15 Sources of Driver Distraction

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CONTENTS

15.1 INTRODUCTION

In determining to what extent driver distraction contributes to road trauma, it is essential to properly define and categorize the potential sources of distraction that exist, inside and outside the vehicle.

Given that distraction, as a concept, has been inconsistently defined in the literature (see Chapter 3), it is not surprising that there has been, between research studies and across time, considerable variation in what is, and is not, considered to be a source of distraction; and in how these sources of distraction are categorized. Consequently, there is currently no common taxonomic description of the sources and categories of driver distraction that exist at this stage in the evolution of the human-vehicle-highway system. This lack of agreement in categorization makes difficult the comparisons between specific sources of distraction and their impact on performance and safety, across studies and over time.

In this chapter we present a taxonomic description of the various sources of driver distraction that are currently known to exist. The taxonomy is derived from selected major studies that have made use of secondary crash-based data sources collected by agencies (typically the police), from selected major observational studies, and from the definition of driver distraction presented in Chapters 1 and 3 of this book. The taxonomy is intended to serve several purposes:

- To begin to resolve confusion about what are, and are not, sources of distraction inside and outside the vehicle
- To provide a common framework for categorizing sources of distraction

- To support the development of less variable protocols for collecting and categorizing crash and epidemiological data
- To provide a framework for predicting the potential impact of these sources of distraction on driving performance
- To provide a basis for the development of checklists that can be used to assess driver distraction

The chapter concludes with a final word on how the taxonomy might be expected to change as the driving task continues to evolve. Further discussion of taxonomic issues relevant to the classification of distraction-related crash data can be found in Chapter 16 of this book.

15.2 METHODS FOR IDENTIFYING SOURCES OF DISTRACTION

There are various complementary methods that can be used to identify and categorize the various potential sources of distraction that exist. The most obvious ones are discussed in the following paragraphs. Gordon, in Chapter 16 of this book, also provides some discussion of this issue.

One vitally important way is to define distraction and then use this definition *a priori* to determine what should, and should not, be regarded as a potential source of distraction. For example, in this book we define distraction as *the diversion of attention away from activities critical for safe driving toward a competing activity* (see Chapters 1 and 3). A critical assumption underlying this definition, as discussed in Chapter 3, is that some aspects of the driving task itself have potential to distract the driver. For example, according to this definition, adjusting the sun visor while driving, even though it is a driving-related activity, has the potential to draw attention away from activities critical for safe driving (e.g., detecting that the vehicle ahead has suddenly braked) and hence can be regarded as a potential source of distraction. As noted in Chapters 3 and 4, driving is a complex, multitask activity, making it likely that the demands of one element of driving will interfere with another. Considering "driving" as a single activity in defining distraction oversimplifies a complex activity and neglects important driving-related distractions drivers must manage.

Another way to create a taxonomy of distraction sources is to carefully sift through crash reports, such as police report forms and reports from in-depth crash studies, to identify sources of distraction (e.g., "using mobile phone") that have been identified as contributing factors in crashes. The problem here is that the range of potential sources of distraction is limited by what is voluntarily reported by crash victims, by the design of police report forms (by the extent to which, e.g., the report form lists as prompts different sources of distraction), and by the knowledge and expertise of police and crash investigation teams in knowing what questions to ask about the potential role of distraction as a contributing factor.

Observational studies, such as the 100-car naturalistic driving study,[1] provide another means of collecting data on potential distraction sources. Here, it is theoretically possible, through the use of video and other sensors, to observe overt driver involvement in all activities that compete with activities critical for safe driving and to record these. This technique is mainly limited by the number and types of sensors

that can be used to record these interactions, identifying what outside-the-vehicle sources the driver is looking at, the difficulties associated with recording the covert diversion of attention toward competing activities, and the possible reluctance of drivers to divert their attention toward some competing activities (e.g., illegal activity) knowing that their behavior is being monitored.

15.3 CODING AND CATEGORIZATION OF DISTRACTION SOURCES

A source of distraction can be thought of as comprising two elements: a physical event or object (e.g., mobile phone) and an action of some kind that is performed on that object (e.g., dialing, talking, and listening). It is important to distinguish between these two elements, as the degree and type of distraction that derives from an object depends on the action that is performed on it. Listening to a mobile phone, for example, has been shown to interfere less with lane keeping than using it to dial a number (see Chapter 11).

In this chapter, we have reviewed the descriptions of sources of distraction reported in seven studies—five crash studies and two observational studies—that have been cited as providing evidence for the role of distraction as a contributing factor in crashes and near-crashes. From these studies, we distilled a list of actions that were identified as being associated with the various sources of distraction cited. These are shown in Table 15.1, along with the studies in which they were reported. These actions are not exhaustive, but they represent the range of actions performed by drivers of current-generation vehicles when engaging in activities that have reportedly contributed to crashes. It can be seen in Table 15.1 that there is some degree of overlap between the items in the list. The actions "manipulating," and "using," for example, share some common elements.

Noteworthy here is a generic taxonomy of task actions developed some time ago by Miller[8] (cited in Ref. 9). Miller's taxonomy, shown in Table 15.2, contains a description of the generic information transformations and control activities that are needed for system operation. These descriptions were derived from a project undertaken for the U.S. Air Force concerned with the development of a generalized taxonomy of human performance. It can be seen that there is virtually no overlap between the list of actions identified in Table 15.1 and those listed in Table 15.2. There are several reasons for this. First, the actions in Table 15.2 are largely more perceptual and cognitive in nature than those in Table 15.1. Second, many of the actions in Table 15.2 are performed covertly and hence are not likely to be captured on police report forms and even in observational studies such as the 100-car naturalistic driving study[1]. Finally, many of the terms in Table 15.2 represent actions, which are in fact subcomponents of the actions in Table 15.1. For example, the term "checking" in Table 15.1 could involve performance of several of the actions in Table 15.2: input select, filter, search, store, store in buffer, and decide/select. Reference will be made to this table again later in the chapter.

