

## Curriculum Vitae

### Correspondence

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### Positions

Assistant Professor of Psychology, George Washington University, Washington, DC, 2004-present

Post-doctoral Research Associate, Carnegie-Mellon University, Pittsburgh, PA, 1998-2004

### Academic Background

Ph.D. in Cognitive Psychology, Penn State University, University Park, PA, August, 1998

MA in Cognitive Psychology, Seoul National University, Seoul, Korea, February, 1991

BA in Psychology, Seoul National University, Seoul, Korea, February, 1989

### Professional Affiliation

Cognitive Neuroscience

Cognitive Science

Psychonomic Society

Society for Neuroscience

### Ad-hoc Reviewer

Acta Psychologica

Journal of Experimental Psychology: General

Journal of Experimental Psychology: Human Perception and Performance

Journal of Experimental Psychology: Learning, Memory, and Cognition

Memory & Cognition

NeuroImage

Psychonomic Bulletin and Review

Psychological Science

### Invited Colloquia

2004 Department of Neuroscience, George Washington University, Washington, DC  
Workshop on the neurocognitive bases of task-control, Max Planck Institute, Leipzig, Germany

Department of Cognitive Science, University of California, Irvine, CA

Department of Psychology, Texas A&M University, College Station, TX

Department of Psychology, Kent State University, Kent, OH

Department of Psychology, George Washington University, Washington, DC

2002 Institute of Gerontology, Wayne State University, Detroit, MI

2001 Department of Psychology, George Mason University, Fairfax, VA

**Journal Articles**

- Sohn, M.-H., Douglass, S. A., Chen, M.-C., & Anderson, J. R. (accepted pending revision). Characteristics of fluent skills in a complex, dynamic problem-solving task. Human Factors.
- Sohn, M.-H., Goode, A., Stenger, V. A., Jung, K.-J., Carter, C. S., & Anderson, J. R. (in press). An information-processing model of three cortical regions: Evidence in episodic memory retrieval. NeuroImage.
- Sohn, M.-H., Anderson, J. R., Reder, L. M., & Goode, A. (2004). Differential fan effect and attentional focus. Psychonomic Bulletin and Review, *11*, 729-734.
- Sohn, M.-H., Goode, A., Koedinger, K. R., Stenger, V. A., Fissell, K., Carter, C. S., & Anderson, J. R. (2004). Behavioral equivalence, but not neural equivalence: Neural evidence of alternative strategies in mathematical thinking. Nature Neuroscience, *7*, 1193-1194.
- Sohn, M.-H., & Anderson, J. R. (2003). Stimulus-related priming during task switching. Memory & Cognition, *31*, 775-780.
- Sohn, M.-H., & Carlson, R. A. (2003). Viewpoint alignment and response conflict during spatial judgment. Psychonomic Bulletin and Review, *10*, 907-916.
- Sohn, M.-H., & Carlson, R. A. (2003). Implicit temporal tuning of working memory strategy during cognitive skill acquisition. American Journal of Psychology, *116*, 239-256.
- Sohn, M.-H., Goode, A., Stenger, V. A., Carter, C. S., & Anderson, J. R. (2003). Competition and representation during memory retrieval: Roles of the prefrontal cortex and the posterior parietal cortex. Proceedings of National Academy of Sciences, *100*, 7412-7417.
- Anderson, J. R., Qin, Y., Sohn, M.-H., Stenger, V. A., & Carter, C. S. (2003). An information-processing model of the BOLD response in symbol manipulation tasks. Psychonomic Bulletin and Review, *10*, 241-261
- Qin, Y., Sohn, M.-H., Anderson, J. R., Stenger, V. A., Fissell, K., Goode, A., & Carter, C. S. (2003). Predicting the practice effects on the blood oxygenation level-dependent (BOLD) function of fMRI in a symbolic manipulation task. Proceedings of National Academy of Sciences, *100*, 4951-4956.
- Sohn, M.-H., & Anderson, J. R. (2001). Task preparation and task repetition: Two-component model of task switching. Journal of Experimental Psychology: General, *130*, 764-778.
- Sohn, M.-H., Ursu, S., Anderson, J. R., Stenger, V. A., & Carter, C. S. (2000). The role of prefrontal cortex and posterior parietal cortex in task-switching. Proceedings of National Academy of Sciences, *97*, 13448-13453.
- Sohn, M.-H., & Carlson, R. A. (2000). Effects of repetition and foreknowledge in task-set reconfiguration. Journal of Experimental Psychology: Learning, Memory, and Cognition, *26*, 1445-1460.
- Sohn, M.-H., & Carlson, R. A. (1998). Procedural frameworks for simple arithmetic skills. Journal of Experimental Psychology: Learning, Memory, and Cognition, *24*, 1052-1067.

