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Degree of Distraction

What cell phones do to a driver's brain

by *Amy Oprean*

In today's fast paced, technology-saturated world, cell phones have changed daily life in a multitude of ways – and not always for the better. A major concern surrounding mobile phones is the hazard of conversation-engrossed drivers losing focus on the road, potentially contributing to crashes. But while anecdotes of cell phone-distracted drivers aren't hard to find, an actual scientific measure of how dangerous cell phones are – both hand-held and hands-free – is still a highly controversial topic among researchers, lawmakers and drivers.

Li Hsieh, Ph.D., associate professor in the Department of Communication Sciences and Disorders in the College of Liberal Arts and Sciences, is one such researcher working to assess the mechanisms underlying how cell phone conversations affect driver performance, with a specific focus on visual event detection.

"Humans were built for multitasking, that's why you see people doing all kinds of things in their cars without crashing; drinking a cup of coffee, playing with the radio, mothers driving with two or three kids fighting in the back," she said. "But there is a limit to this multitasking and finding that limit is key to my research."

While cell phones have exploded in popularity over the past decade, there hasn't been a corresponding rise in crashes on the highways, a finding that has led Hsieh to believe that

some researchers may be drawing exaggerated conclusions from experiments assessing the danger of cell phones. Some of the most widely publicized studies, in fact, use methods that do not distinguish the conversation from other aspects of cell phones – such as dialing and looking for the phone – or even other manual tasks occurring at the time of a collision.

"If you look at a lot of these cell phone studies that have been conducted, they're investigating cell phones along with a lot of other simultaneous activities, such as talking to passengers, changing the radio, and handling the cell phone," she said. "More studies are needed to determine which of these tasks are actually causing the biggest distraction."

Keeping this in mind, Hsieh has designed her study to isolate the conversation element – the cognitive act of conversing in a hands-free cellular call – with the goal of gauging the effects of the conversation alone. Knowing what aspect of cell phone conversations causes the biggest distraction, Hsieh said, could lead to determining appropriate countermeasures that improve driving safety. Her experiment considered not only the behavioral effects of cell phone conversations on a driver's accuracy and reaction time, but also the neurological underpinnings – the areas of the brain that are active when a person is talking on a cell phone while driving.

"We're trying to see what things make people the most distracted, and the neural mechanisms behind that type of distraction," she said.

Hsieh is leading an interdisciplinary and multi-institutional research collaboration on the effect of cell phone conversations on driving performance, funded with a \$1.24 million grant from the Michigan Economic Development Corporation from the State of Michigan. Conducted at Wayne State University, Henry Ford Hospital and the University of Michigan Transportation Research Institute, Hsieh recruited participants to partake in a computer-based driving simulation and on-road driving tests while engaging in a hands-free cellular conversation.

During the computerized driving simulations, participants use a steering wheel to keep a cursor centered on the vehicle's lane, while a self-propelled driving simulation steered through real video footage of metro-Detroit area roads. Throughout the simulations, participants were asked to press down on a foot pedal whenever they saw a "visual event" – a red light representing any sort of visual cue for which drivers should react by braking, such as a stop sign, red light, or pedestrian crossing the street. Participants taking the on-road tests performed the same event detection tasks while driving a real vehicle on open roads.



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After this baseline trial, Hsieh ran several different phases of the experiment during which participants answered the questions of an automated caller. In one, the caller had a neutral voice tone; in another, the caller had an aggressive, emotionally charged tone; and another, the caller asked questions that were complex in nature. Reaction time – the time taken to respond to the visual events – and number of visual events missed were recorded for these trials as well. Depending on the test phase, Electroencephalogram (EEG), Magnetoencephalography (MEG), and functional Magnetic Resonance Imaging (fMRI) scans were done during the driving simulation. EEG recordings of the driver's brain activity were taken during the on-road tests.

Conversations slow driver reaction time

In both lab simulations and on-road tests, neutral conversations caused a delay in participants' reaction times by 60 to 120 milliseconds, but missing a visual event was rare. Reaction times during the alternate "emotionally charged" conversation were actually shorter than those during neutral conversations, but were still longer than the baseline, no-conversation trial. Dr. Hsieh said reaction times may have been faster during conversations with an aggressive caller because being irritated may have caused people to be more alert.

The brain's balancing act

Preliminary results of the brain imaging studies revealed the regions of the human brain that are activated as it juggles attention between the primary task of driving and the secondary task of holding a conversation. The frontal lobe, which controls the allocation of brain resources, showed an increase in activation during conversations taking place while participants performed the simulated driving and event detection scenarios. Other areas of heightened activity included Broca's area, a region that controls language production, and Wernicke's area, a region associated with language comprehension.

The brain appears to adjust and readjust how its resources are divided while multiple tasks are being carried out; an important job that Hsieh's results suggest is performed by several key regions, namely the frontal and parietal lobes. Because the brain does not have unlimited resources, however, some regions see a decline in event-related activation when this multitasking is taking place. This decrease in event-related activation – which Hsieh and her colleagues observed in the parietal lobe and secondary visual cortex – may provide a possible neural mechanism for the increase in visual reaction times while a conversation is taking place.

"The MEG and MRI imaging data show that when a person's reaction time gets longer, it is during times of reduced event-related activity in the parietal lobe as well as the visual cortex," she said. "But even though participants' reaction times were affected, their accuracy was still good. It's actually

pretty hard to make someone completely miss a visual event in those we have tested so far."

Looking to the future

Hsieh's study intends to set a scientific foundation rather than determine a verdict on whether cell phones are safe enough to use while driving, the latter of which would require collecting real-world naturalistic data on actual behavior of drivers when using cell phones on the road. Although subjects did not miss significantly more visual events while conversing in her studies, adding different types of conversations at different intensities could change that, she said. In the meantime, the knowledge gained has provided new insight into how the brain multitasks, and will catalyze studies in several important areas of driver performance research, some of which Hsieh herself plans to pursue.

One area of research Hsieh plans to investigate is the possibility that cell phones negatively affect certain groups more so than others in the larger driving population. She and her collaborators hope to study teenagers, elderly and drowsy drivers to determine if cell phone conversations have a more profound effect on these groups. The results of these studies could be applied to future car or cell phone designs aimed to compensate for driver weaknesses as well as improve rehabilitation and prevention programs for safer driving.

Another area of interest Hsieh plans to investigate is attention blindness while driving. Also known as

Dr. L. Hsieh, associate professor of communications sciences and disorders

the “looked-but-didn’t-see” phenomenon, attention blindness is said to occur when a driver’s gaze is on a visual event, yet they fail to react and do not report seeing it. Hsieh said one of the main reasons for her research is to uncover whether certain types of hands-free cell phone conversations in certain groups of people might produce the degree of attention blindness capable of contributing to crashes.

“Rear end crashes are quite common; that means the object is right in front of you, and you still crash into it,” said Dr. Hsieh, who also records the gaze of people while they participate in her driving simulations and on-road studies. “That’s why we’re doing these studies – to investigate the effect of cell phone conversations not just in ways that can be measured behaviorally, but in ways that allow us to find the neurological causes of those behaviors as well. That’s when improvements in driver safety can be made more precisely and efficiently.”

About Dr. Li Hsieh: Dr. Hsieh received a B.S. in English literature at Soochow University in Taiwan, Republic of China, and an M.A. in linguistics at Fu Jen Catholic University in Taiwan, Republic of China. She received an M.A. in speech-language pathology from Northwestern University and a Ph.D. in speech-language pathology from Purdue University. She did her post-doctoral work in the Department of Cognitive Science at Johns Hopkins University. She joined Wayne State University in 2001.

