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INTERVISTE

Conversation with Sun-Joo Shin

by David Waszek

Sun-Joo Shin is Professor of Philosophy at Yale University. She is widely known for her groundbreaking work on diagrammatic reasoning. In her first book, The Logical Status of Diagrams (1994), *she gave the first fully worked-out example of a logical system based on diagrams (in this case, Venn diagrams). Her second book,* The Iconic Logic of Peirce's Graphs (2002), *drew attention to a neglected diagrammatic logical system designed by Charles Peirce, his "existential graphs." She designed new ways of reading these diagrams and showed how and why the specific diagrammatic strengths of Peirce's graphs have been systematically neglected and misunderstood by later logicians. In her papers, Prof. Shin also shed fresh light on various problems in the philosophy of logic and mathematics by taking into account the fact that actual reasoning usually relies on various forms of representation, including diagrams. In this interview, she discusses her philosophical itinerary and the underlying motivations of her work. She also recounts with honesty the personal aspects of her career.*

1. *How did you get interested in logic?*

SJS: As an undergraduate student in Korea, I wanted to study philosophy of art. My dream was to go to Paris and work on Merleau-Ponty! But there were no scholarships for me in France, and I had no money. So instead, I went to Ohio State – they gave me a good scholarship there. I had to take a variety of basic courses: epistemology, aesthetics, logic, etc. I liked the logic class, which was taught by George Schumm, but I never thought I would specialize in the field.

However, at the end of my first year, I visited a friend at Stanford, and fell in love with the beauty of the campus. I could not believe my eyes – it was so beautiful, I thought I must be dreaming! I decided I had to transfer. I applied the following year and got in (it was in 1987). That is when problems started: no one had asked me what I wanted to study, and I had not realized that they did not do philosophy of art. At the time, philosophy at Stanford was very good, but very small, and they strongly emphasized logic. It was very much "love it or leave it." But then something else happened: I took a class with Jon Barwise, and then another by John Etchemendy just afterwards. They were truly fantastic teachers, both of them. They changed my whole life. I decided to catch up on logic, and took a lot of computer science classes, too. I also decided to write my first paper in that area.

2. *Around that time, Jon Barwise and John Etchemendy were embarking on an ambitious project: they were trying to rethink logic so as to accommodate reasoning not only with sentences, but also with diagrams. Is that how you were led to your PhD topic, on rigorous reasoning with Venn diagrams?*

SJS: Yes. People often ask me how I managed to finish my PhD early. But the main difficulty is finding one's topic. People usually start looking for their topic at the end of their second year: the third year is known as the "wandering around" year. What happened for me is that in June of my second year Barwise and Etchemendy offered me a position as Research Assistant for the summer, on their *Hyperproof* project. It was very intensive: we met every day. I do not think I contributed much to *Hyperproof*; it was too technical, and my programming background was not strong enough. But it was a great opportunity, and I learned a lot.

So, during that summer, Barwise and Etchemendy showed me a draft of what would become their "Visual Information and Valid Reasoning" paper (Barwise & Etchemendy 1991). In that paper, there was an example of rea-

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soning with Venn diagrams. They told me: "Can you try to justify this? We are sure the reasoning is valid, but we have no idea of how to justify it." I still remember staring at their diagrams for a long time. Finally, I hit upon an idea: giving the diagrams a syntax and a semantics. People always think that syntax is for symbolic systems only; but why not for diagrams? That was my idea. In retrospect, it seems simple and obvious. But back then, it was not. I remember sketching my plan to my advisers just before I left to get married, in December 1989. When I came back, they told me it was a great idea; that is the origin of my first paper, "A Situation-Theoretic Account of Valid Reasoning with Venn Diagrams" (Shin 1991).

I wrote a draft, and from then things moved very fast. I presented the paper at a conference in Edinburgh. There were a lot of interesting people there besides our Stanford group: Hans Kamp, Stanley Peters, and many others. On the next day, Etchemendy told me: "Excellent. That paper was your PhD. As soon as we get back to Stanford, you submit it and you apply for a job." I had never thought about that: I still had one more year of funding! But Etchemendy told me, "How do you know that next year there will be a job? There might be one this year." He was right, of course. The job he mentioned – which I got – was at Notre-Dame.

There was something I needed to do before I could submit, however. After my talk, the audience had asked me a lot of questions, but I was so nervous that I could not answer any of them. I was truly frozen to death. John Etchemendy added: "Sun-Joo, you could not answer any of those questions. That is not good. While they have lunch, you should go and ask everyone what their question was, and try to answer. Then you can complete your PhD." I also had to learn LaTeX… Barwise forced me to do it. Almost to the end of my PhD, I was using Microsoft Word. He brought me to his office one day and told me: "You cannot write a dissertation like this. You do not leave this office until you've figured out LaTeX! From today, I am not taking any further Word file from you." He immediately explained the basics to me and gave me some example files to learn from.