**Book Chapters**

- Chen, M.-C., Anderson, J. R., & Sohn M.-H. (2002). Eye-Hand coordination during web browsing. In Ratner, Julie A. (ed.) *Human Factors and Web Development*, (pp 207-224) Lawrence Erlbaum Associates, Inc., Mahwah, NJ.
- Carlson, R. A., & Sohn, M.-H. (2000). Conscious control of complex mental activities: Building fluent routines from component skills. In S. Monsell & J. Driver (Eds.) *Attention & Performance XVIII: Cognitive Control* (pp. 443-464). MIT Press, Cambridge: MA.

**Manuscripts**

- Sohn, M.-H., & Anderson, J. R. (submitted). Response inhibition in task switching.
- Sohn, M.-H., & Carter, C. S. (submitted). Conflict adaptation is independent of stimulus repetition: Evidence for the conflict monitoring model
- Sohn, M.-H., Qin, Y., Carter, C. S., & Anderson, J. R. (in preparation). Changes in the basal ganglia during cognitive skill learning.

**Invited Colloquia**

- 2004 Department of Neuroscience, George Washington University, Washington, DC  
Workshop on the neurocognitive bases of task-control, Max Planck Institute, Leipzig, Germany  
Department of Cognitive Science, University of California, Irvine, CA  
Department of Psychology, Texas A&M University, College Station, TX  
Department of Psychology, Kent State University, Kent, OH  
Department of Psychology, George Washington University, Washington, DC
- 2002 Institute of Gerontology, Wayne State University, Detroit, MI
- 2001 Department of Psychology, George Mason University, Fairfax, VA

**Presentations**

- Sohn, M.-H., Stenger, V. A., Carter, C. S., & Anderson, J. R. (October, 2004). Dissociation of prefrontal-parietal contributions to working memory: Evidence with retrieval and maintenance. The 45th Annual Meeting of the Society for Neuroscience; San Diego, CA.
- Sohn, M.-H., Stenger, V. A., Carter, C. S., & Anderson, J. R. (June, 2004). Dissociation of prefrontal-parietal contributions to working memory: Evidence with retrieval and maintenance. The 10th Annual Meeting of the Organization of Human Brain Mapping; Budapest, Hungary.
- Sohn, M.-H., Albert, M. V., Jung, K.-J., Carter, C. S., & Anderson, J. R. (April, 2004). Pay now or pay later: Preparatory conflict monitoring in the anterior cingulate cortex and the prefrontal cortex. The 11th Annual Meeting of the Cognitive Neuroscience Society; San Francisco, CA.
- Qin, Y., Anderson, J. R., Sohn, M.-H., Stenger, V. A., Fissell, K., Goode, A., Silk, E., & Carter, C. S. (April, 2004). Using fMRI to Inform the Components of a Cognitive Architecture. The 11th Annual Meeting of the Cognitive Neuroscience Society; San Francisco, CA.
- Sohn, M.-H., & Anderson, J. R. (November, 2003). Negative priming in task switching. The 44th Annual Meeting of the Psychonomic Society; Vancouver, BC.
- Sohn, M.-H., Qin, Y., Carter, C. S., & Anderson, J. R. (April, 2003). Changes in the basal ganglia during cognitive skill learning. The 10<sup>th</sup> Annual Meeting of the Cognitive Neuroscience Society; New York, NY.
- Sohn, M.-H., Goode, A. G., Koedinger, K. R., Carter, C. S., & Anderson, J. R. (November, 2002). Verbal processes and symbol manipulation during algebra problem solving. The 43rd Annual Meeting of the Psychonomic Society; Kansas City, MO.
- Qin, Y., Sohn, M.-H., Anderson, J. R., Stenger, V. A., Fissell, K., Goode, A., & Carter, C. S. (November, 2002). Practice study in event related fMRI and base-level activation learning in ACT-R. The 43rd Annual Meeting of the Society for Neuroscience; Orlando, FL.