From the previously mentioned studies, it is also possible to compile and categorize the full range of reported objects and events on which one or more of the actions mentioned in Table 15.1 were performed. These are listed in Table 15.3. Again, these

TABLE 15.1
Driver Actions Associated with Sources of Distraction Cited in the Studies Reviewed

Actions	Studies in Which Cited
Adjusting	S1, S3, GE, JS, G1
Answering	S1, S3, JS, G1, K
Applying (e.g., makeup)	K
Arguing	S1, JS, G1
Attending	JS, G1
Biting (e.g., nails, cuticles)	K
Brushing (e.g., hair, teeth)	K
Changing	GE, JS
Checking (e.g., speedometer/traffic)	G1, G2, K
Cleaning	K
Combing	K
Conversing	S1, S3, G1, K
Dancing (e.g., in car seat)	K
Dialing (manually or using voice)	S1, S3, GE, G1, K
Drinking	S1, S3, GE, JS, G1, K
Dropping	S1, S3, JS, G1
Eating/dining	S1, S3, GE, JS, G1, K
Extinguishing (e.g., cigarette)	S3, K
Fixing (e.g., hair)	K
Flossing (i.e., teeth)	K
Grooming	S3, GE
Inserting (e.g., cassette, CD, contact lenses)	K
Leaning	S3
Lighting (e.g., cigarette)	S1; S3, JS, K
Listening	S3
Locating	S1, S3, GE, JS, G1, K
Looking	S1, S3, GE, JS, G1, K
Thinking (daydreaming, lost in thought)	GE, S1, JS, G1
Manipulating	S3, G1
Moving	G1
Observing (e.g., traffic)	K
Picking up	S3
Praying	GE
Preparing (e.g., to eat)	S3
Pressing	K
Putting on (e.g., jewelery)	K
Reaching	S1, S3, GE, JS, G1, G2, K
Reading	S3, K
Removing (e.g., jewelery)	K
Retrieving (e.g., cassette, CD)	K
Searching	G1, G2
Shaving	K

(*continued*)

TABLE 15.1 (Continued)

Actions	Studies in Which Cited
Smoking (light, smoke, extinguish)	S1, S3, GE, JS, G1, G2, K
Screening (e.g., calls)	K
Singing	K
Spilling	S3, JS
Styling (e.g., hair)	K
Swatting (e.g., a fly)	G1
Talking	S1, S3, GE, JS, K
Texting	G1
Using	S1, S3, GE, JS, G1, K
Viewing	K
Writing	S3, GE

Note: S1, Stutts et al.[2]; S3, Stutts et al.[3]; G1, Gordon[5]; G2, Gordon[5]; K, Klauer et al.[1]; GE, Glaze and Ellis[6]; JS, Joint State Commission.[7]

events and objects are not exhaustive, but are probably representative of the range of events and objects in current-generation vehicles on which one or more actions are performed by drivers when engaging in distracting activities. There was some overlap between the events and the objects identified from the studies reviewed. To overcome this, overlapping items have been incorporated as a subset of superordinate items. For example, "dental floss" appears as a subset of "personal hygiene accessory." It will be noted that under the major source labeled "Internalized activity" we have included several actions: coughing, dancing in seat, itching, praying, singing (to oneself), sneezing, and talking (to self). These are included here, rather than in Table 15.1, given that they are internally derived actions, which involve no overt interaction with any of the objects or events in Table 15.3.

There is a tendency across the studies reviewed to confound the reporting of events, objects, and actions as sources of distraction. In the Glaze and Ellis study,[6] for example, "looking at other people," "eyes not on road," "objects on the road," and "automobile mechanical problem" are all cited as sources of distraction under the category "other distractions outside the vehicle." Presumably for those sources for which no associated action is reported (e.g., objects on the road), there was insufficient data to determine what action was being performed at the time of the incident. As noted by Gordon in Chapter 16, some studies also confound the reporting of some categories of distraction in a way that mixes inside- and outside-the-vehicle sources of distraction within the same category.

From this simple exercise we were able to distil, into the following six broad categories, the various events and objects on which one or more actions were performed by the drivers in the studies reviewed: "things brought into vehicle," "vehicle systems," "vehicle occupants," "moving object or animal in vehicle," "internalized activity," "external objects, events or activities," and "other sources of distraction." The latter category is intended to accommodate sources of distraction that are yet to evolve or be discovered (see Section 15.3.5).

TABLE 15.2
Miller's (1974) Cognitive Task Transactions and the Human Information Processing Resources They Draw Upon

Cognitive Agent Task	General Category of Information Processing	Human Information Processing Resources
1. Input select. Selecting what to pay attention to next	Acquisition	Selective attention Perceptual sensitivity
2. Filter. Straining out what does not matter	Acquisition	Selective attention
3. Detect. Is something there?	Acquisition	Perceptual sensitivity Distributed attention
4. Search. Looking for something	Acquisition	Sustained attention Perceptual sensitivity
5. Identify. What is it and what is its name?	Acquisition/interpretation	Perceptual discrimination Long-term memory Working memory
6. Message. A collection of symbols sent as a meaningful statement	Handling	Response precision
7. Queue to channel. Lining up to process in the future	Handling	Working memory Processing strategies
8. Code. Translating the same thing from one form to another	Handling	Response precision Working memory Long-term memory
9. Transmit. Moving something from one place to another	Handling	Response precision
10. Store. Keeping something intact for future use	Handling	Working memory Long-term memory
11. Store in buffer. Holding something temporarily	Handling	Working memory Processing strategies
12. Compute. Figuring out a logical or mathematical answer to a defined problem	Handling	Processing strategies Working memory
13. Edit. Arranging or correcting things according to rules	Handling	Long-term memory Selective attention
14. Display. Something showing that makes sense	Handling	Response precision
15. Purge. Getting rid of irrelevant data	Handling	Selective attention
16. Reset. Getting ready for some different action	Handling	Selective attention Response precision
17. Count. Keeping track of how many	Handling/interpretation	Sustained attention Working memory
18. Control. Changing an action according to plan	Handling/interpretation	Response precision

(*continued*)

TABLE 15.2 (Continued)

Cognitive Agent Task	General Category of Information Processing	Human Information Processing Resources
19. Decide/select. Choosing a response to fit the situation	Interpretation	Long-term memory Processing strategy
20. Plan. Matching resources in time to expectations	Interpretation	Working memory Processing strategy
21. Test. Is it what it should be?	Interpretation	Perceptual sensitivity Working memory Long-term memory
22. Interpret. What does it mean?	Interpretation	Long-term memory Sustained attention
23. Categorize. Defining and naming a group of things	Interpretation	Long-term memory Perceptual sensitivity
24. Adapt/learn. Making and remembering new responses to a learned situation	Interpretation	Long-term memory
25. Goal image. A picture of a task well done	Interpretation	Long-term memory Processing strategies

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A problematic issue for those classifying distraction-related data is whether to include as sources of distraction those that pertain to events, activities, and actions associated with the driving task itself. As aforementioned, it is our view that any driving-related activity that can draw attention away from activities critical for safe driving is a potential source of distraction. The study by Klauer et al.[1] identified a number of driving-related activities that were cited as instances of "driving-related inattention to forward roadway" (p. 134). These were checking rear mirror, checking center rear-view mirror, looking through windshield (left and right of center), checking side mirrors (left and right), looking through side windows (left and right), and looking at instrument panel (to check vehicle speed, temperature, engine revolutions per minute). We believe that these activities have the potential to divert attention away from activities critical for safe driving and, in line with the definition of distraction adopted in this book, should be regarded as distractions. Hence, the objects, events, and actions associated with them have been included in Tables 15.1 and 15.3.

