"I'm in Neuroplastic Heaven": Putting the Dollhouse in the Context of Modern Neuroscience

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[1] Modern neuroscience works on an underlying assumption of methodological materialism. It assumes that all aspects of human sensation, behavior, and internal experience are fully explained by the structure and function of the brain and the rest of the body. Neuroscience, and science in general, is also monist: it excludes the possibility of any sort of immaterial soul. This assumption of monist materialism can make applying the principles of neuroscience to fictional texts problematic; many cases of speculative fiction texts are explicitly dualist in that the existence of a soul is an established part of the story. *Dollhouse* (2009-2010), however, like real-world science, is explicitly monist and materialist.

[2] The story of *Dollhouse* is driven by a fictional method of neuromodulation, called Imprinting. The degree of understanding and control over the brain that Imprinting would require is well outside the reach of modern neuroscience. However, Imprinting appears to be driven by three real neuroscientific concepts: the idea of the engram, the general idea of neuroplasticity, and a specific aspect of it called Hebb's Law. Grounding Imprinting within the principles of real present-day neuroscience explains the logic of how Imprinting works within the show. But this grounding also relates the practice of Imprinting to the ethical principles that govern neuroscientific experimentation in the real world.

[3] The mere fact that the Dollhouse's programmer Topher is able to contain an entire human personality (either the original personalities of the Dollhouse's 'volunteers' or the artificial ones he constructs) on a

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computer hard drive is strongly suggestive of a materialist universe. Since computers are physical objects, they cannot, reasonably, contain someone's immaterial soul.[1] The alternate hypothesis presented in the show by Paul Ballard, that the Dolls' souls remain with their bodies and are responsible for failures of the Imprinting process, is disproved in several instances within the text ("Omega" 1.12). Echo, whose identity and behavior are central to the discussion of whether Dolls have souls, verbally states that she is not, and contains no aspect of, her Original Personality, Caroline Farrell ("Meet Jane Doe" 2.7). Ultimately her unique abilities are shown to be the result of an unnamed (but entirely physical) factor in her spinal fluid ("The Hollow Men" 2.12). Echo's abilities, Topher's skills, and the experiences of the other Dolls, even allowing for artistic licence, conform to the principles of materialism and also of modern cellular neuroscience.

[4] Understanding *Dollhouse*, therefore, requires understanding the human brain, and the neurobiology of memory. The portrayal of memory in *Dollhouse* has been discussed in earlier works. St. Louis and Riggs examined *Dollhouse* in the context of fairy tales and the psychological theories of Freud and Jung (2010), which are no longer considered part of mainstream psychology. Ginn (2010) noted substantial differences between the behavior of the Dolls, and cognitive psychological models of memory, and major clinical cases of memory loss. Examining memory as a psychological phenomenon does not capture any of the key details of how memory functions at the cellular level or how that is detailed in the show. While Ginn notes that the memory alterations shown in *Dollhouse* do not much resemble real-life cases of memory loss at the behavioral level, its treatment of the principles of memory at the cellular level is much more accurate (Ginn, 2010).

[5] The function of the brain is connected to its structure at multiple levels. The brain is made up of cells. One specific cell type, the neurons, carries out the brain's primary function of processing, using, and storing information. Long, thin, branches called axons, and bushy ones, called dendrites, make up the neurons' highly specialized structure. These branches' connections are called synapses. Large collections of synapses connect neurons together to form networks. The pattern of

different synapses in networks, and their specific patterns of activity (when and how they are active), encode information in the brain (Squire et al., 2008). Since the brain's structure and its function are integrally linked, the static structure of neurons cannot be differentiated from the activity in neuronal circuits in living tissue.

[6] Memories are represented in the brain by a physical network of connections between cells. This physical trace is called an *engram*. The idea of the engram was first described by Karl Lashley in 1930. Lashley was one of the first to demonstrate that memory is distributed throughout the cortex, rather than being localized to a specific region. He hypothesized that the mechanism of creating engrams would involve "equilibrium or dominance of excitation and the relations among the parts, rhythms and timing of activities, patterns of excitation rather than of preformed association paths, express significant facts" (Lashley 1929 qtd. in Bruce, 311). A specific mechanism for learning and the creation of engrams was later provided by Donald O. Hebb in 1949. Hebb's Law states that when one neuron repeatedly causes another to fire, over time the connection between the two will become stronger, so that the first cell will come to excite the second more effectively (Bruce, 2001). Neuroplasticity is the process of neurons altering the nature and strength of the connections and networks they form (Kolb & Gibb, 2014).

[7] Both the materialist nature of the mind in *Dollhouse* and the relationship between Imprinting and modern day neuromodulation techniques have been previously discussed by Muntersbjorn (2010). However, viewing the brain as a constantly adapting network of cells rather than a singular whole resolves the contradiction that "if minds can be recorded digitally and programmed to run on multiple brains, then minds are radically different from brains after all" (5). The material mind is not linked to a specific singular brain, but is instead linked to a specific organization of cellular networks within a brain. The transfer of minds, which Imprinting makes possible, works by changing the network organization of one brain to resemble another.

[8] Identifying specific engrams of basic forms of memory in animal models has just begun to be possible. However, a substantial body of evidence supporting both Langley's concept of distributed memories and Hebb's Law has provided much of the theoretical basis

for how scientists study the mechanisms of memory at the cellular and network level (Kolb & Gibb, 2014; Josselyn, Köhler, & Frankland, 2015). In "A Spy in the House of Love," Topher says that he is "in neuroplastic heaven" (1.9). He also makes a handful of offhand references to engrams and to long-term potentiation, one of the best-understood physical mechanisms of memory formation, throughout the series (Kandel et al., 2012). Dolls and Imprints also largely behave in ways congruent with current neuroscience.

Dollhouse **and the Neuroscience of Memory**

[9] Adelle DeWitt describes the Dolls' resting state as a "blank slate," but based on what we see of the Dolls' behavior, this description is not entirely accurate ("The Target" 1.2). It is never made clear whether this is due to a simplification she uses for the sake of good advertising, or a lack of understanding on her part, but Dolls actually demonstrate multiple forms of memories even in the resting state.

[10] Dolls retain procedural memory. Even in their Doll-state, Sierra, Victor, and Echo retain the memory of how to perform physical actions like washing their hair, doing yoga, and painting (Kandel, et al., 2012). Even here, the effect of Hebb's Law can be seen. Sierra is a noticeably better painter than the other Dolls. In "Belonging" we are shown a selection of paintings which Sierra has made during her time in the Dollhouse, each of them featuring birds, surrounded by ominous black shapes (2.4). Sierra's birds are relatively anatomically accurate, and use color to give the impression of depth and the details of feathers. Echo's paintings, which can be seen briefly in the same scene and much more clearly near the end of "Man on the Street," are two-dimensional and constructed from very basic shapes and simple colors (1.6). Sierra's Original Personality, Priya Tsetsang, is a painter. Her procedural skills related to painting are exceptionally well developed. Although Sierra's singular birds are not as detailed or skilled as the complex artwork Priya produces, Sierra is still able to access some of Priya's skills when she paints. Since the engrams of Priya's painting abilities are especially well developed and thus, harder to erase, it makes sense that they might be activated when Sierra utilizes her own painting abilities ("Belonging" 2.4). Regardless of which personality they are Imprinted with, all Dolls

and Imprints are conditioned to follow someone who asks them "Do you want a Treatment?"[2] ("Ghost" 1.1). They also retain a very limited form of semantic memory, meaning that they have access to a body of facts like the names of the Dollhouse staff and the other Dolls (Kandel, et al., 2012).

