
Driving Competence: The Person × Environment Fit

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A major question that Dr. Ball and her colleagues (Ball & Owsley, this volume) have been investigating is: “What are the Risk Factors for Involvement in Crashes among Older Drivers?” This discussion will focus on two issues that were part of the Ball presentation: (a) conceptualization of driving competence; and (b) the measurement of cognitive functioning as a risk factor and driving performance as the criterion variable of interest.

Psychologists studying driving behavior are often primarily concerned with the characteristics of the older driver—age, cognitive status, health, driving experience, and so forth. Secondly, there is consideration of the demands of the environment or context in which driving occurs. For researchers who are engineers or human factors specialists, the primary focus is on these contextual factors with secondary consideration of the driver in relation to these factors.

DRIVING COMPETENCE: THE FIT OF THE PERSON AND THE ENVIRONMENT

Driving competence is best defined as the congruence or fit between the driver and the environment. Driving competence does not reside solely in the person nor in the environment or context, but in the interaction between the two factors. The need to define competence in terms of a person \times environment interaction has been reinforced in the ongoing research at Penn State on the older driver's ability to make left turns. Competence to make a left turn cannot be studied in the absence of the traffic environment, particularly in the absence of oncoming traffic. Most drivers can execute a safe left turn if there is no traffic. Judgment of gap and rate of closure only becomes critical when there are approaching vehicles.

CONGRUENCE OF INDIVIDUAL SKILLS AND ENVIRONMENTAL DEMANDS

Competence can be conceptualized in terms of the congruence between the individual's capabilities and the demands and resources of the environment. This concept can be illustrated by different types of triangles (Figure 5.5). In the equilateral triangle, there is a balance or congruity between the individual's abilities and skills and the complexity of a particular environmental context.

Incongruity and thus incompetence can occur either when the individual's skill level is inadequate or when more challenging environmental conditions occur. There may be a decrease in competence when the individual's skills decline (due to health, cognitive, or sensory limitations), even though the environmental demands do not change. Alternatively, there may be a decrease in competence when there are more challenging environmental demands, for example an intersection with heavy traffic flow or an intersection with no traffic signal, even though the skills and abilities of the individual have not declined. A decrease in competence can of course occur due to a decline in both the individual and increased environmental demands.

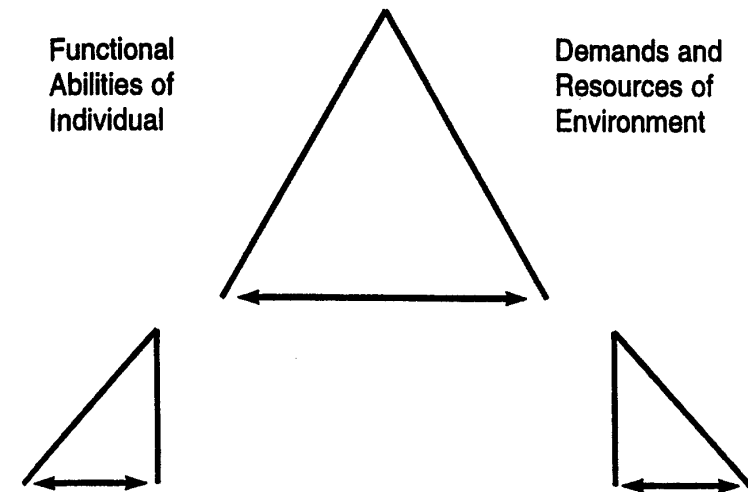


Figure 5.5 Incongruence in person-environment interaction: Three types.

Environmental Factors in the Study of Driving

Although much of this paper will focus on driver characteristics, at least five domains of environmental factors are important to consider when studying driving.

First, there is the physical environment including the weather. As Ball reported, weather conditions are an important factor in the driver's avoidance behaviors. They are also implicated in accidents and fatalities.

Second, there is the environment within the automobile. This includes placement of equipment (e.g., turn signals, mirrors), structural features of the car that facilitate or limit visibility, and warning devices.

Third, there are the structural features of the roadway, including type of intersection, whether there is a signal and type of signal, number of lanes, and presence or absence of turn lanes.

Fourth, there are the dynamic aspects of the roadway, including traffic flow, size of oncoming vehicles, contrast between oncoming vehicles and road.

Finally, there are the social aspects of the driving context. Ball has found that the mental status of the driver is significantly related to whether the driver avoids driving alone, suggesting the issue of copiloting.

