

20 Years of ASSC: are we ready for its coming of age?

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Abstract

This is a subjective summary of the recent meeting of the Association for the Scientific Study of Consciousness (ASSC) in Buenos Aires (2016), with some highlights, as well as reflections on the state of the field in general. I argue that we are likely at a critical point where the field is in the process of transforming itself, and the ASSC meeting is accordingly becoming the premier venue to update each other on the latest exciting findings, rigorous methods, and novel ideas. I also discuss the rapidly changing roles of authoritative opinion and theoretical ideas based largely on speculation, whether we still need them, and where may be the best venues for disseminating them.

Key words: Consciousness; Information integration theory; Higher-order theory

Our Not-so-Humble Beginnings

The 20th annual meeting of the Association for the Scientific Study of Consciousness (ASSC) took place in the beautiful Buenos Aires last year in June 2016. Led by organizer Tristan Bekinschtein's casual, relaxed charisma, the conference started off with an informal vibe. Inside jokes were traded on stage and off. As an "oldie" myself, I was guilty of this indulgence, but also worried about newcomers feeling left out from the insular atmosphere. As soon as cocktails were served, though, my worries were proved unnecessary (or at least, the cocktails calmed my worries anyway). ASSC remains the friendliest, most inspiring, and welcoming conference I have ever attended.

At the opening session, Axel Cleeremans gave a historical review about how the conference has evolved over the years, which was both entertaining and highly informative. It is easy to forget that while philosophical investigations on the nature of subjective experience arguably date back to antiquity, the modern empirical science of consciousness as we know it started as an organized activity only about two decades ago. In the mid-1990s, a series of historical gatherings of a group of highly influential scientists and philosophers took place in Tucson, Arizona, involving such greats as two Nobel Laureates (Crick and Edelman), and a knight who won the Wolf Prize in Physics (Sir Penrose). While the eminence of these giant figures certainly helped raise awareness for the establishment of the field, early on there was a sense of a

need for an additional platform of a more conventional academic nature, to be driven primarily by empirical research from mainstream neurobiology and psychology. Amid some hesitation and debates (e.g. Dave Chalmers kindly shared that he was among those in favor of keeping it as one single meeting), a group spun off from the Tucson conference, and ASSC was born.

The conference "Toward a Science of Consciousness" in Tucson has since been renamed "The Science of Consciousness", and remains active and popular. But in parallel, ASSC has also flourished in its own way. Though the two meetings attract somewhat different audiences, many regularly attend and contribute to organizing both meetings. They serve their complementary purposes harmoniously, as they both continue to develop.

Too Much Data?

How much the times have changed. While there was still no shortage of opportunity for academic celebrity sightings at this year's ASSC meeting, one of my favorite moments of the entire conference was when Biyu He, the youngest keynote speaker in the history of the meeting, diplomatically apologized in advance that her talk would be relatively "data-dense."

She went on to describe several amazing lines of work conducted in her laboratory, including a beautiful functional magnetic resonance imaging (fMRI) study demonstrating the role of

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the prefrontal cortex in bistable perception and ambiguity resolution (Wang et al. 2013); I was told over breakfast the next morning by a long-standing skeptic of prefrontal theories of consciousness that that part of the talk might have just won him over. Another line of work done in Biyu's lab employs sophisticated analysis of the dynamics of the neural activity associated with conscious perception, which seems to echo recent work done by Schurger with Stanislas Dehaene and colleagues (2015) arguing that stability over trials may be a key signature. Although some skeptical concerns were raised later during the coffee break (e.g., if we compared a high-contrast invisible stimulus against a low-contrast invisible stimulus with sufficient statistical power, are we sure their neural responses won't also differ in stability?), and that other aspects of the studies may contradict each other (e.g. regarding whether consciousness enhances within-trial stability), there was a sense that real progress toward a consensus can be readily achieved in the next few years.

Although Frank Tong also looked young, the sheer number of high-profile publications covered in his talk belied his "seniority status" in the field (sorry Frank!). His was also one of my favorite keynotes, in which he described numerous groundbreaking studies done in his lab and by his various lab alumni. A wide variety of experiments demonstrated the role of V1 in many phenomena, including binocular rivalry, attention, working memory, mental imagery, and even dreams. I was unsure whether such a wealth of data supports the argument in favor of V1's central role in visual awareness, or whether it may also backfire: the subjective phenomenology for holding some visual items in working memory seems so different from the vivid experiences of dreaming. If the mechanisms of representation involved in V1 seem highly similar between these cases, doesn't it rather hint at further downstream mechanisms (e.g. in the prefrontal cortex) distinguishing between them? While this issue remains unsolved, perhaps what was important is, this is exactly the kind of questions one can discuss at length at ASSC, where high-quality data are subjected to conceptual analysis often given little emphasis in other more "straight-ahead" scientific conferences – a point I will return to.