- Sohn, M.-H., Qin, Y., Goode, A., Carter, C. S., & Anderson, J. R. (April, 2002). Changes in neural activities during cognitive skill learning: An Event-related fMRI study with pseudo-algebraic problem solving. The Annual Meeting of the 9th Cognitive Neuroscience Society; San Francisco, CA.
- Sohn, M.-H., & Anderson, J. R. (November, 2001). Priming of the stimulus set in task switching. The 42nd Annual Meeting of the Psychonomic Society; Orlando, FL.
- Anderson, J. R., Qin, Y., Sohn, M.-H., Carter, C. S., & Fincham, J. (November, 2001). ACT-R predicts BOLD activation function. The 42nd Annual Meeting of the Psychonomic Society; Orlando, FL.
- Qin, Y., Sohn, M.-H., Carter, C. S., Stenger, V. A., Fissell, K., & Anderson, J. R. (November, 2001). Event-related fMRI in algebra equation problem solving. The 42nd Annual Meeting of the Society for Neuroscience; San Diego, CA.
- Chen, M.-C., Anderson, J. R., & Sohn M.-H. (March, 2001). What can a mouse cursor tell us more? Correlation of eye/mouse movements on web browsing. In Human Factors in Computing Systems: Extended Abstracts of CHI '01, (pp. 281-282). Seattle, WA. Association for Computing and Machinery
- Sohn, M.-H., Ursu, S., Anderson, J. R., Stenger, V. A., & Carter, C. S. (November, 2000). The role of prefrontal cortex and posterior parietal cortex in task-switching. The 41st Annual Meeting of the Psychonomic Society; New Orleans, LA.
- Sohn, M.-H., Douglass, S. A., Chen, M.-C., & Anderson, J. R. (August, 2000). Eye-movement during unit-task execution in a complex problem solving situation. The 44th Annual Meeting of Human Factors and Ergonomics Society; San Diego, CA.
- Carter, C. S., Ursu, S., Sohn, M.-H., Schneider, W., Stenger, V. A., & Anderson, J. R. (June, 2000). Task representation and task switching in dorsolateral prefrontal cortex during event-related fMRI. The 6th Annual Meeting of the Organization for Human Brain Mapping; San Antonio, TX.
- Sohn, M.-H., & Anderson, J. R. (November, 1999). ACT-R does task switching: Effects of foreknowledge and repetition during task-set reconfiguration. The 40th Annual Meeting of the Psychonomic Society; Los Angeles, CA.
- Sohn, M.-H., & Carlson, R. A. (November, 1998). Coordinative modes and the transfer of mental skill. The 39th Annual Meeting of the Psychonomic Society; Dallas, TX.
- Carlson, R. A. & Sohn, M.-H. (July, 1998). Conscious control of complex mental activities: Building fluent routines from component skills. The 18th International Symposium on Attention and Performance; Windsor Great Park, England.
- Carlson, R. A. & Sohn, M.-H. (November, 1997). Operators and directions: Processing similarities in arithmetic and spatial reasoning. The 38th Annual Meeting of the Psychonomic Society; Philadelphia, PA.
- Sohn, M.-H. & Carlson, R. A. (April, 1997). Establishing a viewpoint in spatial judgment. The Annual Meeting of Eastern Psychological Association; Washington, DC
- Sohn, M.-H. (March, 1997). Does practice make perfect? Well, not exactly. The 12th Annual Graduate Research Exhibition, The Pennsylvania State University, University Park, PA.
- Sohn, M.-H. & Carlson, R. A. (October, 1996). Procedural frameworks for spatial judgment. The 37th Annual Meeting of the Psychonomic Society; Chicago, IL.
- Carlson, R. A., & Sohn, M.-H. (November, 1995). Rule application skills have internal structure. The 36th Annual Meeting of the Psychonomic Society; Los Angeles, CA.

**Awards**

Graduate Student Award for Excellence in Research, Penn State University, 1998

Weiss Graduate Scholars Program, Penn State University, 1997-1998

First place award, the 12th Graduate Research Exhibition, Penn State University, 1997

**Research Interests**

Executive control processes

Memory Representations in Problem Solving

Strategy Development during Skill Acquisition

Stimulus Response Compatibility

Spatial Thinking

Working Memory

**Research Positions**

Dr. Lynn Liben, Penn State University, 1996-1997

Dr. Richard Carlson, Penn State University, 1994-1996

Laboratory of Psycholinguistics and Reasoning, Seoul National University, 1991-1993

Dr. Myeong-han Zoh, Seoul National University, 1990-1991

**Teaching Assistantships**

Advanced Research Methods in Psychology Dr. Martha Burton, Penn State University, 1994

Introductory Cognitive Psychology, Dr. Martha Burton, Penn State University, 1994

Introductory Research Methods in Psychology, Dr. Judith Kroll, Penn State University, 1994

Advanced Cognitive Psychology, Dr. Richard Carlson, Penn State University, 1993

Introductory Cognitive Psychology, Dr. James Martin, Penn State University, 1993

## Research Statement

How do we control our thoughts and actions to achieve our goals in the face of distracting information? My research focuses on cognitive/executive control processes mediated by the prefrontal lobes and the interface of the control processes with stimulus-driven processes. I am most interested in the following executive processes:

- Task-set reconfiguration: How people instantiate and maintain the appropriate task set that is consistent with the current goal
- Selective retrieval: How people retrieve the unique and correct memory trace of a memory probe while avoiding incorrect associations.
- Conflict resolution: How task-relevant information emerges out of competition with task-irrelevant information.