Of the remaining studies reviewed, the following additional driving-related activities were cited (primarily by Gordon[4]) as sources of distraction: adjusting vehicle controls/devices, driver dazzled by sun strike, driver dazzled by headlights, checking for traffic, other road users (vehicles, pedestrians, and cyclists), trying to find destination/location, scenery (persons), and police/emergency vehicles/crash scene. (The word "dazzled" in this context can be taken to mean that the driver is affected by direct glare from a bright light source within the field of vision.) With three exceptions (trying to find destination/location, driver dazzled by sun strike,

TABLE 15.3
Events and Objects on Which One or More Actions Were Performed

Major Source	Minor Source	Specific Source	Citation	Likely Actions	Notes
Things brought into vehicle	• Definition: portable objects, devices and living things brought into the vehicle				
	Animal or pet	Generic	S3, GE, G1, G2, K	• Attending to	Restrained or unrestrained
		Dog	S1, JS, G1	• Interference by	
		Insect	S3, JS, G1, K	• Reacting to	
	Document	Generic	S1, S3, GE, JS, G1	• Attending to	
		Book	GE, G1, K	• Reading	
		Newspaper	S3, GE	• Reaching for	
		Map/directions	S1, S3, GE, JS, K	• Searching for	
		Paper/s	S1, S3, JS, K	• Writing on	
		Magazine	K		
		Dockets	JS, G1		
		Mail	S1, S3, GE		
	Drink		S1, S3, GE, JS, G1, G2	• Reaching for • Searching for • Using	Open or closed container
	Eating utensils		K	• Reaching for • Searching for • Using	Pertains to food
	Food		S1, S3, GE, JS, G1, G2, K	• Reaching for • Searching for • Using	With or without a utensil

Grooming accessories	Generic	S3, GE, K	• Looking	
	Makeup	S1, S3, K	• Reaching for	
	Shaver/razor	K	• Searching for	
	Combs/brushes	S3, K	• Using	
Lost object	Can specify the object in terms of minor and specific source	K	• Reaching for • Searching for	Objects brought into the vehicle that are "lost" and are being looked for
Personal effects	Generic	S1, S3, GE, JS, G1 G2, K	• Attending to • Reaching for	
	Purse	S1, S3, GE, JS, G1	• Searching for	
	Wallet	S1, GE, G1	• Using	
	Jewelery	K	• Adjusting	
	Money	S3, GE, G1		
	Contact lenses	K		
	Glasses/sunglasses	S3, GE, G1		
	Clothing/shoes	G1		
	Hand bags/bags	G1		
	Pills/inhaler	S1		
Personal hygiene accessory	Generic	K	• Reaching for	
	Toothbrush	K	• Searching for	
	Dental floss	K	• Using	
	Cuticles	K		
Smoking device	Generic	S1, S3, GE, JS, G1 G2, K	• Attending to • Reaching for	
	Cigarette	S1, S3, JS, G1, K	• Searching for	
	Cigar	S1, S3, K	• Using	
	Pipe	S3, K		
	Lighter	JS, G1		

(*continued*)

TABLE 15.3 (Continued)

Major Source	Minor Source	Specific Source	Citation	Likely Actions	Notes
	Technology device	Cell phone	S1, S3, GE, JS, G1, K	• Attending to • Reaching for	Handheld or handsfree Manual or quick dial
		Pager	S3, GE, G1	• Searching for	
		PDA	K	• Reacting to call	
		Radio telephone	G1	• Conversation	
		Data terminal	S1	• Texting	
		Technology Device	GE	• Using	
	Writing implements	Pen	S1, S3, GE	• Reaching for • Searching for • Using	
	Other device or object		S1, S3, G1, K	• Attending to • Reaching for • Searching for • Using	Caters for other things brought into the vehicle not specified in previous studies or not yet discovered
Vehicle systems	• Definition: displays, controls, objects, and devices already built into the vehicle with which the driver interacts				
	Entertainment	Generic	S1, S3, GE, JS, G1 G2, K	• Attending to • Reaching for	
		CD	S1, S3, GE, JS, G1, K	• Searching for • Using	
		Radio	S1, S3, GE, JS, G1, K		
		Cassette	S1, S3, GE, JS, G1, K		
	Mechanical problem		GE	• Attending to	E.g., engine overheating

	Vehicle controls or device	Generic	S1, S3, GE, JS, G1, G2, K	• Attending to • Reaching for	Instrument panel refers to main displays on main instrument cluster (e.g., speedometer, rpm indicator, temperature gauge)
		Mirrors	S1, S3, GE, G1, K	• Using	
		Heater	S1, S3, GE, JS, G1		
		Air conditioner	S1, S3, GE, JS, G1, K		
		Sun visor	S1, S3, GE, G1, K		
		Glove box	S3, GE, K		
		Ash tray	GE		
		Vehicle lighter	K		
		Lights	S1, G1		
		Wiper/s	S1, G1		
		Seat belt	S1, G1		
		Windows	S3, G1		
		Cruise control	S3		
	Other vehicle system	Generic	S1, S3, GE, G1		Caters for vehicle systems not specified in previous studies or not yet evolved or discovered
Vehicle occupants	• Definition: vehicle occupants other than the driver with whom the driver interacts				
		Generic	S1, GE, JS, G1, G2, K	• Attending to • Reaching for	Front seat or back seat (S3)
		Adult	S3, G1, K	• Conversation	
		Young adult	G1	• Reacting to • Interference by • Arguing with	

(*continued*)

TABLE 15.3 (Continued)

Major Source	Minor Source	Specific Source	Citation	Likely Actions	Notes
		Child	S1, S3, GE, JS, G1, K		
		Baby/infant	S1, S3, G1		
Moving object or animal in vehicle	• Definition: stationary objects or animals that suddenly move in the vehicle due to hard braking, acceleration, or turning or because they have been dropped by the driver or other occupant				
	Generic		S1, S3, GE, JS, G1, K	• Reacting to • Dropped • Reaching for	Can use the things brought into the vehicle category to further breakdown the sources
	Animal		S1, S3, GE, JS		
	Insect		S1, GE, JS		
	Object normally stationary		S1, GE, JS, K		
	Object held previously by driver or occupant		S1, S3, GE, JS, K		
	Other moving object		S1, GE, JS, K		Caters for other moving objects not specified in previous studies or not yet discovered