[11] One of the most robust forms of memory is emotional memory. It is known to persist even when other forms of memory have been lost (Feinstein, et. al., 2010; LaBar & Cabeza, 2006). In the show, Dolls retain implicit emotional memory. They show a constant emotional response to a person, object, or situation (LaBar & Cabeza, 2006). In the episodes "Instinct" and "A Love Supreme," different characters comment that emotional memories can be hard to remove. This indicates that these memories are also particularly persistent in the universe of *Dollhouse* (2.2; 2.8). Interestingly, this form of memory occurs in the Dolls both deliberately and spontaneously. Several Dolls, including Whiskey and November, respond to a mention of Dr. Saunders' name with a smile, stating that "Doctor Saunders is nice," and indicating that all of them feel pleasantly disposed to the Dollhouse physician ("Omega" 1.12; "A Spy in the House of Love" 1.9). Likewise, Echo trusts her handler, Boyd, implicitly and this trust is retained in all of her Imprints. It remains both as her personality develops, and when Paul Ballard replaces Boyd as her handler ("The Target" 1.2; "A Love Supreme" 2.8).

[12] The episode "Needs" is driven in its entirety by emotional memories. The Original Personalities of Caroline, Madeline, Priya, and Anthony each spontaneously recall their most pressing emotional memory: Caroline's need to free the Dolls, Madeline's loss of her daughter, Anthony's attraction to Priya, and Priya's hatred for Nolan Kinnard and need to confront him. None of their other memories are spontaneously recalled, which again attests to the strength of emotional memories (1.8). Priya's hatred and fear of Nolan Kinnard is an example of an emotional memory that recurs throughout the series. Sierra retains Priya's feelings, which she expresses through her paintings in "Belonging." Her birds are constantly surrounded by a black smudge that she "doesn't like," but which is "always there." The birds

themselves are also an expression of emotional memory, as they were a subject Priya liked.

[13] The same persistence can be seen in Sierra and Victor's love for each other. Although their Imprints have no history, and only minimal interaction with each other, that love persists between them despite several attempts by Topher to erase it. Victor/Anthony's attraction to Sierra/Priya is the memory that Anthony recalls in "Needs," instead of anything relating to the traumatic memories (themselves a class of emotional memory) that brought him to the Dollhouse in the first place. This emotional memory persists even though it originated entirely outside of Anthony's experiences, between Priya and one of Victor's Imprints, and then between Victor and Sierra ("True Believer" 1.5; "Needs" 1.8; "Belonging" 2.4; "Stop-Loss 2.9). Claire Saunders' original concern that Victor's feelings for Sierra might be the result of repeated Imprinting for romantic engagements is ultimately shown to be false ("True Believer" 1.5). However, it is another example of how Imprinting behaves according to Hebb's Law; neural patterns which are used frequently get stronger and harder to eliminate.

[14] Priya's feelings are similarly capable of overcoming the limitations that Imprinting should place on them. Mukherjea, in her analysis of Priya's character, describes Kinnard as "shocked to learn that Sierra/Priya—as a whole consciousness that has continuity from Priya's pre-Dollhouse self—is falling in love with Victor/Tony while only one of her Imprints believes herself to love Kinnard" (Mukherjea, 90 [74][3]). Priya acknowledges the primacy of her feelings for Victor in "Belonging," by saying, "I love him so much more than I hate you" (2.4).

[15] Autobiographical memory appears to be the only form of memory that Dolls lack. However, this explicit, conscious memory of past experiences may be present to some degree, as the Dolls do appear to have a sense of change or stability in their environments (Kandel, et al., 2012). One of the Dolls in "The Target" comments in a flashback sequence that "we always shower before we go in the pods," and in "Man on the Street," Victor comments that Sierra usually eats with him and Echo but is currently eating alone. In the same episode, and more

disturbingly, Sierra obviously remembers being raped by her handler Hearn (1.2; 1.6). Despite this, the Dolls' memories are obviously limited. The memories and cognitive capacities of Victor, Sierra, and Echo can be contrasted with related abilities of Anthony, Priya, and Caroline when, in "Needs," they are briefly left in the Dollhouse with their personalities intact but their memories absent (1.8). Anthony, Priya, and Caroline have a clear sense of their own identities and are aware that their memories are missing. Victor, Sierra and Echo, on the other hand, retain only a vague sense of continuity or change over time and are seemingly unaware of the limitations of their own memories ("Needs" 1.8). Even in their resting Doll-state, the Dolls have very limited memories and cognitive abilities; however, it is clear that in some capacity they do retain their cognitive abilities and their internal sense of self.

Dollhouse **and the Neuroscience of Learning**

[16] Ginn references three forms of memory: procedural, episodic, and semantic. These are the basic divisions used in many psychological models of memory to categorize forms of memory based on how they are recalled, and what information they contain. This categorization is useful when studying human behavior. But at the cellular level, there is no consensus as to how these types of memory might be linked to specific types of memory-associated cellular changes. Even cutting edge cellular manipulations, which have had some success in identifying the specific cellular networks that constitute certain engrams, have only succeeded in examining basic conditioning. But the current neuroscientific theory is still that all of these forms of memory are essentially engrams, stored in different places in the brain, and different populations of neurons (Ginn, 2010; Josselyn et al., 2015). All forms of memory are engrams, which are subject to various forms of plasticity[4] (Kandel, et al., 2012).

[17] In *Dollhouse* it is also true that all memories are engrams. This applies to different forms of memory, and means that the Dolls' and Imprints' artificially generated memories are functionally the same as spontaneously generated memories. At the neurobiological level, these patterns of synaptic connections in the brain are subject to alteration as

the brain creates new memories and changes in behavior by altering existing synapses or creating new ones[5] (Kandel, et al., 2012).

[18] The brain experiences this change naturally. As new memories are formed throughout daily life, new synapses are made to encode them, forming new engrams. Some engrams and their associated memories are lost quickly, but some will last for a very long time.[6] Learning occurs when new memories change our behavior in response to our experiences. Those changes are themselves generated, like memories, by the activity of networks of synapses within the brain.[7] Whether a memory is used as well as its degree of emotional significance are some of the factors which determine if a memory will be retained over the long term (Kandel, et al., 2012; Kolb & Gibb, 2014).

[19] It can be assumed that the regular non-Doll characters of *Dollhouse* learn like people in the real world. The Dolls, however, are never shown to be able to learn while in their resting state. While the Dolls are inside the Dollhouse, their environment is very static. In fact, it is deliberately kept as static as possible. In "Gray Hour," when Echo is wiped and returned to Doll-state in the middle of a job, Topher says that "In here we minimize the trauma [of being wiped] with throw pillows and perfectly crunchy lettuce and there's no conflict, but out there it's all fluorescent lights and forceps" (1.4). Without any new circumstances to respond to, there is very little to learn about, but in the highly novel situation of a locked bank vault, Echo still does not exhibit any novel or altered behavior. Instead, she continues to exhibit the same set of rather stereotyped behaviors; asking "Shall I go now?," parroting simple concepts like "jail" and following direct instructions unquestioningly as she does in the familiar environment of the Dollhouse ("Gray Hour" 1.4). Although there is significant newness and opportunity to demonstrate learning, she cannot. It is entirely possible that the true deficit that the Dolls have is not that they cannot remember, but that they cannot learn.

[20] Her capacity to learn and retain memories beyond that of a regular Doll is one of the first indications viewers receive that Echo has abilities that other Dolls do not. Her Imprint Eleanor Penn glitches, recalling Echo's memories of Sierra, in the very first episode broadcast ("Ghost" 1.1). As early as "Man on the Street," Echo obviously recalls

the engagement with Joel Mynor which was disrupted by Paul Ballard. There, she is shown painting an image of herself and Mynor standing outside the house Mynor bought for his deceased wife, and she informs Adelle that "it isn't finished" ("Man on the Street" 1.6). After Echo has all of her Imprints downloaded into her by Alpha in a composite event in "Omega," her ability to retain memories and to learn increases dramatically. In "Belonging," for example, she is shown to not only be able to read, but also to be able to lie about it, two things that Dolls cannot typically do.