The goal of my research program is to achieve a theoretical and mechanistic understanding of the interactions between executive and stimulus-driven processes and the neural circuits that underlie these interactions.

### **Task-set reconfiguration**

People can make non-optimal decisions and take inappropriate actions because they fail to initiate and/or maintain the intended task set. How does the intention to perform a certain task interact with stimulus-driven processes such as priming or stimulus-response compatibility?

One consistent finding in my research is that people perform tasks better when advanced preparation focuses on the task to be performed rather than the objects on which the task will be performed. For example, arithmetic performance was better with advanced information regarding operators than with advanced information regarding operands (Sohn & Carlson, 1998). Also, spatial reasoning performance was better with advanced information regarding viewpoints or reference frames than with advanced information regarding spatial locations or objects (Sohn & Carlson, 2003). The implication of these results is that the most effective form of “intention” may be a procedural frame (e.g., how to process an input stream).

However, another consistent finding is that advanced task-set specification may not completely overcome stimulus-driven processes. For example, even with advanced viewpoint information, spatial judgments were affected by stimulus-response compatibility (Sohn & Carlson, 2003). In task-set switching studies, an opportunity to prepare for an upcoming task reduced the automatic priming effect only in limited situations (Sohn & Anderson, 2003). These results imply relative independence of stimulus-driven processes from executive processes. This notion of independence gained support from a production-based cognitive modeling (Sohn & Anderson, 2001) as well as from an fMRI study in which the inferior prefrontal region exhibited preparation-related activation while the superior prefrontal region exhibited priming-related activation (Sohn et al., 2000).

Ongoing research focuses on the nature of advanced task-set specification and its change with learning. In several fMRI projects, I am investigating which brain regions are particularly

involved in processing advanced information and how different brain regions are involved in learning of explicit declarative knowledge as well as implicit procedural knowledge.

### **Selective retrieval**

One of the most basic operations is to retrieve the right association with a given memory probe, which is not a trivial task because prior experience has created multiple associations to probe stimuli. One line of my research investigates the role of mental representation in selective retrieval. Can people pick up salient information that may bias one kind of mental representation over another? In one study (Sohn et al., 2004), for example, some people learned person-location pairs paying more attention to the person dimension, and others did so focusing on the location dimension. In the subsequent memory test, recognition performance was affected more by the retrieval difficulty in terms of the attended dimension, regardless of which dimension (person or location) was actually attended. This result indicates that (a) attentional focus during learning plays an important role when organizing mental representations and (b) retrieval processes are sensitive to the abstract structure of mental representations.

A related line of my research examines how the human brain deals with selective retrieval. Results from several fMRI studies (e.g., Sohn et al., 2003) indicate a functional dissociation between the prefrontal cortex and the parietal cortex: The prefrontal cortex directly responds to the level of competition (e.g., number of competing associates with a probe). In contrast, the parietal cortex mainly responds to the changes in problem representation, which may or may not be correlated with the level of competition.

Currently, I am investigating whether the fronto-parietal distinction involves any sensitivity to alternative formats of problem representation (e.g., verbal versus symbolic, or visuo-spatial versus auditory).

### **Conflict resolution**

Our environment is relatively unconstrained and affords multiple actions that may not be congruent with each other. This type of incongruence presents a serious problem for a cognitive system because the dominance of the stimulus-driven influence would result in behaviors that may be inconsistent the current goal. Therefore, it is necessary for the system to detect and resolve existing conflicts and react by strengthening goal-driven control mechanisms in order to minimize the effect of distracting information. In relation to conflict resolution, I am interested in two control processes: inhibitory control and conflict adaptation.

Inhibitory processes are necessary so that the influence from potent, reflexive response tendencies can be reduced. My current studies examine the locus of an inhibition-like effect such as negative priming in a task-switching paradigm. For example, negative priming effect may arise because of competitive stimulus selection or because of competitive response selection. I am investigating these possibilities using relatively complex tasks, in which processing stages are clearly distinguished.