Internalized activity	• Definition: driver behavior that has the potential to distract the driver that involves no overt interaction with an object, event, or activity			
	Coughing	G1, G2	• Reacting to	
	Daydreaming or lost in thought	S1, GE, JS, G1, G2, K		E.g., random thoughts, dwelling on emotional issues or recent events
	Dancing in seat	K		
	Itching	G1, G2		
	Medical or emotional impairment	S1, GE, G1, G2		E.g., driver goes into labor, foreign item in their eye, emotionally upset
	Praying	GE		
	Singing	K		In absence of music
	Sneezing	G1, G2		
	Talking	K		When no one else is present
	Other activity	G1, G2		Caters for other internalized activities not specified in previous studies or not yet evolved or discovered

(*continued*)

TABLE 15.3 (Continued)

Major Source	Minor Source	Specific Source	Citation	Likely Actions	Notes
External objects, events or activities	• Definition: Objects, events, or activities outside the vehicle that have the potential to distract the driver or the driver is paying attention to				
	Animal	Generic Deer Dog Elk	S1, GE, JS, G2, K S1, JS S1 S1	• Looking at	On or near roadway and off-roadway
	Architecture		S1, G2	• Looking at	Includes buildings
	Advertising or billboards		S1, G2	• Looking at	Can be static or moving, and located on buildings, billboards, vehicles etc.
	Construction zone or equipment		S1, GE, K	• Looking at	On or near roadway and off-roadway
	Crash scene		S1, GE, G2, K		
	Incident		S1, GE, JS, G2, K		Includes near-misses, armed hold-ups, road rage, etc.
	Insect		S1, GE		
	Landmark		GE, G2		
	Road signs	Generic	S1, GE, G2		Includes all classes of road sign—destination, warning, regulatory and advertising-related

Road users (non-vehicle)	Generic Pedestrians Cyclists People Police	S1, GE, G2, K S1, GE, G2, K G2 G2 S1, G2	• Looking at	Includes using mirrors (rear or side) to check for road users
Road users (vehicle)	Generic Parked Moving/in traffic Police Emergency Waved through	S1, GE, JS, G2 S1, GE, JS, G2 S1, JS, G2 S1, G2 S1, G2 S1, JS	• Looking at	Includes using mirrors (rear or side) to check for road users
Scenery		GE, G2	• Looking at	
Weather	Generic Clouds/sky	GE, G2 S1	• Looking at	
Other objects, events, or activities		S1, GE, JS, G2, K	• Looking at	Includes sources of distraction unrelated to the traffic environment such as sporting events, parachutists in the sky, etc
Other major sources of distraction				Caters for major sources of distraction that are yet to evolve or be discovered

Note: S1, Stutts et al.[2]; S3, Stutts et al.[3]; G1, Gordon[4]; G2, Gordon[5]; K, Klauer et al.[1]; GE, Glaze and Ellis[6]; JS, Joint State Commission.[7]

and driver dazzled by headlights), all of the actions, objects, and events associated with these driving-related activities have been included in Tables 15.1 and 15.3. In our opinion it is not, *per se*, the dazzle from the sun or from headlights that has potential to divert attention away from activities critical for safe driving. Rather, it is the actions performed by the driver in response to the dazzle (e.g., adjusting the sun visor, re-positioning the head, activating the antiglare function of the rear-view mirror, etc.). Similarly, trying to find a destination or location is not of itself a source of distraction. Rather, it is the overt and covert actions (e.g., looking, thinking) performed on the objects (e.g., road signs, maps, instructions, one's internal mental map of the route) associated with navigation that constitute the source of distraction if they have the effect of diverting attention away from activities critical for safe driving. Glare and destination represent distal sources of distraction, compared to proximal sources of distractions that are more commonly discussed.

Glaze and Ellis[6] report some remaining sources of distraction that do not conform with the definition of distraction presented here: "driver fatigue/asleep," "alcohol," "alcohol and fatigue/asleep," and "driver error (misjudgment/inexperience)." In Chapter 3, we define driver inattention as *diminished attention to activities critical for safe driving in the absence of a competing activity.* In our opinion, driver states, such as being fatigued or inebriated by alcohol, are not in themselves sources of distraction. They better fit the description of inattention as they have the effect of diminishing attention to activities critical for safe driving in the absence of a competing activity. Finally, driver error can be considered a consequence of distraction (e.g., if distraction results in a mistake), rather than a source of distraction, regardless of whether it derives from misjudgment or inexperience (the latter might also be regarded as a driver state).

It is often argued that some sources of distraction are unavoidable. If it is assumed that the classification scheme presented in Table 15.3 has some modicum of validity, then it can be used to roughly estimate the proportion of sources of distraction that might be avoidable. Such data might be used to determine which categories and sources of distraction are most amenable to countermeasure development. In Table 15.4, we have made subjective judgments about which sources of distraction we believe are, at least theoretically, avoidable—from the perspective of drivers and other stakeholders. For example, most sources of distraction under the category "things brought into vehicle" would seem to be avoidable; drivers can choose not to bring animals, drink, eating utensils, food, and other things into the vehicle that have potential to distract them. If, however, they require a document, such as a paper map, to assist them in navigating their way to an unknown destination (assuming they cannot memorize the route and do not have an in-vehicle navigation system), then they have little choice but to bring the document into the vehicle with them; the document, in this case, can be considered an unavoidable source of distraction. In developing Table 15.4, it has been assumed that "events," such as spills, mechanical problems, crash scenes, lightening strikes, and moving objects in the vehicle, will be particularly distracting, and would seem to be highly salient relative to visual attention. Hence, events have usually been classified as unavoidable sources of distraction. Of course, the judgments we have made here are, in some cases, highly context dependent.