I was very young and nervous back then; I owe my advisers a lot. I am a fairly rebellious person, but I trusted them completely, and always listened to them, up to this day – Barwise, Etchemendy and also Perry (John Perry was the third member of my committee). Jon Barwise, in particular, was very important for me. I knew his family well, too, particularly his wife. They helped me a lot in many ways. I remember when there was a big earthquake once, and I was too scared to go back up to my room: they went in first to check that everything was fine… It was devastating for me when Barwise passed away.

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3. *So, can you explain a little what your work on Venn diagrams – which became your first book,* The Logical Status of Diagrams *(Shin 1994) – was about?*

SJS: Let me give you some context first. When people think about logic, they have in mind a taxonomy of logical systems like this one:

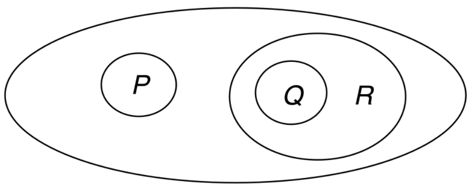
Languages / Meta-assumptions	First-order lang.	Second-order, modal, tense, epistemic lang.
Standard meta-assumptions	Classical logic	Extended standard logic
Many values, relevance, empty-domain	First-order non-standard logic	Extended non-standard logic

I believe it is uncontroversial. In this taxonomy, people tend to think that if a system is closer to classical logic, then it has more status as logic. They will discuss whether logical systems have to be sound and complete, for instance, or what logical constants are, or whether second-order logic is really logic. You can think of papers by Quine, by Hacking… But for those of us working on various forms of representation, even the entire picture was not enough, and we have tried to broaden the entire picture.

Validity is at the heart of logic: logic is just the study of valid reasoning. But people tie validity to logical form. We are very much skeptical about this. Logical form is not the only issue. Those who emphasize logical form are not wrong, but they are missing the point slightly. There is much more to logic. Logic should investigate representational forms in general, not *the* representational form. This has been our basic claim. To substantiate it, our goal was to develop a logic out of hybrid representational forms; that was the ultimate goal. But before that, as a sub-goal, we needed to investigate the logic of non-symbolic representational forms, like diagrams. Hence my work on Venn diagrams.

A new problem started there. I used syntax and semantics to prove that my system for Venn diagrams was sound and complete. I thought, and my dissertation committee thought, that I had proved that one can develop a logic for a non-symbolic system. But then, we got the following criticism: some said, "what she showed, in fact, is that Venn diagrams are a symbolic system!" Can you believe it? I was quite shocked. As my teachers told me, it was because I had only been talking with them – with people inside our group – so I had no idea that others held very different views. It really hurt me at first; I was very defensive. Let me tell you, I learned a very painful lesson back then, in my first year as an assistant professor. But in the end, it turned out to be a very fruitful criticism.

You see, at first, I thought this criticism was completely stupid. How could one not see that Venn diagrams are diagrammatic and not symbolic? But I was wrong. Yes, we have an intuition that the system is diagrammatic. But what makes it that way? And that is how my new goal, or rather sub-sub-goal, was born: finding the differences between diagrammatic and symbolic systems. As I soon realized, it is a mighty difficult task! But I had the strong belief that there was a real difference. Ultimately, though, I realized that no system is purely diagrammatic or purely symbolic, although some systems do have a predominance of one over the other. It is not a binary distinction: there are only symbolic and diagrammatic *features* or *elements*. I do not believe in finding necessary and sufficient conditions for diagrammaticity any longer, but I am looking for such features. Importantly, I think, diagrams are more flexible. This is linked to what I call the "carving-up" principle.



A sample Alpha Graph, the simplest kind of Existential Graphs. Alpha Graphs are equivalent to formulas of propositional logic; they are made of letters corresponding to propositional variables, and of closed curves, called "cuts," enclosing letters and other curves. Alpha Graphs may be translated into usual propositional logic in various ways. The traditional procedure, which Peirce called the "endoporeutic reading," operates from the outside in, treating juxtaposition as conjunction and cuts (i.e. curves) as negation, so that our example graph would be read $\neg(\neg P \wedge \neg(\neg Q \wedge R))$*. Using Shin's principles, one can read this graph in simpler ways. For instance, Q, R and their enclosing cut form a "scroll pattern," which may be read* $(R \Rightarrow Q)$*; similarly, this scroll, combined with P and the cut enclosing the entire graph, forms a second scroll pattern, so that the full formula may be read* $((R \Rightarrow Q) \Rightarrow P)$*. Using Shin's other principles, one may also read the formula as* $(P \vee (\neg Q \wedge R))$*.*