[21] In contrast, Imprints do appear to learn over time despite also being primarily kept in a static environment. Although the Imprints are, at least in theory, fully-fledged people, they only exist for brief periods of time (usually a few hours to a few days) and they are placed in situations that they are literally designed for. Because of this, they have few opportunities to learn new behaviors. However, when they are placed in novel situations, they do learn. In "True Believer," when the Imprint Esther, originally designed as a faithful follower of a cult leader, witnesses him attempt to engineer a suicidal standoff between his cult and the ATF (Bureau of Alcohol, Tobacco, and Fire Arms), she tries to stop him. She also encourages the other cult members to leave instead of continuing to display her earlier unthinking faith ("True Believer" 1.5).

[22] Synaptic connections are plastic all the time, not just during their creation. Therefore, people change over time as they take in new information, gain new experiences, and reconsider old ones, allowing individuals to reshape their behavior gradually over time. When Echo is Imprinted as an undercover FBI agent over the course of several months, she undergoes periodic wipes and re-Imprints ("Vows" 2.1). Her re-Imprints are presumably to prevent this exact sort of gradual change, which could cause deviation from her mission. Claire Saunders, the Dollhouse doctor, is also a long-term Imprint, but she does not receive the same periodic resets. Claire's behavioral changes become more obvious over the course of the series. Initially, Claire is disapproving of the risks DeWitt and Topher are willing to take with the Dolls but, overall, is sympathetic to the Dollhouse and its ability to do good ("A Spy in the House of Love" 1.9). Over time she increasingly comes to see them as the enemy. She also becomes less and less friendly

towards the Dolls.[8] Eventually, she also experiences a dramatic change in perspective when she learns that she is an Imprint rather than an Original Personality ("Omega" 1.12). After that, she becomes quite distraught and distances herself from her Original Personality, whom she comes to see as a totally separate person, and starts coping by vindictively tormenting Topher, which is also new behavior. Topher, in response to her actions, comments that "My work is pristine. If you're losing it, that's your fault" ("Vows" 2.1). He later elaborates that "I didn't make you hate me, you chose to" ("Vow" 2.1), indicating that these feelings and behaviors have developed spontaneously, beyond what she was originally Imprinted with.

Dollhouse **and the Relationship Between Memories and Personhood**

[23] Unlike the obvious distinction between a Doll and an Original Personality, which can be seen on even a brief interaction with a Doll, the exact boundaries between an artificial Imprint and an Original Personality are less immediately apparent to outside observers. Over the course of the first season, Paul Ballard fails to notice that his neighbour Mellie and his chief informant Lubov are both Imprints ("A Spy in the House of Love" 1.9; "Briar Rose" 1.11). Imprints also, as previously mentioned, have the same general reactions to situations as Original Personalities. Even though they are generated on a computer, it is established in "Ghost" that their various traits are based off of scans from Original Personalities ("Ghost" 1.1).

[24] When Dolls have their Original Personalities returned at the end of their contract, their brains are not returned to their original state. They retain the "Active architecture," which was added to allow their brains to be given Imprints. Their Original Personalities are Imprinted onto them from a backup copy, through the same process used to give them artificial Imprints during their time in the Dollhouse. Calvert (2010; 2014) has discussed the implications of this. The permanent physical effects of the Active architecture render ex-Dolls vulnerable to the disruptions we see happening to various Imprints and the potential that their Imprint may be Imprinted onto another body, doubling them ("Echoes" 1.7; "Grey Hour" 1.4; "The Public Eye" 2.5; "The Left

Hand" 2.6). And those original Imprints are often altered, rendering them distinct from the actual Original Personality they started as.

[25] Madeleine Costley and Anthony Ceccoli both volunteer for the Dollhouse in order to have their brains fixed: Madeleine to process her overwhelming grief over the death of her daughter and Anthony to cure intractable Post-Traumatic Stress Disorder (PTSD). Both are subsequently seen after they have been released from the Dollhouse and are free of symptoms ("Instinct" 2.2; "Stop-Loss" 2.9). This is especially notable in Anthony's case. In the episode "Belonging," Victor is seen having post-traumatic flashbacks of Anthony's time in the army despite being a Doll and ostensibly having none of Anthony's memories (2.4). This recollection, once again, relates to the ability of emotions to strengthen memories, an ability that is established both on *Dollhouse* and in real-world neuroscience. The sheer strength of traumatic memories is, in fact, central to the pathology of PTSD (Pittenger, 2013). Even though the Dollhouse's wipes were not sufficient to entirely prevent Victor from showing PTSD symptoms, Anthony shows none of the same symptoms after he is released from the Dollhouse in "Stop-Loss," so something else must have been changed (2.9). Current therapies for PTSD aim to weaken the overly strong traumatic memories, which is believed to occur by weakening the emotional components of the engrams[9] (Kar, 2011). Logically, Anthony has been cured of his PTSD because the relevant synapses have been weakened directly by Topher, so that his previously traumatic memories can be recalled normally. Quite possibly, a similar process was applied to Madeleine Costley prior to her release in "Omega," since when she next sees Paul Ballard in "Instinct," she comments that she's "not sad" [about the death of her daughter] (1.12; 2.2). In the same episode, Topher also, somewhat jokingly, asks if she would like "any additional enhancements" ("Instinct" 2.2). Although it is difficult to tell if Topher is being serious, he has the ability to add isolated skills to an Original Personality, a similar task to removing or changing specific memories, and he eventually does this for Anthony in "The Hollow Men" (2.12).

[26] Although both Anthony and Madeleine have personalities that have been stored, altered, and Imprinted on their brains by Topher, no one within the Dollhouse questions whether their identities are real,

since their Imprints are based on their Original Personalities. This is also true in the case of Paul Ballard. Ballard suffers from catastrophic brain damage in "A Love Supreme" and ends up in coma (2.8). In order to repair the damage, Topher resorts to making him into a Doll and extensively rewiring his brain so that the remaining healthy tissue can carry out all his necessary brain functions. The resulting Imprint is therefore necessarily quite different from the organization of Paul's original brain, but there is little doubt that Paul as a Doll is the same person as the Original Paul, and not a novel artificial personality ("The Attic" 2.10). This form of plasticity, where healthy tissue takes up the function of damaged tissue, is actually one of the major processes by which people recover from brain damage like a stroke, although the brain's natural capacity for plasticity-based recovery is usually much less comprehensive[10] (Kandel, et al., 2012). Although, as a result, Paul is able to return from being comatose to a largely normal state, he loses his romantic feelings for Echo when the areas of his brain that had been storing those engrams were reassigned to do other things. As time goes on, however, his relationship with Echo is eventually rekindled. Whether this is the result of some of his emotional memories remaining active alongside the new programming in the way Sierra's and Victor's seem to, or if their relationship is recreated from scratch neuronally is not clear ("The Attic" 2.10).

[27] Based on these three cases, it is not the Imprinting process which characters use to separate 'artificial' Imprints from 'real' Original Personalities, but rather the origin of the personality. Personalities that originate inside a physical body are real, even if they are later altered: personalities generated on a computer are not. But what about Daniel Perrin? Perrin was a real person, but he is "a Doll version of himself" ("The Public Eye" 2.5). Perrin was "a party-boy, screw-up," but through the intervention of the Dollhouse his personality was altered to give him the ambition to run for and become a United States Senator. His memories were also adjusted to render him unaware of the changes and to create a relationship with his 'wife' Cindy, who is, in reality, his Dollhouse handler. The differences between Perrin and a more typical Imprint are illustrated when Topher and Bennett compare images of the two imprints, showing that Perrin's is much more complex than the

more basic Imprint currently being used on Echo. The two holographic brain images do not contain any scientific information that can be extracted by the audience, but do effectively communicate the degree of difference between a standard Imprint and what was done to Perrin. Perrin's nature as an Imprint successfully fools not only the unaware public, the way Mellie and Lubov originally fooled Paul, but also the better-informed staff of the Los Angeles Dollhouse, who eventually become aware of discrepancies in Cindy's false identity, and conclude that she is the Doll instead ("The Public Eye" 2.5; "The Left Hand" 2.6).