TABLE 15.4
Potential Sources of Distraction and the Extent to Which They Can Be Avoided

Major Source	Minor Source (Events and Objects)	Avoidable Distraction?
Things brought into vehicle	Animal/pet	Yes
	Document	Yes (Although paper maps are unavoidable if the driver has to navigate through unfamiliar territory without a co-pilot or route guidance system)
	Drink	Yes
	Eating utensils	Yes
	Food	Yes
	Grooming accessories	Yes
	Lost object	No (Things get lost; people make mistakes)
	Personal effects	Yes
	Personal hygiene accessory	Yes
	Smoking device	Yes
	Technology device	Yes
	Writing implements	Yes
Vehicle systems	Entertainment	Yes
	Mechanical problem (e.g., engine overheating)	No (Some mechanical problems cannot be avoided, even with regular servicing of vehicle; and when they occur, it is instinctive to attend to them)
	Vehicle controls/devices	Yes (These sources of distraction can be avoided if the attention diverted toward them does not compete with activities critical for safe driving)
Vehicle occupants	Adult front	Yes (Via bans on passenger carriage for young drivers and by passengers moderating their conversation when activities critical for safe driving are being performed by the driver)
	Adult back	Yes (Via bans on passenger carriage for young drivers and by passengers moderating their conversation when activities critical for safe driving are being performed by the driver)
	Child front	No (Although bans on carriage of children by young and novice drivers are feasible)

(*continued*)

TABLE 15.4 (Continued)

Major Source	Minor Source (Events and Objects)	Avoidable Distraction?
	Child back	No
	Baby front	No
	Baby back	No
Moving object or animal in vehicle	Animal	Yes
	Insect	No (It is impossible to prevent all insects from entering vehicle cabin)
	Object normally stationary	No (It is not practical to restrain all loose objects)
	Object previously held by driver/occupant	Yes
Internalized activity	Coughing	No
	Daydreaming/lost in thought	No
	Dancing in seat	Yes
	Itching	No
	Medical/emotional impairment	Yes (People can elect not to drive in these states)
	Praying	Yes
	Singing	Yes
	Sneezing	No
	Talking	Yes
External objects, events or activities	Animal	Yes (Barriers preventing animals from crossing roads and signs warning of animals are feasible, at least in critical locations)
	Architecture	Yes (Architectural structures likely to distract drivers could be located out of sight of drivers, although this may be difficult to implement)
	Advertising billboards	Yes (They could be located out of sight of drivers, or only in locations in which the consequences of distracted driving are not adverse)

(*continued*)

TABLE 15.4 (Continued)

Major Source	Minor Source (Events and Objects)	Avoidable Distraction?
	Construction zone/equipment	No (Instinctive to look/attend—and it is difficult to conceal construction zones/equipment)
	Crash scene	No (Instinctive to look/attend—and it is difficult to conceal crash scenes)
	Incident	No (Instinctive to look/attend—traffic incidents are usually spontaneous events, that are difficult to foresee and avoid)
	Insect	No (Instinctive to look/attend)
	Landmark	Yes (Landmarks likely to distract drivers could be located out of sight of drivers, although this is difficult to implement)
	Road signs	No (Instinctive to look/attend—they are deliberately designed to attract attention)
	Road users	No (Instinctive to look/attend)
	Scenery	No (Instinctive to look/attend)
	Vehicle	No (Instinctive to look/attend)
	Weather (e.g., lightning)	No (Instinctive to look/attend)

For each of the main sources of distraction identified in Tables 15.3 and 15.4, the following are the proportions of sources within that category that would seem to be avoidable:

- Things brought into vehicle 92%
- Vehicle systems 67%
- Vehicle occupants 33%
- Moving object in vehicle 50%
- Internalized activity 56%
- External objects, events, activities 31%

For the category "things brought into the vehicle," for example, it was judged that 11 out of 12 (i.e., 92%) of sources of distraction in that category are avoidable.

Overall, about 55% of all specific sources of distraction identified in Tables 15.3 and 15.4 appear to be avoidable. Sixty-one percent of sources deriving from within the vehicle seem avoidable and 31% of sources deriving from outside the vehicle appear avoidable. It seems, therefore, that there is much scope for countermeasure development and that it is reasonable to concentrate effort on those sources of

distraction deriving from within the vehicle, especially given the seemingly greater difficulties associated with avoiding distractions external to the vehicle (see Table 15.4). The proportions of sources of distraction that are avoidable are, of course, somewhat arbitrary. For example, if a category existed with two items and one of them was deemed to be avoidable, then that category would be 50% avoidable. The degree of "avoidability" is predicated on the assumption that each element in a category is equally frequent. However, in practice, this is not so. The numbers derived above are rough estimates only, and are presented merely to convey to the reader the simple notion that some sources of distraction may be more amenable to countermeasure development than others.

In summary, we have distilled six categories of objects and events (Table 15.3) from several published studies, which define sources of distraction that in recent years have reportedly contributed to road traffic incidents, near-misses, and crashes involving current-generation drivers driving current-generation vehicles on current-generation roads. We have also distilled from the same studies (Table 15.1) a list of actions that were identified as being associated with the sources of distraction listed in Table 15.3. From Tables 15.1 and 15.3, it is possible to derive another table, which lists all factorial combinations of actions that can be physically performed in relation to each object and event. This could serve as a basis for the development of more uniform methods for collecting, coding, and classifying distraction-related data. The take-home message for those involved in collecting, coding, and classifying sources of driver distraction is to be aware of the important distinction that can be made between events and objects on the one hand, and the actions performed on them, or in relation to them, on the other. The collection, coding, and classification of data in this way provides designers and policy makers with important specific information about those actions, for a given event or object, which are most likely to adversely affect performance and safety.

The challenge, of course, is to develop data collection tools such as police reporting forms that are parsimonious and practical enough to administer. Elaborate classification schemes such as the one presented here may be more applicable for obtaining data from in-depth crash studies and naturalistic driving studies. However, well-designed and detailed coding schemes provide flexibility in presenting or summarizing distraction information to the public or other audiences. For example, when discussing risk, the distracting activity is often described as a behavior repertoire that includes action and object, such as, dialing a mobile phone or talking on a mobile phone. If the crash-based information is well described in terms of the action and objects involved, this allows changes in summarizing the information to take place as our knowledge about distraction and risks develops.

15.4 MECHANISMS AND SOURCES OF DISTRACTION

Part II of this book focuses on theories and models of driver distraction. From that discussion it is possible to distil the main underlying dimensions that determine the extent to which a given source of distraction is likely to degrade driving performance. The present chapter has focused on *actual* sources of distraction that have been cited as contributing factors in incidents, near-misses, and crashes. Combining these two

lines of thinking, it is possible to predict whether a given source of distraction will degrade driving performance when a driver interacts with it.

This line of thinking is illustrated in Table 15.5. The table shows, for a particular "object brought into vehicle" (i.e., a mobile phone), a chronological set of actions that might be performed when using the object to phone a friend and, for each of these actions, the underlying dimensions (or mechanisms) that influence the degree to which that action is likely to degrade driving performance. A whole family of such tables could be generated for the various specific sources of distraction identified in Table 15.3.

The actions in the second column from the left are derived from Table 15.1. The remaining columns represent the underlying dimensions referred to in the preceding text.