On the theme of having too much quality data, there were too many examples to do them all justice, so I will just highlight a few. Sid Kouider presented amazing data in his symposium talk showing that infants seem to have the metacognitive abilities to realize when they get things wrong. This was interesting and highly relevant for previous debates at ASSC, because philosophers have sometimes challenged David Rosenthal's higher-order thought theory of consciousness, with claims that infants are clearly conscious in the sense of having sensory experiences, and yet they lack the capacity for the relevant higher-order cognition because their prefrontal cortex is underdeveloped. Well, apparently they do not lack such capacity exactly, according to Sid's findings, which were meanwhile published in *Current Biology* (Goupil and Kouider 2016) since the conference took place.

From the same session, Micah Allen's excellent work on how arousal may modulate confidence in perceptual decision task has also just been published in the high-profile journal *eLife* (Allen et al. 2016). The amount of high-impact quality work first presented as an ASSC abstract is just staggering for a small conference – another point for which I will give more examples below.

Nathan Faivre also presented interesting work in the symposium on multisensory processing. Specifically, he used psychophysical methods to quantify one's introspective capacities (i.e. the ability to self-monitor to distinguish between correct and incorrect decisions) in different sensory modalities, and found

substantive differences. What struck me as intriguing was: perhaps this explains why some modalities come with phenomenology that is sometimes described as relatively "thin," (e.g. sense of agency, as compared to vision). Perhaps this may be a useful framework to quantify elusive concepts such as "phenomenological richness" and "subjective salience" in a more rigorous manner.

Cutting Edge Methods

The examples above were of course my highly subjective selection. Often, specific results are interesting to us mainly because we have been doing similar experiments, or thinking about related questions. But ASSC is also a place to share new experimental and analytical methods that should be interesting and relevant to pretty much everybody.

Looking back, there have been many essential methods I have learned first at ASSC. I recall hearing about continuous flash suppression (CFS) from the then graduate student Nao Tsuchiya at Caltech (Tsuchiya and Koch 2005). Of course, by now CFS has been used in hundreds of published studies. It was also Alex Maier who convinced me in Toronto (2010) in his symposium talk that multi-unit recording in non-human primates was going to be the future, and started my interest in that area. In Kyoto (2011), I first heard Mitsuo Kawato presenting groundbreaking results using the novel method of decoded fMRI neurofeedback (Shibata et al. 2011). It would not be an exaggeration to say that this moment utterly changed my career, completely revived my interests in human neuroimaging. Last year in Paris (2015), Jean-Remi King presented an ingenious method to infer about stability of neural representations via temporal generalization of MEG decoding (King & Dehaene 2014). It is hard to conceive that it would not make a huge impact.

This past year, I was glad to see many high-quality psychophysics studies. I am particularly partial to this kind of work, combining careful but simple quantitative models with quality behavioral data that is easy to replicate and verify. This kind of work is often overlooked, because they do not produce pretty brain pictures. But they can highly benefit studies of consciousness, by bringing in the much needed rigor and clarity. David Carmel's talk on testing attention models with highly sophisticated reasoning is a great example of this. Student Jason Samaha's talk also cleverly adopted simple psychophysical models to infer about the functions of percepts experienced with high subjective confidence. That work may be more relevant than some of us thought, because it is conceptually not clear whether there is such a thing as conscious perception with zero subjective confidence, so understanding the function of confidence may tell us something about the function of consciousness too.

Another exciting project was presented by Sara Kimmich, whose work won one of the poster awards (Neuroscience). To my mind, this was an excellent example of a poster that might have had more quality data than a keynote. In that work she presented fMRI neurofeedback based on co-activation/deactivation of activity in multiple brain regions. If proven to be effective, this is something that has tremendous potential for application in the clinical realm, as many mental disorders are characterized by specific abnormalities in brain connectivity, which seems to be manipulable by this novel method.

Other winners of the poster awards include: Sridhar Jagannathan (Neuroscience), Raechelle Gibson (Psychology), Laurene Vuillaume (Psychology), Horacio Andres Chiarella (Philosophy), and Astrid Schomacker (Philosophy).

Finally, the young investigator award winner this year, Satoshiro Tajima, gave a master class on embedding theory, explaining in as simple and clear terms as one could, how we can make inferences about circuit-level interactions between neuronal populations based on coarse measures such as electroencephalography (EEG) (Tajima et al. 2015). This is perhaps the most analytically sophisticated James Prize lecture we have seen at ASSC – and I truly hope this becomes a trend!