[28] It is never entirely addressed within the show whether Perrin is 'real' or not. A large portion of his unaltered Original Personality is described as being present, and when Perrin and Echo discuss it in his garden in "The Left Hand" he states that not only does he still feel like a single continuous self, but also that he does not necessarily want to return to how he was ("The Public Eye" 1.6). The primary difference between Daniel Perrin and Anthony Ceccoli or Madeleine Costley is not whether or how their brains have been altered (which in all three cases comes down to rearranging specific circuits of neurons in specific ways); it is why they have been altered. Anthony and Madeleine both specifically wanted to be changed, and the alterations that were made were to correct a change associated with distress or illness. In Perrin's case a totally novel set of motivations and interests were added to his otherwise healthy mind without his knowing. But, given that everything is being done in the same way, Anthony and Madeleine's recovery from mental illness is no more or less real than Perrin's desire to run for office. As previously described, people's fears, opinions, and interests routinely change over time. In fact, the wayward son of a political family developing political ambitions is much more likely to occur spontaneously than recovery from PTSD, which is notoriously difficult to treat (Jawetz, 2012; Kar, 2011).

[29] Since the memories that are artificially Imprinted into Dolls and Imprints behave the same way as memories which are created spontaneously, then from the perspective of a brain cell they are the same, and so are the artificial personality traits and quirks and alterations to existing people's minds. On that basis all the Imprints on *Dollhouse*, no matter how short-lived, are real individual people. The 'tabula rasa' Doll

personas are also individuals, distinct from both their Original Personalities and their Imprints. Different characters show different levels of awareness of this fact throughout the show. Topher comments in the unaired pilot episode "Echo" that "everyone is programmed" as part of a larger discussion to illustrate the equivalency between the memories and reactions of Imprints and those of Original Personalities (1.0). In "Ghost," and again in "Vows," he comments on the necessity of Imprints being "a whole person," not just a collection of desirable traits (1.1; 2.1). But in a conversation with Claire Saunders, Topher asks why she did not "find out who [she] used to be" and have DeWitt "re-Imprint [her] old identity" ("Vows" 2.1). Saunders, who clearly understands the implication of that action, replies that "I don't want to die," which would be the ultimate fate of her current identity in the case of being re-Imprinted with her Original Personality ("Vows" 2.1).

[30] Echo at one point refers to herself in "Omega" as "a container . . . nobody, just the porchlight, waiting for [Caroline]," rather than a so-called 'real' individual. However, she eventually comes to realize that she is a unique personality even if she is not an Original Personality, stating "I'm not her" ("Omega" 1.12; "Meet Jane Doe" 2.7). Paul Ballard, on the other hand, immediately replies with "you don't know that [you aren't her]" and for the majority of the show he treats Echo like a damaged version of Caroline[11] ("Meet Jane Doe" 2.7). Madeleine Costley, in contrast, seems to grasp the personhood of Imprints as well as Original Personalities intuitively; when she sees Echo in "Instinct" reacting to the loss of 'her' baby, Madeleine says that it "was [real] for her," while Paul tries to reassure her that it was "all pretend" (2.2).

[31] Neither Paul nor Madeleine is entirely correct about the reality of Echo's experiences. From the perspective of an external observer, it is true that many of the experiences Echo remembers never happened. In "Instinct" for instance, she did not actually give birth, and she was deliberately deceived about many of her real experiences. She was not married to Nate Jordan, and Jack was not actually her baby. But Madeleine is also correct in her observation that Echo's experiences are entirely genuine and subjectively true (2.2). If an engram programed by a computer has an identical effect on brain function to one created through experience, then in a biological sense the Imprints' artificial

memories are real. The Imprints have real memories of false events. So, while their memories of events might not be accurate, the Imprints' perceptions, knowledge, reactions, and skills are as genuine as their personalities, and should be treated with the same degree of seriousness and respect as anyone else's rather than written off as pretend things happening to pretend people (Jawetz, 2012).

Dollhouse **and the Neuroscience of Forgetting**

[32] Creating Imprints depends on both creating and erasing memories. Forgetting is an active process. It is not merely the absence of memory, and it is much less well-studied and less well-understood than the process of creating memories. The formation of memory occurs in three broad stages: encoding, storage, and retrieval. Very broadly, encoding refers to the creation of the engram,[12] storage is simply the presence of the engram in the brain, and retrieval is the process of recalling the information for conscious use. Forgetting can occur at any of these three stages (Kandel, et al., 2012).[13] Forgetting during the storage stage is referred to as trace decay, and it occurs when the engram for a memory actually ceases to exist (Wixted, 2004). However, forgetting during retrieval is much more common, and is called retrieval failure.[14] When this happens, the engram is intact but cannot be activated correctly. This is the form of forgetting that causes people to remember the correct answer just after the exam (Wixted, 2004). Most forgetting of long-term memories occurs because of retrieval failure. Reasons for retrieval failure include cue-dependence, where memories cannot be retrieved without an appropriate external reminder, and interference, where new memories suppress the retrieval of old ones (Wixted, 2004). Trace decay, the actual destruction of engrams, is believed to be almost exclusively pathological when it happens to long-term memories. This is what happens in memory loss due to brain damage or Alzheimer's disease (Squire et al., 2008). Based only on this information, the memory wipes that occur in *Dollhouse* would have to be based on retrieval failure, not trace decay, or else the Dolls' brains would be slowly destroyed as engrams were destroyed (similar to what actually happens in dementia). And, once again, this seems to be borne out by the evidence within the show itself.

[33] In the very first episode, "Ghost," the Dollhouse staff reference 'glitching' (1.1). In "Echoes" it is revealed that Dolls are said to glitch when they remember experiences from past Imprints. The drug which is released in "Echoes" causes the exposed Actives (Imprinted Dolls) to glitch;[15] November remembers Mellie being broken up with by Paul, Dr. Gawa remembers Sierra being raped, Tom remembers Anthony fighting in Afghanistan, and Alice remembers Caroline Farrell breaking into a Rossum Lab. Victor also glitches spontaneously in "Belonging" and has flashbacks of Anthony's time in the military when Sierra's painted face reminds him of it ("Echoes" 1.7). [16] Echo, of course, glitches more and more over time until she completely remembers every Imprint which is placed into her brain as the unique factor in her cerebrospinal fluid breaks down her repeated wipes ("The Hollow Men" 2.12). Echo is a special case, but all the Dolls are capable of glitching under the right circumstances. This suggests that all Dolls do in fact retain some engrams of memories from their Original Personalities and from their Imprints but are unable to recall them because of some combination of interference from more recent Imprints and a lack of the necessary cues.

Dollhouse **and Non-Neural Physiology**

[34] Even though Topher can, apparently, control the structure of a person's brain and the strength of the synaptic connections with incredible precision through Imprinting, he still struggles, over the entire series, to control Echo's Imprints because of the wipe-blocking factor in her cerebrospinal fluid ("The Hollow Men" 2.12). Echo is not special because of her (non-existent) soul, but because of a part of her body not affected by the Imprinting process. Given that other Dolls do exhibit some of the same wipe-resisting behavior that Echo does, it is not firmly established whether Echo's unique factor is actually totally exceptional, or just exclusively powerful or efficient ("Belonging" 2.4; "Stop-Loss" 2.9; "The Attic" 2.10).

[35] Genetic differences and glia are two other major factors affecting brain function that would not be affected by plasticity-based Imprinting. People have different genetic variants of many of the proteins that determine how neurons work, and no amount of alteration

to synaptic structure can make a brain produce a protein for which it does not have a gene. Alterations made to neurons also will not affect the glia, a collection of different types of brain cells, which are not neurons (Kandel, et al., 2012). Glia do very little direct information processing, but they can certainly affect neural functioning, since they are involved in metabolic and structural support for the neurons, repair damage, and regulate neural function (Kandel, et al., 2012). None of these aspects of brain function are referenced directly in *Dollhouse*, but in "Echoes" when Topher explains that human bodies are "our own little cesspools of hormones, enzymes, chemical reactions . . . [and] how your body reacts depends on a multitude of indefinable factors," these are some of his "indefinable factors" ("Echoes" 2.7).