Columns 3–7 derive from the multiple resource model of attention articulated by Wickens and Horrey in Chapter 5 of this book. According to this model, the degree to which two tasks can be time-shared effectively can be predicted by their joint difficulty (labeled "demand level"), and the degree to which they overlap in demand for common resources that vary along four dimensions: processing stage (perceptual-cognitive-motor), processing code (verbal vs. spatial), perceptual modality (auditory vs. visual), and visual channel (focal vs. ambient). Wickens and Horrey assert that since driving (both hazard monitoring and lane keeping) is primarily a visual-spatial-motor task, it is predicted (and observed) to be fairly efficiently time-shared with those tasks that are auditory and language based (both in perception—hearing speech, and in action—speaking). Furthermore, they argue that because ambient and focal vision use separate resources, lane keeping and hazard monitoring can be well time-shared, given that the latter employs foveal vision.

The headings in each of columns 3–7, which derive from the model, are defined as follows.

- *Perceptual modality incompatibility* refers to the extent to which the task that competes for the driver's attention shares the same perceptual modality (auditory vs. visual) as tasks that comprise the driving task.
- *Code incompatibility* refers to the extent to which the task that competes for the driver's attention shares the same processing code (verbal vs. spatial) as tasks that comprise the driving task.
- *Visual channel incompatibility* refers to the extent to which the task that competes for the driver's attention shares the same visual channel (focal vs. ambient) as tasks that comprise the driving task. These terms are synonymous with foveal and peripheral vision, respectively.
- *Stage incompatibility* refers to the extent to which the task that competes for the driver's attention shares the same processing stages (perceptual-cognitive-motor) as the tasks that comprise the driving task.
- *Demand level* refers to the joint difficulty of the driving task and the task that competes for the driver's attention.

The greater the extent to which an action shares the same resources as driving, the higher is the degree of incompatibility between that action and driving, and the higher is the expected degree of distraction induced by performance of that action while driving.

TABLE 15.5
Mechanisms Moderating Distraction Deriving from Use of a Handheld Mobile Phone

		Underlying Dimensions Moderating Potential for Distraction										
Overall Activity	Action (Derived from Table 15.1)	Perceptual Modality Incompatibility (Visual vs. Verbal)	Code Incompatibility (Verbal vs. Spatial)	Visual Channel Incompatibility (Focal vs. Ambient)	Stage Incompatibility (Perceptual-Cognitive-Motor)	Demand Level	Nonignorability	Unpredictability	Uninterruptability	Nonadjustability	Duration	Mean Score
Phone a friend (assumes driver knows number)	Looking (to locate phone in car)	Visual (High)	Spatial (High)	Focal (High)	Perceptual (Medium)	Low • Assuming that driving conditions are easy	Low • Assuming call is self-initiated	Low • Assuming there is a cradle to hold the phone	Low • Assuming call is self- initiated	Low	Low • Assuming few, short, glances	1.7
	Reaching (to pick up phone)	Visual (Medium) • Assuming minimal visual guidance is needed	Spatial (High)	Focal (Medium) • Assuming minimal visual guidance is required	Perceptual-Motor (Medium)	(Low) • Assuming that driving conditions are easy	(Low) • Assuming call is self-initiated	(Low) • Assuming there is a cradle to hold the phone	(Low) • Assuming call is self-initiated	(Low)	(Low) • Assuming minimal visual guidance required	1.5

Looking (at phone to determine whether display screen is in right mode for call) whilst holding it	Visual (High)	Verbal (Low) • Assuming low spatial demands	Focal (High)	Perceptual (Medium)	(Low) • Assuming that driving conditions are easy	(Low) • Assuming call is self-initiated	(Low) • Assuming driver is familiar with display screens	(Low) • Assuming call is self-initiated	(Low)	(Low) • Assuming one or two short glances	1.4
Dialing (friend's telephone number)	Visual (High) • Assuming manual dialing and visual guidance required	Spatial (High) • Assuming manual dialing	Focal (High)	Perceptual-cognitive-motor (High) • Assuming manual dialing, visual guidance and driver has to recall phone number	(High) • Assuming that driving conditions are easy	(Low) • Assuming call is self-initiated	(Low) • Assuming driver is familiar with device	(Low) • Assuming driver can make call when they like	(Low)	(High) • Assumes manual dialing and frequent glances	2.2
Talking (to friend) whilst holding the phone	Verbal (Low) • Assumes eyes are on the road ahead	Verbal (Low) • Assuming eyes are on the road ahead	Neither (Low) • Assuming eyes are on the road ahead	Cognitive (Medium) • Assuming eyes are on the road ahead and minimal motor resources required to speak	(Medium) • Assuming that phone conversation is casual, reception is good and driving conditions are easy	(Low) • Assuming the conversation is casual	(Low) • Assuming driver is familiar with device	(Low) • Assuming conversation is casual and they can interrupt and resume it whenever they like	(Low) • Assuming driver can slow down or terminate speech depending on changing traffic conditions	(High) • Assumes phone call spans long period (e.g., 10 min)	1.4

(*continued*)

TABLE 15.5 (Continued)

	Underlying Dimensions Moderating Potential for Distraction											
Overall Activity	**Action (Derived from Table 15.1)**	**Perceptual Modality Incompatibility (Visual vs. Verbal)**	**Code Incompatibility (Verbal vs. Spatial)**	**Visual Channel Incompatibility (Focal vs. Ambient)**	**Stage Incompatibility (Perceptual-Cognitive-Motor)**	**Demand Level**	**Nonignora-bility**	**Unpredicta-bility**	**Uninterrupta-bility**	**Nonadjusta-bility**	**Duration**	**Mean Score**
	Pressing ("Menu" button on phone to terminate conversation) whilst holding it	Visual (Low) • Assumes little or no visual guidance needed	Spatial (Low) • Assuming low spatial demands	Focal (Low) • Assuming little or no visual guidance needed	Perceptual (Low)	(Low)	(Medium) • Assuming that, once decision to terminate is made, task is difficult to ignore	(Low)	(High) • Assumes that, once terminated, call is not easily resumed	(Medium) • Assumes that driver may not have a total say in when conversation should be terminated	(Low) • Assumes single short-duration glance, or no glance, and simple button press	1.4
Mean Score		2.2	2.0	2.2	2.0	1.2	1.2	1.0	1.3	1.2	1.8	1.6

The remaining column headings are described in Chapter 4 and reflect a control theoretic interpretation of recent research concerning interruptions and multitask management (see, e.g., Refs. 10–14). These are defined as follows:

- A competing task is said to be *nonignorable* when it is so compelling or demanding that the driver cannot disengage from it.
- A competing task is *unpredictable* when its onset is unexpected or its consequences cannot be foreseen by the driver.
- An *uninterruptible* competing task is one that cannot be postponed or cannot be resumed after interruption.
- Where it is impossible for the driver to change the demand associated with the performance of a competing task, the task is said to be *nonadjustable*.
- *Duration* refers to the total time taken to complete a competing task. It can be viewed as a measure of total exposure to all of the above demands. In the context of distraction, a short-duration task is preferable to a long-duration task.