The aggressive or hostile behavior of other drivers on the roadway would be another instance of social factors.

These environmental factors are of interest in their own right. From a psychological approach, however, these environmental factors are important to the extent that they increase or decrease the mental load required of the driver. For example, with respect to making a left turn, features of the roadway such as turn lanes and traffic signals at an intersection can reduce the memory load, speed of processing demands, and vigilance required of the driver. Reduction in mental load is particularly important when a driving situation involves what in psychology is known as a *dual task*—the driver must attend and make decisions based on multiple sources of information simultaneously.

DRIVING COMPETENCE VERSUS DRIVING PERFORMANCE

In studying the everyday functioning of older adults, it is useful to distinguish between *competence* and *performance*. Everyday *competence* has been defined as the adult's ability or potential to perform adequately those activities considered essential in a given domain, such as driving (Willis, 1991, 1996). Competence must be differentiated from everyday *performance*—what the individual actually does routinely in daily life. Competence represents ability to carry out, when necessary, a broad array of activities considered essential of a task such as driving, even though in daily life the adult may not perform these activities or only performs a subset of these activities.

With respect to mobility, an older adult may be capable (physically and cognitively) of going outside one's home or neighborhood but may not choose to do so for any number of reasons—depression, lack of interest, or an idiosyncratic reason such as they can't take

their pet to certain public places. An older driver may be competent to make left turns or to drive at night but may choose in daily life to avoid these activities.

This distinction between competence and performance is important for a number of reasons. First, legal judgments regarding whether a guardian or conservator should be appointed for an individual are usually based on the competence of the individual rather than their daily behavior, unless their behavior is endangering other individuals (Smyer, Schaie, & Kapp, 1996; Grisso, 1986). Secondly, the traditional manner in which the individual's ability to live independently, involving ADLs (Activities of Daily Living) and IADLs (Instrumental Activities of Daily Living) is based on capability not routine performance (Lawton & Brody, 1969). The question is asked "Can the individual carry out an activity" not "Does the individual routinely perform an activity." The assessment of IADLs often serves as the basis for determining the capability of the older adult to live independently and for determining eligibility for health and social services.

Dynamic Nature of Competence

Research on driving performance is often studied on a single occasion or over very short time intervals. In real life, competence is dynamic. It changes across time as the individual ages and also as the demands of the environment increase or decrease. Thus, if competence to drive is seen as the congruence of the person's ability and the demands of the environment, both aspects of the equation must be continually monitored across the individual's driving lifespan.

STUDY OF RISK FACTORS IN DRIVING

In considering risk factors related to the driving performance of older adults, three broad domains of variables are often studied. These include: (a) the characteristics of the older driver; (b) a measure of driving performance; and (c) outcome measures, such as involvement in a crash or fatality. Two of these three factors will now be considered in more detail.

In studying risk factors, social scientists often use a structural modeling approach in which the characteristics of the individual are viewed as correlates or predictor variables. Whether individual characteristics account for differences among persons in their driving performance is examined. Driving performance is the criterion variable of interest. What aspects of driving performance are related to outcome measures such as crash involvement is also examined. Finally, whether individual variables influence outcome measures directly or indirectly through their impact on driving performance is considered.

The risk factor domains of vision and cognition have been of primary interest to those in cognitive aging research that study older drivers. Consideration of the measures used to assess vision and cognition suggests that a broader and more diverse array of vision or perception variables may have been considered than cognitive measures.

Often cognition has been assessed by a global or general measure rather than by a battery of tests assessing different dimensions of intelligence. Use of a global measure such as the MMSE (Mini-Mental State Examination) (Folstein, Folstein, & McHugh, 1975) or MATTIS (Mattis, 1976) is quick and efficient and provides the investigator with information on whether the individual is within the normal range of functioning. These measures are often used in assessment of dementia, and thus the investigator can compare the older driver's score to cutoff scores or norms used in clinical investigations.

These global cognitive measures, however, have serious limitations when the focus is on understanding what aspects of cognition are associated with driving behavior. First, these global measures involve test items representing a number of different mental abilities. A global measure often involves measures of verbal ability, memory, and reasoning or executive functioning. These different abilities have different developmental trajectories in adulthood (Schaie, 1996). The very different developmental trajectories for various abilities are masked when cognitive functioning is represented as a single score from a global measure.