[36] Echo's own "indefinable factor" could also come from outside the brain. Our brains do not exist in isolation and they interact constantly with the other systems of our bodies. In *Dollhouse* this is most obviously highlighted in the episode "Instinct," where Echo is Imprinted as a young mother to a new baby. At the beginning of the episode Topher crows that he has "made code for the brain that changed the physical body . . . on a glandular level," inducing the hormonal changes associated with birth and lactation (2.2). This is actually far less impressive than it sounds, as one of the major hormones associated with giving birth, post-natal bonding, and lactation is oxytocin, which is produced by the hypothalamus and then released by the pituitary gland, both of which are technically parts of the brain. Oxytocin is a neurohormone, meaning it is produced by neurons within the hypothalamus, but released into the bloodstream like a hormone[17] (Squire et al., 2008).

[37] Although the hypothalamus is composed of neurons and located in the brain, thus making it fair game for Topher to manipulate, the endocrine system that Topher is attempting to influence in "Instinct" does not work like the brain. Both the brain and the endocrine system are involved in transmitting information throughout the body. Communication within the brain is point-to-point; signals in one place do not affect other places. This is not the case with the endocrine system. When hormones like oxytocin are released into the bloodstream, they inevitably travel throughout the body affecting all target tissues

(Squire et al., 2008).[18] As a result of the effect of one hormone's presence, all the target tissues, including the brain, may be affected (Squire et al., 2008).

[38] In "Instinct," even once Echo has been wiped, she still retains a memory of having a child (2.2). Whether or not this is a realistic response to hormonal changes is hard to determine, as the technology used in *Dollhouse* is fictional. Some of Echo's response could well have been unique to her biology instead of being a general endocrine effect. However, it does illustrate the point that what occurs in the brain cannot be entirely separated from the rest of the body. The brain receives constant feedback and information from the endocrine, immune, and peripheral nervous systems[19] (Squire et al., 2008; Irwin & Rothermundt, 2012). These interactions can become quite complex. Each system can directly or indirectly affect the brain and vice versa, and any of these mechanisms could potentially alter a Doll's response to an Imprint (Irwin & Rothermundt, 2012).

[39] Oxytocin could also provide another explanation for the robustness of Sierra and Victor's romantic relationship. Oxytocin is involved in forming romantic/sexual pair-bonds similarly to the formation of maternal bonds. Romantic relationships, especially in their early stages, have also been found to involve changes in the sex hormone testosterone and the hormone cortisol, which is involved in response to stress (De Boer et. al, 2012; Coria-Avila et. al., 2014). If the effects of hormones can create an emotional bond which resists the Dollhouse's wipes in Echo, then it follows that it could do the same for Sierra and Victor. This centers the explanation for the incredible perseverance of their relationship firmly around their bodies. This is something that has been discussed in multiple other analyses. Jowett's in-depth analysis of Sierra and Victor's relationship raises the question "if Victor and Sierra are 'soul mates' to the point that Tony and Priya also fall in love, does this suggest that they are still programmed, not by the Dollhouse or Rossum, but by social conditioning or biology?" (148 [137]). This interpretation suggests strongly that the answer is yes. Further, the source of the "continuity from Priya's pre-Dollhouse self" (90) that Mukherjea describes (2014) or the "complex interrelated webs of experience wherein all possible Victors love all possible Sierras"

referenced by Muntersbjorn (20) is essentially Priya and Anthony's bodies acting on their various Imprints. This too is not unique to Dolls and Imprints. Paul's attraction to Caroline, for example, or Topher's attraction to Bennett, could be explained in the same way.

[40] There is a second way in which brain function is intrinsically connected to the human body in *Dollhouse* and that is that, to all appearances, only human brains can perform the functions of human brains: "embodiment cannot be avoided" (Calvert, 2010, 12). We first see the wedges that the various Imprints are stored on at the beginning of the very first episode, establishing that they are generated and stored on computers. In "Omega" and "Belonging" we see two of the places where the wedges are stored while not being used to Imprint Dolls. Both of them are simply securely locked shelves; there is no indication that the Imprints are used in any way when not being Imprinted into Dolls, and, of course, none of the Imprints, Dolls, or Original Personalities ever have any memory or sense of time passing while not Imprinted (1.12; 2.4). Together these two things suggest that the Imprints are not in any way 'on' or 'awake' while in the computer.[20] The Original Personalities, the Dolls, and their Imprints all seem to be awake and aware only when they are Imprinted into and existing as an actual, physical, living human brain, not when they are merely being simulated by computer.

The Ethical Failures of the Dollhouse

[41] Scientific ethics is not a new topic for either the science fiction genre or Joss Whedon. As discussed more thoroughly by Koontz (2010), "casting advances in technology as the malevolent genie let out of its bottle by hapless scientists has been a common theme in both the science fiction and horror genres at least since Shelley's *Frankenstein*," (12) and "in *Dollhouse* Whedon creates a platform to examine several issues that have trailed tendrils through his earlier work . . . one of these . . . is the idea that the growth of technology is something to be watched very suspiciously" (11).

[42] But determining a framework for research and the use of new technology without doing harm is also something that scientists and ethicists must consider in the real world. So, when framing the neuroscience of *Dollhouse* as an extension of modern neuroscience, it is

also relevant to discuss the ethics of *Dollhouse* within the same framework. Modern biomedical research of all sorts is guided globally by a set of ethical guidelines outlined concretely in the Helsinki Declaration, which was first written in 1964 and most recently updated in 2013 (World Medical Association, 2013). The actions of the Rossum Corporation and the Dollhouse violate many if not all of the major guiding principles set out in the Declaration. It is a secret illegal venture, when researchers have obligations to abide by the laws of the country they are working in, to be monitored by an external ethics board, and to publicise their findings. Subjects' right to medical care should never be impacted by either their choice to participate in research or their refusal to do so, but Anthony's access to PTSD treatment was conditional on his agreeing to work for Rossum ("Stop-Loss" 2.9; World Medical Association, 2013). Researchers are supposed to avoid personal and financial conflict of interest, or, at minimum, to declare them, but Rossum allows its employees to access the services of the Dollhouse, and this is kept as an open secret among Rossum employees ("A Spy in the House of Love" 1.9; "Haunted" 1.10; "Belonging" 2.4; World Medical Association, 2013).

The Impact of Imprinting on Informed Consent

[43] "The requirement to seek their free, informed and ongoing consent" (9) is an ongoing ethical issue rampant in *Dollhouse* (Canadian Institutes of Health Research, et al., 2010; World Medical Association, 2013). Ethical consent is not only violated by the Dollhouse, but violated in ways that are specifically impacted by the creation of multiple individuals by the Imprinting process. The parallels between the Dollhouse and real world forms of human trafficking are discussed as early as the first episode, when Paul Ballard explains to his superiors that he interfered with another ongoing FBI investigation because it involved a major human trafficking ring ("Ghost" 1.1). The Dollhouse further evokes human trafficking through its deliberate recruitment of vulnerable, isolated people, the Dolls' inability to leave once recruited, and the heavily sexual nature of many of their engagements (Mukherjea, 2014; Ginn & Porter, 2014; Bennett, 2011; Sutherland & Swan, 2014).

[44] In "Man On the Street," Hearn, Sierra's original handler,

justifies raping her by explaining that it is fundamentally the same as various Imprints in the same body being sent on engagements involving sex (1.6). This is an inaccuracy that centers around the way the Imprinting process complicates the issue of consent. Sierra, Priya, and each of the Imprints placed in Sierra's brain are independent people who would have to give consent to sex separately, just as any two people cannot give sexual consent for each other. Sierra's Imprints do not "think [they are] in love, for all of a day" ("Man on the Street" 1.6): they *are* in love and consent to sex with their various lovers and just happen to only exist for a day. Neither Sierra nor Priya ever think they are in love outside of their love for Victor/Anthony ("Man on the Street" 1.6; "Belonging" 2.4).

