance, is an indication of impaired operator judgment. This cue was found during the study to be a *good* predictor of motorcycle DWI.



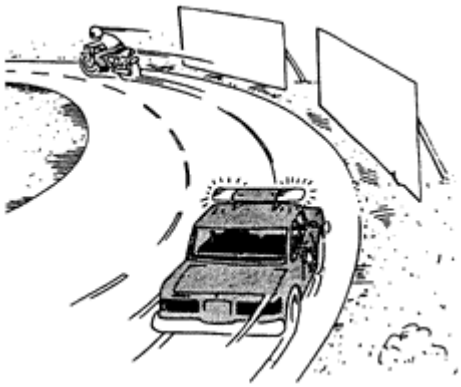
Running Stop Light or Sign

Failure to stop at a red light or stop sign can indicate either impaired vigilance capabilities (i.e., did not see the stop light or sign — or officer), or impaired judgment (i.e., decided not to stop). What ever the form of impairment, if you observe a motorcyclist to run a stop light or sign, there is a *good* chance that he or she is DWI.



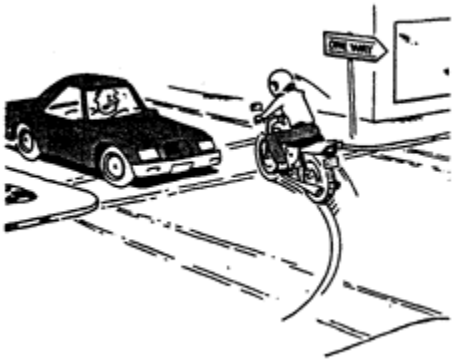
Evasion

Evasion, or fleeing an officer, is a relatively frequent occurrence. If a motorcyclist attempts to evade an officer's enforcement stop, study results indicate that there's a *good* chance he's DWI.



Wrong Way

Obviously, riding into opposing traffic is extremely dangerous. Study results showed that when you find a motorcycle going the wrong way in traffic there is a good chance that the operator is under the influence. This includes going the wrong way on a one way street, and crossing a center divider line to ride into opposing traffic.



This brochure and the other associated training materials are based on NHTSA Technical Report No. DOT HS 807 839, "The Detection of DWI Motorcyclists." The project is summarized in a NHTSA *Traffic Tech* with the same title, which is available upon request from NHTSA, Traffic Safety Programs (NTS-23), 400 Seventh Street, SW, Washington, D.C. 20590.

A list of the law enforcement agencies that contributed to the development of the Motorcycle DWI Detection training program is provided below.

Arizona Department of Public Safety
California Highway Patrol
Illinois State Police
Maryland State Police
Massachusetts State Police
New Mexico State Police
Ohio Highway Patrol
Texas Department of Public Safety

Albuquerque (NM) Police Department
Dallas (TX) Police Department
DeRidder (LA) Police Department
Eau Claire (WI) Police Department
Eau Claire (WI) County Sheriff's Office
Jacksonville (FL) Police Department/Sheriff's Office
Lake Charles (LA) Police Department
Los Angeles (CA) Police Department
Marlborough (MA) Police Department
Metro Dade (FL) Police Department
Norfolk (VA) Police Department
Santa Barbara (CA) Police Department
Sulphur (LA) Police Department
Tucson (AZ) Police Department

MOTORCYCLE DWI DETECTION GUIDE

NHTSA has found that the following cues predicted impaired motorcycle operation.

Excellent Cues (50% or greater probability)

- Drifting during turn or curve
- Trouble with dismount
- Trouble with balance at a stop
- Turning problems (e.g., unsteady, sudden corrections, late braking, improper lean angle)
- Inattentive to surroundings
- Inappropriate or unusual behavior (e.g., carrying or dropping object, urinating at roadside, disorderly conduct, etc.)
- Weaving

Good Cues (30 to 50% probability)

- Erratic movements while going straight
- Operating without lights at night
- Recklessness
- Following too closely
- Running stop light or sign
- Evasion
- Wrong way