Why is a focus on distinct mental abilities, rather than global functioning, important in studying risk factors in driving performance? There are at least two reasons. In the study of vision, it

has been useful to examine distinct factors such as acuity, contrast sensitivity, and central and peripheral vision and to determine whether they are significant predictors of outcomes such as involvement in crashes. Similarly, examining the relation of distinct abilities to driving behaviors and outcome measures should be useful. It is important to understand the relative contribution to driving performance of those abilities that show early age-related decline and those exhibiting later decline. It should be very useful to clinicians and rehabilitation therapists if the relationship between specific abilities and particular driving skills were examined more carefully.

It seems likely that different driving tasks involve different constellations of mental abilities. This leads to the final topic dealing with the measurement of driving performance. Assessment of driving performance, particularly of an older adult, in a safe, reliable, and objective manner is a major challenge to research in this area. Given this challenge, several distinct approaches to obtaining some index of driving performance have evolved.

One major dimension is whether the assessment is direct and objective or indirect and subjective. There is obviously a continuum from indirect to direct approaches. Objective, direct assessment involves on-road driving performance while indirect approaches involve a proxy rating or self-report of driving behavior without direct on-road performance. The older adult's report of avoidance behaviors discussed by Ball is an indirect measure of driving performance. Performance on a simulator falls somewhere along this continuum.

Another dimension along which measurement of driving performance varies is the specificity of the driving task. Some assessments focus on a global or summary rating, while others focus on specific driving tasks/behaviors (driving at night, making a left turn).

Figure 5.6 presents a hierarchical approach to studying the relationship between distinct mental abilities and specific driving tasks. There are a subset of mental abilities that are probably involved in most driving tasks. These may include the speed of processing aspects of the useful field of view (UFOV) task discussed by Ball, complex reaction time, and working memory ability.

When considering particular driving behaviors, however, the role of specific abilities becomes more evident. For example, wayfinding and some parking tasks (e.g., parallel parking) are likely to involve spatial ability—the ability to mentally rotate and visualize automo-

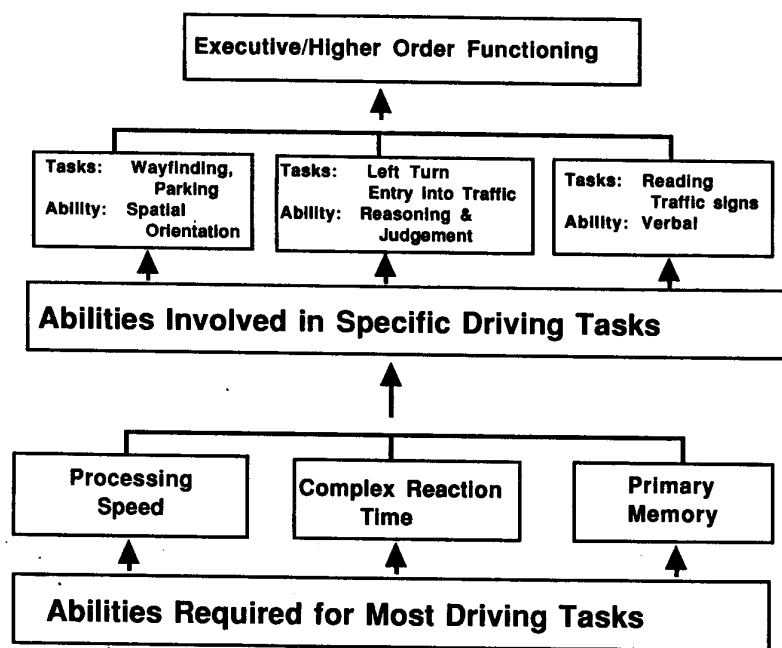


Figure 5.6 A hierarchical approach to studying the relationship between mental abilities and specific driving tasks.

biles and roadway structures in two- and three-dimensional space. One the other hand, interpreting road signs may be influenced significantly by verbal ability and experiential knowledge. Executing a left turn in traffic involves skills such as inductive reasoning and judgment of gap and rate of closure. At the top of the hierarchy are what psychologists call executive functioning—the ability to make decisions in complex situations. For example, planning a route through a new environment or dealing with a demanding traffic situation involves executive functioning. Executive functioning is represented by a constellation of higher-order cognitive skills.

An important next step in research is examining the relationship between specific mental abilities and particular driving tasks for the older driver. Specifying these relationships are important in their

own right and as a precursor to developing targeted behavioral interventions with the older driver.

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