4. *I see. So this new question is what led you to your next book,* The Iconic Logic of Peirce's Graphs *(Shin 2002), which discusses* Existential Graphs*, a diagrammatic logical system designed by Charles Peirce. Can you explain your carving-up principle, which you introduce in this book?*

SJS: When reading Peirce's Existential Graphs (see figure above), that is, translating them into usual logical notations, people were always using Peirce's "endoporeutic reading:" they were reading the graphs in just one way. But when you translate an Existential Graph that way, you end up with a very cumbersome formula. My idea was to allow reading off from the graph two further visual elements (again, see figure):

1. Whether you have an even number or odd number of cuts (that is, closed curves) around a juxtaposition: if an even number, the juxtaposition is read as conjunction, if in an odd number, it is read as a disjunction of negated formulas;
2. The "scroll pattern" that Peirce himself mentioned, which is read as an implication.

If you do this, you get multiple ways of reading the graphs. The idea is that with a graph, some *Gestalt* might hit you, and then its meaning becomes much clearer. That can never happen in a symbolic system, which guarantees that there is only one reading. I believe that if you have this carving-up principle (that is, if you have several different readings) then you have a predominantly diagrammatic system. Again, there must be other good principles, but this one is very important, I think.

I recently started a paper on the difference between Arabic and Roman numerals, which would apply the carving-up principle. People often claim that Roman numerals are more diagrammatic than Arabic numerals, because they are much closer to representing a collection of things (I and I and I…). But I think they are wrong: it is the other way around. Arabic numerals are much more diagrammatic, because you can read them off in many ways, but without ambiguity.

5. *On another topic, you have also been a pioneer in using computer-aided teaching methods in logic. While at Stanford, you were one of the first to use Barwise and Etchemendy's logic teaching software, including* Tarski's World *and* Hyperproof *– which use on-screen diagrams – to teach elementary logic courses. What are you using now? Given your experience with these methods, what advice would you have for designing a logic curriculum more effective at improving students' reasoning skills?*

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SJS: I rarely teach introductory logic classes now (I usually teach more advanced material, for instance incompleteness). But whenever I do, I use Barwise and Etchemendy's textbook *Language, Proof, and Logic* (Barker-Plummer, Barwise & Etchemendy 2011), which includes the *Tarski's World* software. This book is truly excellent. Students love it. A big advantage is that the grading of homework is automatic, which means that you can assign many more questions, so students have much more practice. At the end of the class, they solve very complicated questions easily. My teaching assistants, who in most cases did not learn logic using this book, cannot believe it! Each time, it is the same: when my TAs first see my final exam, they basically tell me "Are you out of your mind? The students will not be able to do any of it!" And each time, they are proven wrong. The students succeed beautifully.

People sometimes complain that you have to buy a new book to be able to use the software: there is no second-hand market. But in fact, this keeps the price low by ensuring that enough copies are sold each year. Indeed, given that it is a huge book it is very affordable, and students are often surprised by its low price. Jon Barwise had told me from the start: "In the long run, it is the only way to keep the price down. You will see." And he was right.

6. *In recent years, you have been applying your understanding of diagrammatic reasoning to issues in the philosophy of mathematics and logic. Can you tell us more about your current work? What do you think a closer attention to the variety of representations can bring to the philosophy of mathematics?*

SJS: As I said before, I am still looking for new case studies on the symbolic-diagrammatic distinction. That is one part of my current research.

I am also interested in abductive reasoning. Let me explain. When we brainstorm, when we try to solve a problem, we draw diagrams. Something about diagrams stimulates our minds. That is really something we need to understand better. Peirce introduced the idea of abductive reasoning, by which he meant a kind of guessing or conjecture. My claim or hunch is that something like abductive reasoning – though not exactly in the same sense as Peirce's – is needed in the deduction processes. Suppose we want to deduce conclusions from some given information. The problem we have is that there are many pieces of information which follow from any given information. We have to choose the right one among all these. That is where abductive reasoning comes in: because there are too many choices, we need to make a guess. I want to claim that something diagrammatic somehow helps this abductive reasoning, somehow stimulates our minds to choose the right one. I recently wrote a paper on this, "The Role of Diagrams in Abductive Reasoning" (Shin 2016). Clearly, my goal is still the same: there must be something special about diagrams, and I am trying to understand what it is.

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