[45] Genuine informed consent must be given by someone who is fully informed about the nature of what he or she will be doing and what the risks are, and must be uncoerced and able to be withdrawn at any point (World Medical Association, 2013; Canadian Institutes of Health Research, et. al., 2010). Sierra, a Doll, may actually be incapable of giving consent to sex at all, since "an informed choice [to give consent] is one that is based on as complete an understanding as is reasonably possible" (Canadian Institutes of Health Research, et al., 9). Sierra never uses the words sex or rape when referring to what happened to her. Her lack of understanding precludes genuine consent in a way that evokes childhood sexual abuse (Nadkarni, 2014). If Dolls are, in fact, incapable of learning things like what sex is, then it is possible that they may be generally unable to give consent, but the exact determination of when and in what circumstances an individual lacks the capacity to consent is complex and beyond the scope of this article. Imprints on romantic/sexual engagements, in contrast, give every indication of being able to consent. Sierra's confused and obviously distressed compliance in "Man on the Street" is directly contrasted with Mellie's active interest in Paul Ballard in the same episode (1.6).

[46] But the active consent of an Imprint, while genuine, is not sufficient. Your right to decide exactly what happens to your body extends even past your death. There is no situation in which you can sign a metaphorical blank check and allow someone to do whatever he or she wants to your body (Canadian Institutes of Health Research et al.,

2010; World Medical Association, 2013; Sutherland & Swan, 2014, 229). Real consent for Imprinting would involve the Original Personality giving specific consent to the process of wiping and Imprinting, and also to each activity the Imprinted personality would undertake. Furthermore, just as the Doll's Original Personalities should have been given the opportunity to consent to the activities of the Dolls and Imprints, the Dolls and Imprints should have been given the opportunity to consent to being wiped and re-Imprinted just as much as the Original Personalities. That never happens; not only are they never asked, but the Imprints' conditioned positive response towards any offer of "a treatment" makes real consent impossible. Even if they knew what "a treatment" involved, and there is no indication that they do, they lack the ability to refuse.

[47] The consent that the Original Personalities do give simply to enter the Dollhouse is also not actually valid. Adelle DeWitt repeatedly emphasizes that the Original Personalities to whom the Dolls' bodies belong are "volunteers," which is true only in the sense that they did, technically, sign a consent form ("Ghost" 1.1; "Echoes" 1.7; "Briar Rose" 1.11). But true consent[21] requires that volunteers consent without being coerced, and every volunteer in the show has been coerced: Caroline consented to avoid jail, Priya was kidnapped and gave consent while drugged, and Anthony and Madeleine both agreed in order to be able to access medical treatment ("Ghost" 1.1; "Instinct" 2.2; "Belonging" 2.4; "Stop-Loss" 2.9; Canadian Institutes of Health Research, et al., 2010; World Medical Association, 2013).[22] If there are people who volunteered freely to be Dolls, they are not featured on the show.[23] Sutherland and Swan have discussed the role that signing a contract plays in disguising the unethical nature of the Dollhouse's practices by creating an air of legitimacy and creating a sense of obligation in the "volunteers," even though such contracts are illegal and would be unenforceable. Consent forms as they specifically apply to scientific research share many similarities with the business contracts they describe. They provide a formal record of the consent process for both the researcher and the research participant and a concrete outline of the participant's role in the study, including, in a real consent form, the right to withdraw from the study without question. However, it is

also worth noting that the consent form can be altered or even omitted to prevent such a form from creating in the participant the exact sense of artificial obligation which Sutherland and Swan describe (Sutherland & Swan, 2014; Canadian Institutes of Health Research, et. al, 2010).

[48] The practicalities of the Imprinting process further complicate obtaining informed consent by preventing the volunteers from leaving. Volunteers in scientific research have the right, and must maintain the ability, to revoke consent and leave at any time (Canadian Institutes of Health Research et al., 2010; World Medical Association, 2013). The Dollhouse's volunteers, who are immediately wiped and backed up onto wedges, have no such ability. This option is effectively nonexistent for the duration of their term in the Dollhouse.

Conclusions

[49] Imprinting is a form of technology well beyond the reach of modern neuroscience. Its mechanisms and effects are, ultimately, dictated by the show's creators and writers. However, it is also an expansion of some of the basic theories that drive neuroscientific research, meaning that it is possible to describe the science of the Dollhouse in some detail. The two key principles of neuroscience which are the most clearly utilized in *Dollhouse*, neuroplasticity and the theory of the engram, describe the interconnected structure and function of the brain at the cellular level, and how the highly specific pattern of interconnections of nerve cells creates behavior. Viewing the brain as a complex pattern of cellular connections resolves, in one sense, one of the central dilemmas of how *Dollhouse* portrays the mind as simultaneously totally physical and dependent on the brain, while at the same time, free to move between individual brains, or even inhabit more than one at a time (Muntersbjorn, 2010; Calvert, 2014).

[50] If it is the pattern of cellular connections within a brain that is important to create an individual, then the mind must be embodied through the brain. But an individual mind can exist in any number of brains, or persist past the death of the original brain, by being copied into a new one. It also means that the fundamental origin of those patterns is not a meaningful determinant of whether an individual is real

or not. An artificial engram, or an artificial complete personality has all the same properties as a real one.

[51] But at the same time, the same science complicates the portrayal of minds as truly able to be independent of specific bodies. The individual variation of each body will exert its own influence on each mind. The neuroplasticity which allows engrams to be altered can also reinforce them to the point that they can persist and become active in later Imprints which are supposed to overwrite them. Each of a Doll's Imprints are therefore unique individuals, but they also exist in an interdependent system where they will influence each other and be influenced by the same biology (Mukherjea, 2014). The neuroscience that describes the mechanisms that go into creating an identity ultimately does not provide explicit answers as to where the boundaries between identities should be placed.

[52] Neuroscience does not provide explicit answers about identity, but it does provide a framework for how individuals, whether they are truly independent from each other or not, should be treated. If Imprinting is applied neuroscience, then those who apply it are neuroscientists, and should be governed by the rules by which neuroscientists are governed: That, "while the primary purpose of medical research is to generate new knowledge, this goal can never take precedence over the rights and interests of individual research subjects" (World Medical Association, 2191). There are numerous examples of this rule not being respected, throughout the series, adding another facet to the way *Dollhouse* portrays an organization with a lack of respect for consent (Nadkarni, 2014; Ginn & Porter, 2014; Bennett, 2012; Mukherjea; 2014). But the science involved also suggests that Imprinting is not just practiced non-consensually, but is in fact, unable to be genuinely consensual. Dolls, Original Personalities, and Imprints are independent individuals who happen to exist at different times in the same body. But this status renders them unable to totally control their own body, and their own interests, without impinging on the control of another person.[24]

Works Cited

"The Attic." Writ. Maurissa Tancharoen, and Jed Whedon. Dir. John Cassaday. *Dollhouse*. Season Two, Episode Ten. Fox Broadcasting Company. 18 Dec. 2009. Television.

"Belonging." Writ. Maurissa Tancharoen, and Jed Whedon. Dir. Jonathan Frakes. *Dollhouse*. Season Two, Episode Four. Fox Broadcasting Company. 23 Oct. 2009. Television.

Bennett, Eve. "Deconstructing the Dream Factory: Personal Fantasy and Corporate Manipulation in Joss Whedon's *Dollhouse*." *Slayage: The Journal of the Whedon Studies Association*. 9.1 (Spring 2011) <http://www.whedonstudies.tv/uploads/2/6/2/8/26288593/bennett_slayage_9.1.pdf> Web. 15 Jul. 2016.

"Briar Rose." Writ. Jane Espenson. Dir. Dwight Little. *Dollhouse*. Season One, Episode Eleven. Fox Broadcasting Company. 1 May 2009. Television.

Bruce, Darryl. "Fifty Years Since Lashley's *In Search of the Engram*: Refutations and Conjectures." *Journal of the History of the Neurosciences*. 10(3) (2001). 208-218. Print.