Each action can be rated—high, medium, or low—on each of these underlying dimensions. We have chosen this three-point rating scheme for illustrative purposes only. In combination, these ratings can be used to judge the degree to which that action is likely, through distraction, to degrade driving performance. In Table 15.5, "low" ratings imply low potential for distraction and "high" ratings imply high potential for distraction. A worked example is presented in the following paragraphs to clarify interpretation of the table.

In Table 15.5 (column 2) it is assumed that the first action performed by the driver, to phone a friend on their handheld mobile phone, is to look within the vehicle for his or her phone (i.e., looking). This is primarily a visual task, as is driving; hence, both tasks will compete for the driver's vision. Perceptual modality incompatibility (column 3) in this case is high because the two visual tasks are fundamentally incompatible with each other.

Code incompatibility (column 4), similarly, is high. Looking for the phone is primarily a spatial task, as is driving. Hence, both tasks will compete for the driver's spatial processing resources.

Visual channel incompatibility (column 5) is also high, assuming that the driving task involves frequent monitoring for potential and actual hazards. Looking for the phone and looking out for hazards both require focal, or foveal, vision. Hence the two tasks will compete for common visual processing channels. If the driver were to drive on a straight road in the middle of the Sahara Desert, with no speed limit and no potential for conflict with any actual road hazards, then the main task of driving would be lane keeping (which relies more on peripheral vision). Here, the two tasks would be more compatible.

Stage incompatibility (column 6), similarly, is medium. Looking for the phone is primarily a perceptual task, as is driving. Hence, both tasks will compete for the driver's perceptual resources.

Looking for the phone to locate it requires relatively little attention, especially if it is normally placed in the same location within the vehicle; it is not a very difficult task to perform. Hence, it is assumed that the combined demand level for both

tasks (looking and driving) is low, assuming that driving conditions at the time are relatively easy.

It is assumed that looking for the phone, when the decision to phone a friend is self-initiated, is not so compelling or demanding that the driver cannot disengage from it. Hence, the rating for "nonignorability" is low.

The driver can choose when to start looking for the phone and can foresee the consequences of looking away from the road. The degree of predictability of locating the phone depends on how the driver stores the phone. If the phone is kept in a docking station then finding it would be very predictable; if the driver stores it on the passenger seat, then finding it might be less predictable. Hence, the rating for "unpredictability" is low, especially if the location of the phone is already known (e.g., if it is housed in a cradle when not in use).

Looking for the phone is a task that can be postponed and resumed after interruption by some aspect of the driving task (e.g., a braking lead vehicle), assuming that the decision to make the call is self-initiated. Hence the rating for "uninterruptability" is low.

The driver can choose to change the demand associated with the performance of the "looking" task by, for example, glancing only briefly inside the vehicle while driving. Hence, the task is low in "nonadjustability."

Finally, it is assumed that the driver knows where the phone is located and that the total time required to look for it will be minimal (less than 1 s), with only a single eye glance. Hence, the looking task is rated as a low-duration task. Of course, as discussed in Chapter 9 (in relation to the *R* metric), a looking task may, in some circumstances, be minimally distracting, even if it has a relatively long task duration. This might be so, for example, if the task is interruptible, enabling it to be broken down, or "chunked," into smaller subtasks, each requiring a short eye glance.

Similar lines of reasoning were used to derive the ratings for each of the other actions in the remaining rows of the table (i.e., rows 2–6).

It is possible to use Table 15.5 to make predictions about the likely impact on the driving performance of individual actions, or of all those actions that comprise an overall activity. For example, if the ratings high, medium, and low are converted into scores of 3, 2, and 1, respectively (where 3 denotes high distraction potential and 1 denotes low distraction potential), then the unweighted mean score for the action "looking (to locate phone in car)" in Table 15.5 is 1.7. Unweighted mean scores for this and the remaining actions are shown in the last column of the table. Across rows, the table can be used to draw attention to those actions for a given activity that have the propensity to be relatively more distracting than others. The action of dialing a friend's telephone number has the highest rating of 2.2. Across columns, the table reveals which underlying dimensions contribute most to the propensity to distract drivers. Here, the ratings suggest that, for a self-initiated call on a handheld mobile phone, it is competition for common processing resources, rather than the control characteristics of the activity, that contributes most to distraction. Averaging across rows yields a mean score of 1.6 for the six actions comprising the overall activity of phoning a friend. This score can be used to compare, for the same device (i.e., handheld phone), the relative propensity of different overall activities to distract a driver.

Of course, further work is needed to determine the relative weightings that might be given to the scores on each of the underlying dimensions. The relative weighting given to the dimension "duration" is of particular importance here, as it can be viewed as a measure of total exposure to all of the above dimensions. The ratings in Table 15.5 suggest that dialing a friend's telephone number (rating 2.2) is more distracting than talking on the phone while keeping your eyes on the road (rating 1.6), assuming that both tasks have an equally high rating for duration. This trend is consistent with the findings from the 100-car naturalistic driving study,[1] which suggest that dialing a handheld device is more risky (odds ratio 2.8) than using the device to talk and listen (odds ratio 1.3; see Chapter 16). However, data from the same study reveal that the population-attributable risk (PAR) associated with dialing a handheld mobile phone, which takes into account exposure of the population at large to this risk, is the same as that for using the device to talk and listen (3.6% for both; see Chapter 16). This implies that it might be appropriate to differentially weight scores on the "duration" dimension, to take into account not only estimated task completion times but also differential patterns of driver exposure (to the extent to which these are known).

Table 15.5 provides the basis for the development of checklists that might be used to assess the distraction potential of a device or activity. The difficulty, of course, is in using the data in Table 15.5 to make absolute judgments about acceptable levels of predicted distraction for a given action, or overall activity. For example, is an absolute score of 1.7 for "looking" to locate the phone in the car acceptable? Further work is needed to define threshold values beyond which it can be determined that an action, or overall activity, has unacceptably high potential to distract the driver. For the moment, the table is better suited to making relative rather than absolute judgments about this.

15.5 SOURCES OF DRIVER DISTRACTION: THE FUTURE

The major and specific sources of distraction identified in Table 15.3 are, of course, those that derive from the operation of current-generation vehicles, driven by current-generation drivers, on current-generation roads, in the current social, economic, and political climate. Further, they derive from selected studies in only a few countries. As the driving task, and society itself, continues to evolve, so too will the events and objects that drivers interact with and the actions they perform on them. Consequently, the sources of distraction identified in Table 15.3 will inevitably change. As various distraction prevention and mitigation strategies are implemented and begin to take effect (see Chapters 30 through 32), the extent to which the existing sources of distraction show up as contributing factors in crashes and near-crashes will also change.