Philosophy Still Kicking

One thing puzzled me about Satoshiro's talk. Toward the end he presented data (Tajima et al. 2015) in apparent support of the information integration theory (IIT): during wakefulness as compared to an anesthetized state, subjects' brain connectivity showed a higher level of complexity. This all seems to make sense from the perspective of the theory. But, importantly, the complexity of brain connectivity was also similar whether subjects' eyes were open or closed. I suppose proponents of the theory can argue that closed eyes just provide a different state of visual phenomenology, not one that it is less phenomenological. But isn't it true that when eyes are opened, they usually move, and thus the rich content of visual phenomenology also updates itself more frequently?

Ned Block suggested that perhaps this means that IIT is a theory of cognition, not of consciousness. Ever the wise and sharp discussant, to my mind his point also anticipated another recent result from Tononi's group (Sasai et al. 2016): while driving and listening to the radio, the brain connectivity patterns look as if there are two independent network complexes. To the extent this kind of complexity measures of connectivity are related to IIT at all, does it not mean that according to the theory, a unified individual breaks down into two conscious entities every time one multitasks? It seems all the more plausible that what breaks down are streams of cognitive processes, not consciousness itself. What this means for the theory will probably need to be discussed further.

The same powerful motif applies to many other talks at the conference. During wakefulness as compared to coma or an anesthetized state, of course one is more conscious. But during wakefulness, one also has more thoughts, memories, etc. Therefore, the same point by Ned Block was raised again during other talks concerning studies on different states of consciousness. I find this point particularly important, as it highlights why careful experiments within a sensory modality, like vision, are still crucial for directly testing theories of consciousness. Studies of different conscious states are highly interesting and relevant for practical clinical purposes, but in general they do not afford the level of experimental precision needed for isolating important confounds, such as cognition and objective perceptual capacities.

Jakob Hohwy's talk is another demonstration of how a philosopher can shed much needed light on scientific debates. I have great respect for my former colleague Karl Friston, but his theory of predictive coding (Friston 2010) sometimes struck me as unnecessarily abstruse. As such, I worry that some people look up to the theory precisely because they find it so difficult to understand, as deeply "profound" things tend to be. Hohwy did a great job in making it as plain and clear as possible, thus allowing a useful discussion on the merits and limits of the theory.

My favorite session involving philosophy talks, though, was the one where Megan Peters, Ian Phillips, Ned Block, and Bob Kentridge debated whether unconscious perception existed at

all. Toward the end of the discussion there was a feeling that it all hinged on how you define perception. Normally, such purely terminological disputes are just frustrating and uninteresting. But in his defense, toward the end of his talk Ian Phillips also clearly laid out the conditions under which his views could be empirically falsified. I wish there was more time for such discussion to be laid out.

This kind of empirical falsifiability is most important for theoretical developments – a point that became crucial in a session titled "The quest for neural correlates of consciousness – New directions and challenges for established perspectives", where the global workspace theory (GWT) and IIT were highlighted. In a year where the word "Establishment" has such unpleasant connotations in world politics, I feel the title was unfortunate. I am sure the organizer Manuel Schabus had no intention of mockery though! Instead we should take the positive reading of the word, to consider a theory as "established" when it makes clear empirical predictions not made by major opponents, and that such predictions are tested and confirmed by multiple labs around the world. In that sense, however, shouldn't Victor Lamme's highly influential local recurrency theory also qualify?

But I digress. In that excellent session, Christine Blume provided novel insights on the relationship between circadian rhythm and disorders of consciousness. Challenges were thrown at GWT by Mike Snodgrass, based on his EEG data (Silverstein et al. 2015), and then, to my mind, ably defended by Stan Dehaene, who also presented results on "unconscious" working memory. Melanie Boly also gave a *tour de force* introduction to IIT. However, in the discussion, there was a sense that it is difficult at this point to distinguish empirically between the two theories (GWT vs. IIT), even for the proponents themselves. To my mind, this is a critical issue that needs to be addressed, and ASSC provides the best opportunity to do so. At our stage of theoretical development, for a theory to be able to explain known facts is good. But more important is to be able to make clearly falsifiable, novel, and nontrivial predictions not made by opposing theories, so that people can actually attempt to test and arbitrate rather than "support" the theories. When a prediction fails, it cannot be pushed under the rug. This kind of tally-keeping is hard work, but necessary for obvious reasons.