For conflict resolution, it is also necessary to adjust the level of cognitive control to the existing level of conflict, especially when the conflict level in the environment changes dynamically. The crucial evidence for this conflict adaptation is that conflict susceptibility is sequentially

modulated, reflecting the previous conflict level as well as the current conflict level. One study (Sohn & Carter, in preparation) showed that this modulation is independent of stimulus or response priming, suggesting that the conflict adaptation is a genuine cognitive control process.

In terms of neural substrates, the anterior cingulate cortex (ACC) and the dorso-lateral prefrontal cortex (DLPFC) have been implicated as part of a conflict-monitoring circuit. Important questions are: Is the ACC selectively responsive to different types of conflict? What are the temporal and causal interdependencies between the ACC and the DLPFC? Currently, I am investigating the role of ACC in various conflict resolution situations and the relation of the ACC to other cortical regions.

### **Related papers**

- Sohn, M.-H., & Anderson, J. R. (2001). Task preparation and task repetition: Two-component model of task switching. Journal of Experimental Psychology: General, *130*, 764-778.
- Sohn, M.-H., & Anderson, J. R. (2003). Stimulus-related priming during task switching. Memory & Cognition, *31*, 775-780.
- Sohn, M.-H., Anderson, J. R., Reder, L. M., & Goode, A. (2004). Differential fan effect and attentional focus. Psychonomic Bulletin and Review, *11*, 729-734.
- Sohn, M.-H., & Carlson, R. A. (1998). Procedural frameworks for simple arithmetic skills. Journal of Experimental Psychology: Learning, Memory, and Cognition, *24*, 1052-1067.
- Sohn, M.-H., & Carlson, R. A. (2003). Viewpoint alignment and response conflict during spatial judgment. Psychonomic Bulletin and Review, *10*, 907-916.
- Sohn, M.-H., & Carter, C. S. (in preparation). Conflict monitoring in task switching.
- Sohn, M.-H., Goode, A., Stenger, V. A., Carter, C. S., & Anderson, J. R. (2003). Competition and representation during memory retrieval: Roles of the prefrontal cortex and the posterior parietal cortex. Proceedings of National Academy of Sciences, *100*, 7412-7417.
- Sohn, M.-H., Ursu, S., Anderson, J. R., Stenger, V. A., & Carter, C. S. (2000). The role of prefrontal cortex and posterior parietal cortex in task-switching. Proceedings of National Academy of Sciences, *97*, 13448-13453.



## Teaching Interests

An ideal teacher would be a moderator who facilitates the exchange of ideas among students as well as between students and the teacher. Thus, it is crucial to encourage students' participation and make sure they are not passive recipients of information. This can be achieved by providing as much hands-on experience (e.g., class demonstration, group projects) as a given situation allows.

I have listed below sample course descriptions that reflect my teaching interests. I present these courses as examples that I believe will provide opportunities both for students to become familiar with the important issues in contemporary cognitive psychology and for me to reconstruct and reorient my own research. These sample courses can be easily redesigned for different levels of advancement. I am also prepared to teach experimental design and methods, introductory psychology, and cognitive psychology with an emphasis on a neuroscience approach.

### **Models of Working Memory**

This course will survey research on working memory with an emphasis on its processing aspects. The goal is to provide theoretical perspectives on various executive functions of working memory (e.g., maintenance, manipulation). The course has two parts. The first part will be devoted to identifying the differences and similarities between representative models of working memory. The second part will be devoted to applying the implications of the models to empirical phenomena. The empirical research for the second part will be selected from various sub-disciplines of cognition including attention, memory, action, and problem solving. Readings will also include evidence from the cognitive neuroimaging and individual differences literatures.

### **Skill Acquisition and Transfer**

This course will survey the classical and current research and theories on human learning. Specific topics include instance-based versus rule-based theories of learning, learning by example and analogy, implicit learning, automaticity and expertise, and problem-solving strategies. Readings will cover empirical laboratory research, computational modeling approaches, neurophysiological evidence, and the implications of current learning theories for real-world learning. In-depth discussions will be focused on issues such as why a certain learning theory explains a certain phenomenon better than others and why this can change depending on tasks and learning environments.

### **Spatial Thinking**

This course will survey the classical and current research on spatial attention and cognition. The emphasis will be on understanding various representational formats of space and objects, mechanisms of retrieving and manipulating spatial knowledge, and how these are related to actions in space. Topics will include physiology of spatial perception, object-based versus location-based attention, spatial working memory, mental rotation, spatial stimulus-response compatibility (SRC), and navigation in the real-world and virtual environments. In-class demonstration and exercises will be provided in the form of participation in classical studies such as mental rotation and spatial SRC tasks as well as various group projects with real world-flavor (e.g., map design for a small scale environment).