How the main and specific sources of distraction listed in Table 15.3 are likely to change in future is not clear. Some will remain the same, some may disappear altogether from crash databases, and new sources will appear. Many factors will determine which ones remain, disappear, and emerge. Some of these were alluded to earlier in this chapter. These include the definitions that are used for determining what should and should not be regarded as distraction, what is voluntarily reported by crash victims, the design of data collection methods (e.g., crash studies, naturalistic

driving studies), and the knowledge and expertise of police, crash investigation teams, and researchers in knowing what questions to ask about the potential role of distraction as a contributing factor in crashes. Other factors may also intervene.

Consider, for example, "things brought into the vehicle." Stricter legislation to ban specific objects from being brought into the vehicle (e.g., animals or pets) or to ban the use of specific objects brought into the vehicle while it is in motion (e.g., cigarettes) may be effective in eliminating some of these sources of distraction, perhaps in countries with strong enforcement regimes and a highly compliant driving population. Conversely, nomadic devices (with driving or nondriving-related functions) that can be brought into the vehicle will likely increase in number and functionality and, if they divert attention away from activities critical for safe driving, will surface as new specific sources. As data collection and coding schemes become more refined, it is likely that various other things brought into the vehicle will also surface as specific sources of distraction.

Sources of distraction deriving from driver interaction with "vehicle systems" are also likely to change in various ways. As data collection methods and tools become more refined, further sources of vehicle system-related distraction will be discovered for existing systems. The rapid proliferation within vehicle cockpits of factory-fitted entertainment systems (e.g., DVD players), vehicle information and communication systems (VICS; e.g., traveler information, Internet), and advanced driver-assistance systems (ADAS, e.g., adaptive cruise control, in-vehicle navigation, collision warning) may create new sources of distraction if the systems, and the functions they support, are poorly designed and located, or used inappropriately.[15,16] Conversely, some sources of distraction may disappear as system interfaces in vehicle cockpits become progressively better designed for human use, and workload managers, and other real-time distraction mitigation systems, limit driver exposure to competing activities when drivers are most vulnerable to the effects of distraction. Well-designed ADAS technologies that partially or fully automate some driving functions and tasks will make driving easier; however, in doing so, they may encourage drivers to compensate for the resultant reduction in workload by engaging in nondriving activities not yet known.

"Vehicle occupants" will always remain potential sources of distraction. Legislation can be used, however, to eliminate, at least temporarily, some vehicle occupants as sources of distraction. For example, in some countries specific legislation already exists that prohibits young novice drivers, as part of graduated licensing systems, from carrying certain passengers known to elevate their crash risk through distraction or peer pressure.

The specific sources of "moving objects or animals in the vehicle" that distract drivers are unlikely to change, although it is possible that, as more nomadic devices are brought into the vehicle, these may constitute additional items that have potential to move within the cabin if unrestrained. As noted previously, more stringent legislation may also have the effect of eliminating some of these sources of distraction.

As data collection and coding schemes become more refined, it is also likely that new sources of "internalized activity" will surface, although this may depend to some extent on the prevailing legislative regimes. If careless driving and other regulatory provisions continue to be used to blame drivers for involuntarily diverting their

attention away from activities critical for safe driving toward internalized activities, drivers will continue to be reluctant to voluntarily report such episodes to enforcement authorities. As a greater amount of information is presented to the driver in the cockpit, the amount of internalized activity is likely to increase; there will be more to think about while driving.

As noted by Gordon in Chapter 16, considerably greater effort has gone into classifying sources of distraction deriving from inside the vehicle than those deriving from outside the vehicle. As data collection methods and tools become more refined, it is likely that many new "external objects, events, and activities" that have potential to distract drivers will be discovered. Advances in technology outside the vehicle have potential to influence the sources of distraction that emerge in future from crash and other studies in different ways. On the one hand, new technologies that are poorly designed and located, whether they are driving or nondriving related, may give rise to distraction and surface as additional sources of distraction. On the other hand, as more information currently displayed outside the vehicle is displayed to the driver inside the vehicle, one might expect a reduction in the number of sources of distraction that derive from outside the vehicle as shown in Table 15.3. Legislation and traffic engineering measures can play a powerful role in determining what remain as sources of distraction outside the vehicle. Legislation can be used, for example, to regulate the location, design, and operation of objects and events outside the vehicle, which have potential to distract drivers. It can be used to regulate the location and design of advertising billboards at certain road sites, to ban the presentation of advertising material on the back of buses, taxis, and other structures, and to prevent events from being staged at locations likely to distract drivers. Engineering countermeasures can be implemented to prevent animals from crossing roadways at certain locations, to divert traffic away from prominent landmarks and scenery likely to attract attraction, and to prevent or minimize interactions with other road users in high-workload areas (e.g., via installation of overhead pedestrian walkways). Tingvall, in Chapter 33, has underscored the importance of traffic engineering design in creating a distraction-tolerant road system. At least theoretically, measures of this kind have potential to eliminate several of the external objects, events, and activities listed in Table 15.3.

As the vehicle cockpit evolves, and the driving task becomes progressively more automated, the role of the driver, like that of the aircraft pilot, will inevitably change—from being less of an active controller of the vehicle to being more of a systems monitor. This will result, over time, in an increased emphasis on higher-level perceptual and cognitive activity, and an accompanying decrease in the number and types of control operations required to drive a vehicle.[17] If so, it is probable that more of the actions in the Miller[8] taxonomy will be performed on objects, events, and activities inside and outside the vehicle.

15.6 CONCLUSIONS

In this chapter, we have proposed a taxonomic description of the various main and specific sources of driver distraction that have been identified as contributing to crashes and near-misses in current-generation vehicles, driven by current-generation

drivers on current-generation roads. The taxonomy is derived from several studies that have made use of secondary crash-based data sources collected by agencies (typically the police), from selected observational studies and from the definition of driver distraction presented in Chapters 1 and 3 of this book. The taxonomy is intended to serve several purposes: to begin to resolve confusion about what are, and are not, sources of distraction, inside and outside the vehicle; to provide a framework for categorizing these sources of distraction; and to support the development of less variable methods for collecting and coding crash and epidemiological data.

We have also provided a matrix for predicting the potential impact of these sources of distraction on driving performance, which provides a theoretical basis for the development of checklists that can be used to assess the level of driver distraction deriving from performance of a particular activity. The taxonomy and framework presented here will need to be updated as the driving task continues to evolve.

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