BIOGRAPHICAL SKETCH

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NAME: Isabel Gauthier, Ph.D.

eRA COMMONS USER NAME (credential, e.g., agency login): isabelzaza

POSITION TITLE: David K. Wilson Professor of Psychology

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Université du Québec a Montréal	B.A.	1993	Psychology
Yale University	M.S.	1995	Psychology
Yale University	Ph.D.	1998	Psychology
Massachusetts Institute of Technology	Postdoc	1999	Psychology
Yale School of Medicine	Postdoc	1999	Psychology

A. Personal Statement

Since 2000, I have headed the Perceptual Expertise Network, now part of the NSF funded Temporal Dynamics Learning Center. This is a collaborative bringing together leaders in various areas of research (Marlene Behrmann, Daniel Bub, Tim Curran, Jim Tanaka, Bob Schultz, David Sheinberg, Tom Palmeri and Mike Tarr) using a multi-disciplinary approach to understand how perception and categorization are shaped by experience.

Starting with my dissertation research published in 1999, I have been at the forefront of the use of human brain imaging to study the influence of learning and the role of expertise in accounting for the organization of the visual system. I have developed methods to manipulate the sort of experience subjects have with objects and demonstrated how the same object category can be represented in different ways in the brain, linking such neural differences to behavioral differences in processing strategy. I have also pioneered methods to measure perceptual expertise for real world categories (such as cars, birds or musical notation) and have studied its neural correlates in the ventral occipital temporal cortex.

B. Positions and Honors

1999-2004 Assistant Professor, Department of Psychology, Vanderbilt University
2002 Young Investigator Award, Cognitive Neuroscience Society
2003 APA Distinguished Scientific Award for Early Career Contribution to Psychology
2004 Associate Professor, Department of Psychology, Vanderbilt University
2008 Troland research award from the National Academy of Sciences
2009 Professor, Department of Psychology, Vanderbilt University
2011 Professor of Radiology and Radiological Sciences
2010 Heller lecture, The Hebrew University, Jerusalem, Israel
2012 David K. Wilson Chair of Psychology, Vanderbilt University
2012 Graduate mentoring award, College of Arts and Science, Vanderbilt University
2012 Fellow of the Society of Experimental Psychologists
2014 Chancellor Award for Research, Vanderbilt University
2015 Southeastern Conference Professor of the Year

C. Contribution to Science

1. Studying perceptual expertise in the laboratory

For my dissertation research, I developed methods for training people in the laboratory to become perceptual experts with novel objects. Before this work, the study of perceptual expertise relied on real-world experts and it had been proposed that 10 years of expertise (e.g., in dog show judges) was necessary for hallmarks of face-like expertise, such as configural processing, to develop. I supervised the creation of the novel objects called “Greebles” for use in my dissertation. These objects possess certain characteristics in common with faces (e.g., small number of parts in a common symmetrical organization) but because they are novel, experience can be controlled. My colleagues and I subsequently used Greebles or other similar object sets in studies using behavioral, fMRI and ERP measures to understand the effects of training on object representations and their neural substrates. Notably, in a recent paper (Chua, Richler & Gauthier, in press), we confirmed a claim made in my first paper with them in 1997, which is that expertise training with novel objects can lead people to process them in a holistic manner similar to how we process faces. Relative to the original work, the 2015 study uses an even shorter training, but a much larger sample of subjects, in line with recent trends in psychology for better considerations of statistical power. Greebles, and variations of the training procedure developed in my dissertation, have been used in several dozen papers by other research groups. This work is important because it provided our field with methods to study perceptual expertise in the laboratory, affording more control over aspects of the stimuli and experience. This work can be considered the foundational influence for the creation of the “Perceptual Expertise Network”, a group of scientists and their trainees who have been collaborating for 15 years to study perceptual expertise using convergent methods.

Gauthier, I., & Tarr, M.J. (1997). Becoming a "Greeble" expert: Exploring mechanisms for face recognition, *Vision Research,* 37(12), 1673-1682.