To me this is a clear example of the kind of occasions where we need the help from philosophers, to play the role of the critical arbitrator between theories. Science depends on peer review, not just for publication but also for funding that directly affects job security. As such, there are harsh things that need to be said but are not always wise for scientists (especially the junior ones) to say. Philosophers, on the other hand, are relatively free from this burden and conflict of interest. They have an important duty to play the role of an unbiased referee, calling scientists out for potential foul play. As such, we should all be glad about the presence of philosophers at ASSC. The challenge ahead is for them to catch up on the increasingly technical science, while resisting the temptation to jump onto bandwagons themselves. We should applaud those for taking this challenge head on, and should continue to keep ASSC the perfect place for all this to happen.

Data versus the "Establishment"

So far I have had mostly positive things to say about our recent meeting, but some disclaimers are in order: I was not able to attend every talk, and space limitation means that I have to skip a few mentions even though I liked them very much. It is also true that there were some talks I went to and did not like as

much as others, but instead of going into unhelpful bashing, perhaps this comment I have heard several times over coffee breaks and late-night drinking sessions neatly sums it all up:

“This talk should have been at Tucson.”

This really should not be taken negatively, because as mentioned earlier, the Tucson consciousness conference is still going very well. It is particularly celebrated for its diversity in ideas and approaches, not shying away from intriguing hypotheses even when they may not be accepted as rigorously demonstrated in the mainstream just yet. But it is also true that ASSC is a decidedly different venue, given its historical origin.

As we see more and more students and postdocs at ASSC who are doing sophisticated experiments, introducing us to novel methods that we struggle to follow, and making a serious impact in the mainstream sciences, this is exactly how we should expect relatively speculative authoritative opinions to be received at the meeting. When I first went to ASSC in Barcelona too long ago (2002), I was a starry-eyed student who was keen to hear about whatever directions some wise senior scholar could point me in. But students and postdocs these days are not as naive as I was. They hold the future of the field, and they know it. If we have an idea we want to push for, it will be up to us to bring in the empirical evidence and solid arguments to convince them that it may be worth their time. Without them – not just students in our own labs but those in other labs too – our theories can never become “established.”

Of course, this is not to say we will or should just turn into another “workaday” science meeting. Conceptual and philosophical issues will remain important at ASSC, making it a distinctly interesting venue. Despite that, there is a timely need for us to display our capacity and resolve for seriousness and rigor to the wider scientific community. ASSC can well remain “different,” but it must not be treated as a playground for presenting indulgent work that we do not feel comfortable discussing with our more “hard-nosed” colleagues. Most of us, myself certainly included, have probably been guilty of this at some point. But truth is, if we do not start to comport ourselves as an academic gathering of the highest caliber, we will never become one. This is a point that is perhaps appreciated more easily among colleagues who have had to compete for funding in the USA in recent years.

For better or worse, mainstream US funding is conservative compared to that of Europe (and most other places), for our field at least. It is not that competing for funding in Europe is “easier,” but in the USA more pilot data is often needed, and rigorous demonstrations of “safe” ideas are often better received than riskier, more provocative projects. Importantly, faculty positions, especially prestigious ones, are also closely tied to mainstream funding. As such, in the past decade we have seen a highly asymmetrical growth between the two sides of the Atlantic, in terms of relevant new faculty or principal investigator positions for the field. It would be rather heartless of me, someone with job security, to fail to see the significance of this for our students and postdocs. Because people often compete for jobs in different countries, stagnation in one geographical section of the job market can hurt us all.

Perhaps this is also part of the reason why many of the keynote speakers we invited do not tend to return to our meetings, at least not together with their bright graduate students and

postdocs; multiple colleagues in the USA have told me frankly that they do not want to do this for the fear that this would hurt the students’ careers. Overall, the field has done well in Europe, Australia, and Asia for the past decade, but maybe not quite so well in the USA. You do not have to think the USA is particularly important – it is just a huge chunk of academic space. For a small conference, we are in need of that space for growth.

Can we finally end this taboo against the “c-word” once and for all? I believe we can. If you have attended this recent meeting as well as the last one in Paris, perhaps you will agree with me that it really feels as though we are at a watershed where a major transformation – like what happened to “attention” in the 1980s and ‘90s – is finally within our reach. So much has changed in our neighboring field of attention, but one striking thing is how the topic is now so well received by “mainstream” conferences like Vision Sciences Society and Society for Neuroscience. To attain the same status necessary for our further growth, we will have to indulge a little less in pushing too hard for our own ideas prematurely, at ASSC as well as in the popular media alike. Instead, we would do well to collectively build a more rigorous empirical standard for the field, by focusing on the relatively tractable questions at present, so as to give the mainstream sciences a chance to take us seriously. This is what ASSC is really about.

In an optimistic mood, I do wonder if I am just worrying too much. The students and postdocs who told me which talks they did not like might have decided about all this for us already.

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