List of Zyg's contributions:

New Psychophysics - this diagram is a new way to describe the role of the three types of phenomena, physical, biological and mental, operating in perception. The underlying formalism is based on symmetry: its invariance and redundancy aspects. My paper with de Barros is published in Frontiers.

Zyg's Conjecture: veridical 3D vision is mathematically and computationally so difficult that there is only one way to do it.

Once you accept this, it follows that all animals (including us) that see the 3D world veridically (or nearly so) use the same algorithm. A computer that can also see veridically, must be using the algorithm that is used by the human visual system. So, there is no longer any need to wonder about whether computer vision should emulate biological vision. It must.

"What role does symmetry play in the perception of 3D objects?" - see our blog on the Oxford University Press Web site.
"Questions about symmetry and visual perception" - tumblr on the Oxford University Press Web site.

When Gestaltists stated that "the whole is different from the sum of its parts" they meant that the visual system is not linear. Recall that in a linear system, the response to a linear combination of inputs is a linear combination of the responses to the individual inputs. This is not the case in vision. See the demo (courtesy of Prof. Tadamasa Sawada), which shows that the percept of a 2D hexagon and of a 2D "Y junction" cannot explain the percept of a 3D cube.

My work is directed by exploring new ideas rather than following established views. In this approach, rational arguments are as important for me as experimental results. The emphasis on principled reasoning means that in my view, cognitive psychology is not a bag of tricks; Neither is my research. A list of my most important contributions is provided below (in chronological order):

1987 – compared symmetry discrimination of 2D figures with the eye fixation inside vs. outside the figure
1988 – showed the role of subsampling in the periphery in the context of the complex-log representation in the area V1 of the visual cortex
1992 - formulated perspective invariants thereby providing the first model-based invariants in vision
1994 - proposed a new theory of shape constancy that is NOT based on "taking slant into account"
1995 - developed a pyramid model explaining the speed-accuracy trade-off in vision and mental size transformation
1997 - explained the role of the calibrated camera model in shape perception
1999 - demonstrated shape constancy for solid shapes and explained the apparent controversy between Rock's and Biederman's results

2000 - developed a pyramid model that shows how human beings solve the Traveling Salesman Problem (TSP)
2000 - contributed to the rediscovery of Wertheimer's phi motion
2001 - published a theoretical paper on inverse problems in vision, making it clear that *a priori* constraints are at least as important as the information in the retinal image
2001 - provided a new criterion for classifying illusions as important or unimportant
2005 - discovered a new binocular phenomenon showing that *a priori* 3D shape constraints are more important than binocular disparity
2006 - developed a TSP model that emulates human visual attention and eye movements
2008 - published the first coherent treatment of the history of shape perception – "3D Shape" book
2009 - introduced a new theory of 3D shape perception based on symmetry, compactness and planarity constraints
2009 - contributed to the demonstration that the experimental method that uses an adjustable elliptical probe to measure perception of local surface orientation (slant and tilt) is fundamentally flawed
2011 - developed a new Bayesian theory of the veridical binocular perception of symmetrical shapes that emphasizes the role played by stereoacuity
2011 - demonstrated that *a priori* constraints are more important in achieving reliable shape constancy than depth cues
2011 - published psychophysical results on the transfer of skilled movement that suggested that the motor system has a pyramidal architecture, very much like the architecture of the visual system
2012 - modeled the veridical recovery of 3D scenes and 3D figure-ground organization
2013 - showed that symmetry is the *sine qua non* of shape - book chapter
2013 - developed a TSP model with a small human-like working memory
2014 - published a new theory of 3D veridical vision – "Making a machine that sees like us" book.
2014 - contributed to the discovery of new model-based invariants for 3D, piecewise planar, symmetrical curves
2016 - showed that a perceived closed curve is the shortest path in the log-polar representation (aka complex logarithmic map) present in the primary visual cortex (area V1) of primates
2016 - explained how 3D visual perception can be a "hard science" because symmetry, the least-action principle and the conservation laws operate in 3D vision: book chapter
2016 - helped to explain 3D and 2D figure-ground organization by using 3D symmetry and gravity *a priori* constraints
2017 - helped to formulate the first fully automated 3D shape recovery model. The model solves the problem by applying symmetry to binocular images: demos
2018 - helped to study and model 3D shape recovery of symmetrical and nearly-symmetrical shapes: demos
2019 - described a process analogous to Noether's (1918) theorem that explains visual perception (AJP paper) - preprint
2021 – Established group invariance as the fundamental concept in perception (in collaboration with Acacio de Barros)
2022 – showed that symmetry provides a foundation for human problem solving – "Problem solving" book.

2022 – conjectured that insight problem solving is a form of an NP-completeness – “Problem solving” book.
2022 – showed that NP-hard problems are treated by humans as ill-posed inverse problems – “Problem solving” book.
2022 – helped establish that Multidimensional Scaling is NOT used by humans to solve problems that reside in a space that is not Euclidean.
2023 – helped establish the relation between 3D translational symmetry and 3D mirror symmetry.
2023 – helped elaborate a computational model of closed curve integration using a complex-log map using edges and color. Demonstrated that spatially global integration operates only around the fixation point.
2024 – helped formulate a computational model of 3D shape recovery that works with both orthographic and perspective images.