Gauthier, I., Tarr, M.J., Anderson A.W., Skudlarski, P. & Gore, J. C. (1999). Activation of the middle fusiform ‘face area’ increases with expertise recognizing novel objects. *Nature Neuroscience,* 2(6):568-573.

Rossion, B., Gauthier, I., Goffaux, V., Tarr, M.J., Crommelinck, M. (2002). Expertise training with novel objects leads to left lateralized face-like electrophysiological responses. *Psychological Science.* 13(3):250-57.

Chua, K.-W., Richler, J.J., & Gauthier, I. (in press). Holistic processing from learned attention to parts. Journal of Experimental Psychology: General.

2. The expertise account of specialization in the fusiform face area

During my post-doctoral work, I chose to work with a leader in my field who had a very different interpretation of my dissertation work with Greebles. In particular, Nancy Kanwisher was of the opinion that expertise with Greebles engaged the face-selective fusiform face area (FFA) because they had a face-like organization. We designed a study of real-world expertise with cars and birds, agreeing that the expertise account of the selectivity for faces in FFA predicted expertise effects for these two very different categories. This led to the publication of the first study of expertise effects in the FFA for familiar objects in 2000. Although Kanwisher chose not to be an author on that paper, the effect (a correlation between the selective response to an object category in the FFA and behavioral performance individuating such objects outside of the scanner for this category) has since been replicated many times, both in my lab and by others including a post doc of Kanwisher at the time, Yaoda Xu (Xu, 2005). In another paper in 2000, I brought to the field’s attention the existence of another face-selective region in occipital cortex which I called the occipital face area (OFA). In her dissertation, my graduate student Rankin McGugin demonstrated expertise effects in the peak of face-selectivity in FFA at high resolution, using 7Tesla imaging, showing that face and expertise effects were spatially indistinguishable given what is known of face-selective patches in neurophysiology. In some of our most recent work, we found that expertise effects for objects in FFA are robust to several kinds of manipulations, while they are particularly vulnerable to the presentation of objects of expertise simultaneously with faces, suggesting common resources. The implications of this line of work are important because they

refute the theory that the FFA is a domain-specific module that only processes faces and treats all other non-face objects in the same manner.

Gauthier, I., Skudlarski, P., Gore, J.C., & Anderson, A. W. (2000). Expertise for cars and birds recruits brain areas involved in face recognition. *Nature Neuroscience*, 3(2): 191-197.

Gauthier, I., Tarr, M. J., Moylan, J., Anderson, A.W., Skudlarski, P. & Gore J.C. (2000). Does visual subordinate-level categorization engage the functionally defined fusiform face area? *Cognitive Neuropsychology,* 17(1/2/3), 143-163.

McGugin, R.W., Gatenby, C., Gore, J.C., Gauthier, I. (2012). High-resolution imaging of expertise reveals reliable object selectivity in the FFA related to perceptual performance. *Proceedings of the National Academy of Sciences*, *109*(42), 17063-17068. PMCID: PMC3479484.

McGugin, R.W., Van Gulick, A.E., Tamber-Rosenau, B.J., Ross, D.A. & Gauthier, I. (2014). Expertise effects in face selective areas are robust to clutter and diverted attention but not to competition. *Cerebral Cortex:* bhu060. Method A journal submission, in process. Pending PMCID.

3. Individual differences in high-level vision

In the study of object recognition, individual differences are often ignored and there is no tradition in the psychometric measurement of relevant abilities. For several years, faces were the only visual category for which there were any reliable measure of individual differences over the whole range of abilities in the normal population. While my early work was concerned with differences in performance between people (e.g., novices vs. experts), in more recent years I have become interested in the study of the underlying causes of these differences in performance, in particular how to separate effects of domain-general differences in ability vs. domain-specific experience. A great many arguments in our field are based on comparing faces to one object category. However, when differences in performance exist across individuals for a single category, it is virtually impossible to disentangle the role of experience from ability. To address this, my students and I created the "Vanderbilt Expertise Test", a battery or reliable measures of object recognition, for 8 different categories. This battery allowed us to show that the correlation between object recognition and face recognition performance increases as a function of the degree of reported experience with objects. This is important, as it demonstrates how inferences about the underlying structure of the mind from individual differences in performance can be misleading. Experience needs to be accounted for. In other work we evaluated the reliability of a standard measure of an important concept in skilled vision, holistic processing, and showed that although the measure is very sensitive for group studies, its reliability is too low to use in individual differences research. We then published the first measure of face holistic processing designed explicitly for the purpose of measuring individual differences, providing the field with a reliable measure to test some of its most common assumptions about the role of holistic processing in face recognition. All of our tests are available for other users online.