Calvert, Bronwen. "Mind, Body, Imprint: Cyberpunk Echoes in the Dollhouse." *Slayage: The Journal of the Whedon Studies Association*. 8.2 & 3 (Summer/Fall 2010). <http://www.whedonstudies.tv/uploads/2/6/2/8/26288593/calvert_slayage_8.2-3.pdf> Web. 2 Jul. 2016.

---. "'Who did they make me this time?': Viewing pleasure and horror." *Joss Whedon's* Dollhouse*: Confounding Purpose, Confounding Identity*. Ed. Sherry Ginn, Alyson R. Buckman, Heather M. Porter. Plymouth, Rowman & Littlefield. 2014. 127-139. Ebrary.

Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, and Social Sciences, and Humanities Research Council of Canada. "Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans" <http://www.pre.ethics.gc.ca/pdf/eng/tcps2/TCPS_2_FINAL_Web.pdf>. Web. 9 Feb. 2014.

Coria-Avila, Genaro A., Manzo, Jorge, Garcia, Luis I., Carrillo, Porfirio, Pfaus, James G., "Neurobiology of Social Attachments" *Neuroscience and Biobehavioural Reviews.* 43 (2014) 173-182. Print.

De Boer, A., Van Buel, E. M., Ter Horst, G. J. "Love is More Than Just a Kiss: A Neurobiological Perspective on Love and Affection." *Neuroscience.* 201 (2012) 114-124.

"Echo" Writ. Joss Whedon. Dir. Joss Whedon. *Dollhouse.* Unaired Pilot. Twentieth Century Fox Home Entertainment. 2009, Unaired, 2010 DVD.

"Echoes." Writ. Elizabeth Craft and Sarah Fain. Dir. James Contner. *Dollhouse.* Season One, Episode Seven. Fox Broadcasting Company. 27 Mar. 2009. Television.

Feinstein, Justin S., Duff, Melissa C., Tranel, Daniel. "Sustained Experience of Emotion After Loss of Memory in Patients with Amnesia" *Proceedings of the National Academy of Sciences of the United States of America.* 107(17) (2010) 7674-7679. Print.

"Ghost." Writ. Joss Whedon. Dir. Joss Whedon. *Dollhouse.* Season One, Episode One. Fox Broadcasting Company. 13 Feb. 2009. Television.

Ginn, Sherry. "Memory, Mind, and Mayhem: Neurological Tampering and Manipulation in *Dollhouse*." *Slayage: The Journal of the Joss Whedon Studies Association.* 8.2 & 3 (Summer/Fall 2010). <http://slayageonline.com/essays/slayage30_30/ginn.pdf>. Web. 27 Jan. 2014.

Ginn, Sherry & Porter, Heather, M. "'I Possess the Means to Satisfy My Vagaries': What Motivates the Dollhouse Clients?" *Joss Whedon's Dollhouse: Confounding Purpose, Confounding Identity.* Ed. Sherry Ginn, Alyson R. Buckman, Heather M Porter. Plymouth, Rowman & Littlefield. 2014. 112-125. Ebrary.

"Gray Hour." Writ. Sarah Fain and Elizabeth Craft. Dir. Rod Hardy. *Dollhouse.* Season One, Episode Four. Fox Broadcasting Company. 6 Mar. 2009. Television.

"Haunted." Writ. Jane Espenson, Maurissa Tancharoen and Jed Whedon. Dir. Elodie Keene. *Dollhouse.* Season One, Episode Ten. Fox Broadcasting Company. 24 Apr. 2009. Television.

"The Hollow Men." Writ. Michele Fazekas, Tara Butters, and Tracy Bellomo. Dir. Terrence O'Hara. *Dollhouse.* Season Two, Episode Twelve. Fox Broadcasting Company. 15 Jan. 2010. Television.

"Instinct." Writ. Michele Fazekas, and Tara Butters. Dir. Marita Grabiak. *Dollhouse.* Season Two, Episode Two. Fox Broadcasting Company. 2 Oct. 2009. Television.

Irwin, Michael R., Rothermundt, Matthias. "Clinical Psychoneuroimmunology" *Handbook of Clinical Neurology: Neurobiology of Psychiatric Disorders Vol. 106* Ed. T. E. Schlaepfer, C. B. Nemeroff. 211-225. Elsevier. 2012. Science Direct. 3 Jul. 2016.

Jawetz, Ryan. "Identity and Memory in *Dollhouse*." *Joss Whedon: The Complete Companion, The TV Series, The Movies, The Comic Books and More.* Ed. Mary Alice Money. London, Titan Books. 2012. 393-397. Print.

Josselyn, Sheena A., Köhler, Stefan, Frankland, Paul W. "Finding the Engram." *Nature Reviews Neuroscience.* 16(9) 521-534. Print.

Jowett, Lorna. "'I Love Him. . . . Is That Real?': Interrogating Romance Through Victor and Sierra". *Joss Whedon's* Dollhouse*: Confounding Purpose, Confounding Identity.* Ed. Sherry Ginn, Alyson R. Buckman, Heather M Porter. Plymouth, Rowman & Littlefield. 2014. 140-152. Ebrary.

Kandel, Eric R., Schwartz, James H., Jessell, Thomas M., Siegelbaum, Steven A., Hudspeth, A. J. ed. *Principles of Neural Science 5th Edition.* USA: McGraw-Hill Professional. 2012. Print.

Kar, Nilamadhab, "Cognitive Behavioural Therapy for the Treatment of Post-Traumatic Stress Disorder: A Review" *Neuropsychiatric Disease and Treatment.* 7 (2011) 167-181.

Kolb, Bryan, & Gibb, Robbin. "Searching for the Principles of Brain Plasticity and Behaviour" *Cortex.* 58 (2014) 251-260. Print.

Koontz, K. Dale. "Czech Mate: Whedon, Capek and the Foundations of the Dollhouse". *Slayage: The Journal of the Whedon Studies Association.* 8.2 & 3 (Summer/Fall 2010) <http://www.whedonstudies.tv/uploads/2.6.2.8.26288593/koontz_slayage_8.2-3.pdf>. Web. 2 Jul. 2016.

LaBar, Kevin S., Cabeza, Roberto "Emotional Memory" *Nature Reviews Neuroscience.* 7 (2006) 54-64. Print.

"The Left Hand." Writ. Tracy Bellomo. Dir. Wendey Stanzler. *Dollhouse*. Season Two, Episode Six. Fox Broadcasting Company. 4 Dec. 2009. Television.

"A Love Supreme." Writ. Jenny DeArmitt. Dir. David Straiton. *Dollhouse*. Season Two, Episode Eight. Fox Broadcasting Company. 11 Dec. 2009. Television.

"Man on the Street." Writ. Joss Whedon. Dir. David Straiton. *Dollhouse*. Season One, Episode Six. Fox Broadcasting Company. 20 Mar. 2009. Television.

"Meet Jane Doe." Writ. Maurissa Tancharoen, Jed Whedon, and Andrew Chambliss. Dir. Dwight Little. *Dollhouse*. Season Two, Episode Seven. Fox Broadcasting Company. 11 Dec. 2009. Television.

Mukherjea, Ananya. "Somebody's Asian on TV: Sierra/Priya and the Politics of Representation". *Joss Whedon's* Dollhouse*: Confounding Purpose, Confounding Identity*. Ed. Sherry Ginn, Alyson R. Buckman, Heather M Porter. Plymouth, Rowman & Littlefield. 2014. 82-97. Ebrary.

Muntersbjorn, Madeline. "Disgust, Difference, and Displacement in the Dollhouse." *Slayage: The Journal of the Whedon Studies Association*. 8.2 & 3 (Summer/Fall 2010) <http://www.whedonstudies.tv/uploads/2/6/2/8/26288593/muntersbjorn_slayage_8.2-3.pdf>. Web. 2 Jul. 2016.

