

**DECLINING FUNCTIONAL ABILITIES AND
ADVANCED DRIVER ASSISTANCE SYSTEM
(ADAS) TECHNOLOGIES**



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16. Abstract As people age, they are more likely to experience declines in vision, movement, and thinking abilities (known as functional abilities) that are needed for safe driving. Advanced Drive Assistance System (ADAS) technologies may help people maintain safe driving for longer even when faced with declining functional abilities. There is little information, however, about which ADAS can be most useful for specific functional ability declines. Based on research conducted by the University of Michigan Transportation Research Institute (UMTRI), we have developed a table that provides recommended ADAS technologies for those who are starting to experience declines in 28 functional abilities. Each ADAS technology is linked to further information about how the technology works.					
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Introduction

As people age, they are more likely to experience declines in vision, movement, and thinking abilities (known as functional abilities) that are needed for safe driving. ADAS technologies may help people maintain safe driving for longer even when faced with declining functional abilities. There is little information, however, about which ADAS can be most useful for specific functional ability declines. Based on research conducted by the University of Michigan Transportation Research Institute (Eby et al., 2008a; 2008b, 2015; Molnar et al., 2010), we have developed a table that provides recommended ADAS technologies for those who are starting to experience declines in functional abilities. Note that this list is not just for the older drivers but can be useful for anyone who is experiencing declines in functional abilities. Also, if you or someone you know is experiencing any of these physical challenges, it is recommended that they have a conversation with their primary care provider about how these declines may relate to driving. It may also be beneficial to have a combination of ADAS to best support your driving needs. Finally, keep in mind that these technologies may not be sufficient to assure a driver's safety-each as each driver's needs are unique.

Declines in Functional Abilities and ADAS to Help Overcome These Declines

Functional Ability Decline	Definition	ADAS
Reduced Visual Acuity	Reduction in the eye's ability to see fine details and see images at a distance that are in-focus.	<ul style="list-style-type: none"> • Adaptive headlights • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Forward collision warning • Left turn crash avoidance • Level 2 automated driving system • Obstacle detection • Pedestrian detection • Rear cross traffic alert • Sideview camera
Increased Sensitivity To Glare	A diminished ability to see things in dim lighting conditions when bright lights (glare), such as headlights, are present, making it harder to see well at night.	<ul style="list-style-type: none"> • Adaptive cruise control • Adaptive headlights • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Drowsiness alert • Forward collision warning • High speed alert • Hill descent assist • Hill start assist

		<ul style="list-style-type: none"> • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Pedestrian detection • Rear cross traffic alert • Sideview camera • Voice activated controls
Reduced Peripheral Vision	Diminished ability to see objects at the edges of one's field of view.	<ul style="list-style-type: none"> • Automatic parallel parking • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Drowsiness alert • Forward collision warning • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Parking sensors • Pedestrian detection • Rear cross traffic alert • Sideview camera • Voice activated controls
Reduced Contrast Sensitivity	Diminished ability to distinguish differences between objects and the background, which often makes it difficult to see at night.	<ul style="list-style-type: none"> • Adaptive headlights • Bicycle detection • Blind spot warning • Brake assist • Forward collision warning • Left turn crash avoidance • Level 2 automated driving system • Obstacle detection • Pedestrian detection • Rear cross traffic alert • Sideview camera
Poor Depth Perception	Diminished ability to determine spatial relationships, namely distances between objects, in three dimensions.	<ul style="list-style-type: none"> • Adaptive cruise control • Automatic parallel parking • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Drowsiness warning • Forward collision warning

		<ul style="list-style-type: none"> • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Parking sensors • Pedestrian detection • Rear cross traffic alert • Sideview camera • Voice activated controls
Visual Scanning Deficits	A decreased ability to search the environment to keep track of what is going on around us	<ul style="list-style-type: none"> • Adaptive cruise control • Automatic parallel parking • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Drowsiness alert • Forward collision warning • High speed alert • Hill descent assist • Hill start assist • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Parking sensors • Pedestrian detection • Rear cross traffic alert • Sideview camera • Voice activated controls
Visuospatial Deficits	A decreased ability to think about and perceive the arrangement of objects in space, including one's position relative to the environment and recognizing differences in the shape, size, proportion, and angle of objects.	<ul style="list-style-type: none"> • Adaptive cruise control • Automatic parallel parking • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Drowsiness alert • Forward collision warning • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection

		<ul style="list-style-type: none"> • Parking sensors • Pedestrian detection • Push button start • Rear cross traffic alert • Sideview camera • Temperature warning • Voice activated controls
Divided Attention Deficits	A reduced ability to do two things at once, such as keeping track of ones driving speed and what other cars are doing.	<ul style="list-style-type: none"> • Automatic parallel parking • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Forward collision warning • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Parking sensors • Pedestrian detection • Rear cross traffic alert • Sideview camera • Voice activated controls
Difficulty Following Directions	Difficulty with following an instruction or series of instructions for doing or finding something.	<ul style="list-style-type: none"> • Blind spot warning • Brake assist • Forward collision warning • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Pedestrian detection • Voice activated controls
Cognitive Rigidity	A decreased ability to shift focus away and consider alternative actions, thoughts, or solutions.	<ul style="list-style-type: none"> • Adaptive cruise control • Blind spot warning • Lane departure warning • Lane keeping assist • Level 2 automated driving system • Navigation assistance • Voice activated controls
Selective Attention Deficits	A diminished ability to ignore what is not important while focusing on what is important, such as a driver quickly directing their attention to the most	<ul style="list-style-type: none"> • Automatic parallel parking • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Forward collision warning • Lane departure warning

	important things happening outside the vehicle.	<ul style="list-style-type: none"> • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Parking sensors • Pedestrian detection • Rear cross traffic alert • Sideview camera • Voice activated controls
Slowed Information Processing	An increasing delay or reduction in the ability of one's mind to consistently monitor what is going on in the environment and one's body to react appropriately.	<ul style="list-style-type: none"> • Adaptive cruise control • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Drowsiness alert • Forward collision warning • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Pedestrian detection • Rear cross traffic alert • Sideview camera • Voice activated controls
Forgetfulness	A diminished ability to remember information that is important for doing one's current activity, such as a familiar traffic route of the rules for safe driving behavior.	<ul style="list-style-type: none"> • Adaptive cruise control • Adaptive headlights • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Drowsiness alert • Forward collision warning • High speed alert • Hill descent assist • Hill start assist • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Pedestrian detection • Rear cross traffic alert

		<ul style="list-style-type: none"> • Sideview camera • Voice activated controls
Getting Lost	Unable to navigate or find one's way in a familiar area.	<ul style="list-style-type: none"> • Blind spot warning • Level 2 automated driving system • Navigation assistance • Voice activated controls
Confusion	Inability or delay in ability to process information and make critical judgments	<ul style="list-style-type: none"> • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Drowsiness alert • Forward collision warning • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Pedestrian detection • Push button start • Rear cross traffic alert • Sideview camera • Temperature warning • Voice activated controls
Impaired judgment	Diminished ability to assess conditions and draw reasonable conclusions.	<ul style="list-style-type: none"> • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Forward collision warning • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Obstacle detection • Pedestrian detection • Rear cross traffic alert • Sideview camera
Depression	A disorder characterized by an inability to concentrate, insomnia, loss of appetite, feelings of extreme sadness, guilt, helplessness and hopelessness, and thoughts of death.	<ul style="list-style-type: none"> • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Drowsiness alert • Forward collision warning • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection

		<ul style="list-style-type: none"> • Pedestrian detection • Rear cross traffic alert • Sideview camera • Voice activated controls
Drowsiness/Sleepiness	A state of impaired awareness associated with a desire or need to sleep.	<ul style="list-style-type: none"> • Adaptive cruise control • Adaptive headlights • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Drowsiness alert • Forward collision warning • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Pedestrian detection • Rear cross traffic alert • Sideview camera • Voice activated controls
High Levels of Pain	A high level of suffering or painful sensations that are at a level that disrupts normal activities.	<ul style="list-style-type: none"> • Adaptive headlights • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Drowsiness alert • Forward collision warning • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Pedestrian detection • Push button start • Sideview camera • Temperature warning • Voice activated controls
Anxiety	Feelings of nervousness and/or fear, as a reaction to a stressful situation.	<ul style="list-style-type: none"> • Adaptive cruise control • Automatic parallel parking • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Drowsiness alert

		<ul style="list-style-type: none"> • Forward collision warning • High speed alert • Hill descent assist • Hill start assist • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Parking sensors • Pedestrian detection • Push button start • Rear cross traffic alert • Sideview camera • Temperature warning • Voice activated controls
Impulsiveness	<p>Personality trait associated with lack of control over emotions, especially anger, difficulty delaying gratification, and novelty seeking.</p>	<ul style="list-style-type: none"> • Adaptive cruise control • Automatic parallel parking • Bicycle detection • Blind spot warning • Curve speed warning • Drowsiness alert • Forward collision warning • Level 2 automated driving system • Navigation assistance • Obstacle detection • Parking sensors • Rear cross traffic alert • Sideview camera • Voice activated controls
Upper Body Stiffness	<p>Decrease in upper-body range of motion and the decreased ability to move the upper body easily or comfortably.</p>	<ul style="list-style-type: none"> • Automatic parallel parking • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Drowsiness alert • Forward collision warning • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Parking sensors • Pedestrian detection • Rear cross traffic alert

		<ul style="list-style-type: none"> • Sideview camera • Voice activated controls
High Level of Upper Body Weakness	Decrease in ability to resist strain or stress, or exert physical force using the upper body, such as pushing oneself out of a seating position.	<ul style="list-style-type: none"> • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Forward collision warning • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Obstacle detection • Pedestrian detection • Rear cross traffic alert • Sideview camera
Slowed Physical Movements	Delay or reduction in one's ability to change the direction or motion of one's body parts, such as reaching for something.	<ul style="list-style-type: none"> • Adaptive cruise control • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Forward collision warning • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Obstacle detection • Pedestrian detection • Rear cross traffic alert • Sideview camera
Endurance	A diminished ability to maintain normal physical functioning without becoming excessively fatigued over time.	<ul style="list-style-type: none"> • Adaptive cruise control • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Forward collision warning • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Navigation assistance • Obstacle detection • Pedestrian detection • Rear cross traffic alert • Sideview camera • Voice activated controls
Neuropathy-Feet	The presence of unusual or unpleasant sensations such	<ul style="list-style-type: none"> • Adaptive cruise control • Automatic parallel parking

	as tingling, burning, itchiness, clumsiness, and/or a prickling sensation and sensitivity to touch in one or both feet.	<ul style="list-style-type: none"> • Bicycle detection • Blind spot warning • Brake assist • Curve speed warning • Forward collision warning • High speed alert • Hill descent assist • Hill start assist • Lane departure warning • Lane keeping assist • Left turn crash avoidance • Level 2 automated driving system • Obstacle detection • Parking sensors • Pedestrian detection • Rear cross traffic alert • Sideview camera
Impaired Coordination	A diminished ability to performed organized actions of muscles or groups of muscles in the performance of movements or tasks, making it more difficult to control the steering wheel, hold onto to the car key and operate the ignition, and use other vehicle controls.	<ul style="list-style-type: none"> • Adaptive cruise control • Bicycle detection • Blind spot warning • Curve speed warning • Forward collision warning • Left turn crash avoidance • Obstacle detection • Pedestrian detection • Sideview camera
Tremors	An involuntary trembling or quivering often caused by nervous agitation or weakness	<ul style="list-style-type: none"> • Adaptive cruise control • Automatic parallel parking • Bicycle detection • Blind spot warning • Curve speed warning • Forward collision warning • Left turn crash avoidance • Obstacle detection • Parking sensors • Rear cross traffic alert • Sideview camera

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