McGugin, R.W., Richler, J.J., Herzmann, G., Speegle, M. & Gauthier, I. (2012). The Vanderbilt Expertise Test Reveals Domain-General and Domain-Specific Sex Effects in Object Recognition. *Vision Research,* 69:10-22. PMCID: PMC3513270.

Ross, D. A., Richler, J.J., & Gauthier, I. (2014). Reliability of Composite Task Measurements of Holistic Face Processing. *Behavioral Research Methods,* 22(6), 1-8. PMCID: PMC4074229.

Gauthier, I., McGugin, R.W., Richler, J.J., Herzmann, G., Speegle, M. & VanGulick, A.E. (2014). Experience moderates overlap between object and face recognition, suggesting a common ability. *Journal of Vision*, 14, 8.7. Method A journal submission, in process. Pending PMCID.

Richler, J.J., Floyd, R.J., & Gauthier, I. (2014). The Vanderbilt Holistic Face Processing Test: a short and reliable measure of holistic face processing. *Journal of Vision. 14(11):* 10. Method A journal submission, in process. Pending PMCID.

4. The role of holistic processing in face recognition

"Holistic processing", the tendency to process all the parts of an object together, is used to refer to a host of phenomena that could reflect multiple mechanisms. However, most agree that people process faces as wholes, even when told to focus on parts, whereas people have little trouble selectively attending to parts of objects. In early work on holistic processing, I was able to demonstrate that the mechanisms that give rise to holistic processing of faces are shared with those that give rise to holistic processing of cars in car experts. In the first of many studies on interference between two domains of expertise published in 2003, we showed that when engaged in concurrent tasks of face and car perception, the more someone had expertise with cars and processed them holistically, the less likely they were to process faces holistically. Despite this early work, I quickly realized that the heterogeneity in methods used to measure holistic processing, without evidence that they are related, may impede convergence about the underlying mechanisms. My colleagues and I have been the proponents of one specific method to the measurement of holistic processing, based on our work suggesting that another method lacked validity due to response bias confounds. This has led to a heated but we would argue an important debate in our field concerning the importance of choosing and evaluating our measures carefully. In the first meta-analysis on the topic, we have shown that these decisions are crucial when different methods that may at first glance appear to be variations on a common theme provide results that are inconsistent with each other. While there remain people in the field who still prefer to stick with the measure we critique, in the last few years there has been a number of independent labs confirming our evaluation of these tasks, and/or adopting the task we argue is more valid. This line of work is significant both because it concerns one of the most important hallmarks of face recognition, but also because it has put forward the crucial need for measurement validation without which theoretical progress is hampered.

Gauthier, I., Curran, T., Curby, K.M. & Collins, D. (2003). Perceptual interference supports a non-modular account of face processing. *Nature Neuroscience,* 6: 428-32.

Richler, J.J., Tanaka, J.W., Brown, D.D. & Gauthier, I. (2008). Why does selective attention fail in face processing? *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 34(6): 1356-68.

Richler, J.J., Cheung, O.S. & Gauthier, I. (2011). Holistic processing predicts face recognition. *Psychological Science, 22(4):*464-71. PMCID: PMC3077885.

Richler, J.J. & Gauthier, I. (2014). A meta-analysis and review of holistic processing. *Psychological Bulletin, 140(5)*: 1281-302. PMCID: PMC4152424.