Nadkarni, Samira. "'In My House and Therefore in My Care': Transgressive Mothering, Abuse and Embodiment." *Joss Whedon's* Dollhouse*: Confounding Purpose, Confounding Identity*. Ed. Sherry Ginn, Alyson R. Buckman, Heather M Porter. Plymouth, Rowman & Littlefield. 2014. 98-111. Ebrary.

"Needs." Writ. Tracy Bellomo. Dir. Felix Alcala. *Dollhouse*. Season One, Episode Eight. Fox Broadcasting Company. 3 Apr. 2009. Television.

"Omega." Writ. Tim Minear. Dir. Tim Minear. *Dollhouse*. Season One, Episode Twelve. Fox Broadcasting Company. 8 May 2009. Television.

Pittenger, Christopher "Disorders of Memory and Plasticity in Psychiatric Disease." *Dialogues in Clinical Neuroscience*. 15 (2013) 455-463. Print.

"The Public Eye." Writ. Andrew Chambliss. Dir. David Solomon. *Dollhouse.* Season Two, Episode Five. Fox Broadcasting Company. 4 Dec. 2009. Television.

"A Spy in the House of Love." Writ. Andrew Chambliss. Dir. David Solomon. *Dollhouse.* Season One, Episode Nine. Fox Broadcasting Company. 10 April 2009. Television.

Squire, Larry R., Berg, Darwin, Bloom, Floyd E., du Lac, Sascha, Ghosh, Anirvan, Spitzer, Nicholas C. ed. *Fundamental Neuroscience 3rd Edition.* Canada, Academic Press. 2008. Print.

St. Louis, Renee, Riggs, Miriam. "'A Painful, Bleeding, Sleep': Sleeping Beauty in the Dollhouse." *Slayage: The Journal of the Whedon Studies Association.* 8.2 & 3 (Summer/Fall 2010). <http://www.whedonstudies.tv/uploads/2/6/2/8/26288593/stlouis_riggs_slayage_8.2-3.pdf>. Web. 2 Jul. 2016.

"Stop-Loss." Writ. Andrew Chambliss. Dir. Felix Alcala. *Dollhouse.* Season Two, Episode Nine. Fox Broadcasting Company. 18 Dec. 2009. Television.

Sutherland, Sharon and Sarah Swan. "'There Is No Me; I'm Just a Container': Law and the Loss of Personhood in *Dollhouse*." *Reading Joss Whedon.* Ed. Rhonda V. Wilcox, Tanya R. Cochran, Cynthea Masson, David Lavery. New York, Syracuse UP. 221-236. Print.

"The Target." Writ. Steven S. DeKnight. Dir. Steven S. DeKnight. *Dollhouse.* Season One, Episode Two. Fox Broadcasting Company. 20 Feb. 2009. Television.

"True Believer." Writ. Tim Minear. Dir. Allan Kroeker. *Dollhouse.* Season One, Episode Five. Fox Broadcasting Company. 13 Mar. 2009. Television.

"Vows" Writ. Joss Whedon. Dir. Joss Whedon. *Dollhouse.* Season Two, Episode One. Fox Broadcasting Company. 25 Sept. 2009. Television.

Wixted, John T., "The Psychology and Neuroscience of Forgetting" *Annual Review of Psychology.* 55 (2004) 235-269. Print.

World Medical Association "World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects." *Journal of the American Medical Association.* 310(20) (2013) 2191-2194. Print.

Notes

[1] Editor's note: One might recall, however, that in Whedon's fantasy series *Buffy the Vampire Slayer* (1997-2003), Angel's soul (explicitly named as such) is contained in a physical vessel, the Orb of Thesulah.

[2] Conditioning is an automatic learned response to a stimulus. Conditioning is directly related to Hebb's rule, and it is a very commonly studied form of memory formation. Conditioning is also very old evolutionarily and can be seen in almost every kind of animal, even very simple ones like snails (Pittenger, 2013).

[3] Editor's note: Because the Ebrary page numbers differ from those of the hard copy, the hard copy page numbers are provided in brackets.

[4] The forms of memory listed here are actually categories each with subtypes; most memory research would focus on just one subtype of one of these forms of memory (Kandel, et al., 2012).

[5] The best-studied mechanism for creating new memories is a process called Long Term Potentiation (LTP), which is name-checked but never described within the show. Without going into mechanistic details, LTP occurs when either one cell excites another repeatedly in a short period of time, or two cells excite the same one nearly simultaneously. When this happens in addition to the cell firing, the synapse which is being excited gets physically larger. If the process continues, the synapse may become so big that it splits in two, forming a new synapse. These new and strengthened synapses provide a physical basis for new memories and changes in behavior (Kandel, et al., 2012).

[6] Memories which naturally do not last are short-term memories (of which there are actually several forms). Those that can and do last for long time periods, including life-long memories, are called long-term memories. All the various forms of memory discussed in this essay are long-term memories (Kandel, et al., 2012).

[7] Technically, only the synaptic patterns that encode memories are usually referred to as engrams, but the patterns that encode other things, like personality traits, can be thought of in a similar way.

[8] The Dolls, however, do not change their response towards her as she becomes less friendly, which is further evidence of their inability to learn.

[9] This can be thought of as the process of synaptic strengthening in reverse, although in reality, the cellular mechanisms are quite different (Kandel, et al., 2012).

[10] Although this mechanism for repairing a damaged brain is quite realistic, the references to specific brain areas made during this episode are not accurate.

[11] The difference between Echo and Caroline-with-Amnesia is made very clear in "Needs," where we actually see how Caroline behaves without her memories (1.8).

[12] This is split into two phases, creation and consolidation, in some models. Consolidation is the gradual formation of an engram after the initial creation of a less stable, short-term memory (Kandel, et al., 2012).

[13] Not all information is retained in memory; much is simply discarded during the encoding phase—not technically a form of forgetting; since the memory never exists, it cannot be forgotten (Kandel, et al., 2012).

[14] Neither of these terms, however, are used consistently throughout the literature to describe these processes.

[15] While the behavior of the characters during this episode conforms realistically to the interference model of forgetting, the drug's mechanism, which supposedly "breaks down natural inhibitions in the hippocampus in order to awaken sleeping parts of the brain" is entirely fictional.

[16] A specific image or circumstance causing the recall of a memory is what is meant by a memory "cue."

[17] Oxytocin also acts as a neurotransmitter within the brain (Kandel, et al., 2012).

[18] Any tissue which is affected by a hormone is a target tissue. The response of a tissue to a hormone is determined by which tissues contain receptors for the hormones to bind to (Kandel, et al., 2012).

[19] This includes basic sensory information like heat and touch, but also information from the sympathetic and parasympathetic nervous system which control arousal (sexual and otherwise), stress, heart rate, and numerous other functions and so are critical for how we experience stress, fear, and other emotions and the enteric nervous system, which controls digestion.

[20] Given that brains generate behavior, personality, and experience through their function, not their simple structure (in real life, if your brain is entirely without function, you are dead and cease to exist), it is possible that it is not the actual brain that is stored on the wedges at all, but just a set of instructions needed to configure a brain correctly, but equally possible, in the absence of evidence one way or another, that there is an entire, inactive virtual brain on each wedge.

[21] The ethics of consent here are the principles used in biomedical procedures and research involving human subjects (Canadian Institutes of Health Research et al., 2010).

[22] As a point of clarification, the mere fact of needing and accessing medical treatment, even for procedures as invasive as imprinting, is not in and of itself coercive, but the fact that Madeleine and Anthony had to agree to work for the Dollhouse for five years in order to access it is.

[23] The huge amount of money the Dollhouse 'volunteers' are given could also, in and of itself, be considered a form of coercion. Participants in research must be offered reasonable compensation, meaning that the amount offered must match the amount of time required and the amount of discomfort or risk participants may be exposed to, but also that it not be excessive, since being offered outsized amounts of compensation can lead to people's agreeing to risky procedures against their better judgement. However, as it is difficult to assess how much compensation is 'reasonable' for five years of someone's life, this point was not included in the main body of the essay.

[24] The author wishes to acknowledge Tiffany Sostar for both the original inspiration for this essay and the impetus to publish it.