5. Perceptual expertise with musical notation

One goal of my overall research program has been to extend the expertise framework to other domains beyond those that function like face recognition. Importantly, I do not consider perceptual expertise to be solely supported by areas that are generally recognized as face-specific – rather, I have proposed that the face network is engaged in domains when the dominant task is to individuate objects that share a configuration and when experience allows for holistic processing. Therefore, while it has been interesting to see other groups become interested in domains like chess or radiographs which have been argued to engage holistic processing and the face network, my graduate student and I decided to develop a line of research on a domain that should engage a different kind of processing and therefore different areas in the brain: the visual perception of musical notation. At the time, while there was considerable work in music perception and production, this was not a focus of any research. In a first fMRI study of selectivity for musical notation, we found that a broad network or visual, auditory and motor areas was more active when expert music readers looked at a single note on the screen, relative to a control character, and this even if the task did not require music reading. Notably, the FFA was not selective for musical notation, but area V1 was. We followed-up on these surprising results in later work. First, we showed that while FFA is not selective for musical notation, activity in the FFA predicted the magnitude of holistic effects with larger sequences of notes. Second, we used event-related potential to show that the expertise effect in V1 for musical notation was not due to feedback and was obtained as early as 40 ms post stimulus onset. In later experiments, we showed that this effect was specific to blocked conditions, and that the perceptual advantages that music readers experience for musical notation, such as reduced visual crowding, also require blocked presentations. This work is important because it characterizes a kind of

perceptual expertise that at least in part taps different mechanisms then face-like expertise, in this case a fine tuning of visual templates in early visual cortex, as studied in other research under the umbrella of perceptual learning.

Wong, Y.K. Gauthier, I. (2010). A multimodal neural network recruited by expertise with musical notation, *Journal of Cognitive Neuroscience,* 22(4): 695-713.

Wong, Y.K., Gauthier, I. (2010). Holistic processing of musical notation: Dissociating failures of selective attention in experts and novices. *Cognitive and Affective Behavioral Neuroscience, 10*, 541-551. PMCID: PMC3044322.

Wong, Y.K. & Gauthier, I. (2012). Music-reading expertise alters visual spatial resolution for musical notation, *Psychonomic Bulletin and Review,* 19(4):594-600. PMCID: PMC3394230.

Wong, Y.K., Peng, C., Fratus, K.N., Woodman, G.F. & Gauthier, I. (2014). Perceptual expertise and top-down expectation of musical notation engages the primary visual cortex. *Journal of Cognitive Neuroscience, 26(8)*: 1629-43. PMCID: PMS4074229.

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D. Research Support

Current
Do individual differences in face recognition predict perceptual expertise – NIH, 1R21 EY021868-01A1 (Gauthier PI), 9/3/13-5/31/15 NCE. The goal of this project is to understanding the causes of individual differences in how we recognize faces and objects can help us understand the mechanisms in the brain that support skilled perception, as in the skills required for medical diagnosis, and facilitate behavioral genetic studies of high-level vision, shedding light on a hereditary form of a visual face recognition deficit called developmental prosopagnosia. Gauthier oversees all phases of the proposed project, and is responsible for experimental design and implementation, data collection and analysis, theoretical development and preparation of manuscripts.

The temporal dynamics of learning – NSF, SMA-1041755 (Cottrell PI, Gauthier subcontract), 9/23/06-9/30/16. This grant funds a multidisciplinary Center to study the temporal dynamics of learning involving investigators from fields as diverse as cognitive science, machine learning and robotics, developmental and perceptual psychology, and neuroscience. The administrative location of the Center is at the University of California, San Diego. The subcontracts from this center funds a range of activities in my laboratory, targeting the temporal dynamics of perceptual expertise.

Past
The role of expertise in object perception, 2 R01 EY013441-06A2, NIH, Gauthier (PI) 8/2009 - 8/2013.
This grant supported investigations of the neural bases and behavioral outcomes of visual expertise training with objects, focusing on comparisons between training protocols. Gauthier oversaw all phases of the proposed project, and was responsible for experimental design and implementation, data collection and analysis, theoretical development and preparation of manuscripts.