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Life as Cycle

The Datafication of Menstrual Health

On August 10, 2018, the US Food and Drug Administration (FDA) announced the approval of the first mobile app for contraception.[1] Developed in Switzerland by Elina and Raoul Berglund, Natural Cycles combines daily self-reported data and a basal smart thermometer to predict a user's ovulation window. Marketed primarily toward cisgender heterosexual women, the app tracks qualitative and quantitative information about the user's menstrual cycle. The basal thermometer provides an "indirect" measure of hormones, which is combined with self-reported data, processed through the app's algorithm, and interpreted as a "green" or "red" day, indicating whether a user should use contraception. Like other predictive algorithms, Natural Cycles is designed to learn a user's behavioral and bodily patterns over time: through dedicated daily self-tracking, the user is rewarded with the knowledge that they can engage in sexual activity without contraception.[2] The FDA's announcement followed the European Commission's (CE) approval in 2017, with both organizations citing the support of the largest scientific study ever conducted on natural contraception, which surveyed 15,000 women over eight months, and revealed the app and smart thermometer to be 93 percent effective under typical use,[3] a full 6 percent higher than the average contraceptive pill.[4]

Natural Cycles is part of the growing "femtech" industry, which primarily targets cis women through the language of "empowerment," health, and wellness. For example, the Berglunds claim their product helps women avoid hormone-based contraception and become more "aware and in con-

trol of their bodies than ever before . . . to empower women to take control of their fertility."[5] And like other femtech products, technology and biomedical frameworks for health are at the center of these goals. The Natural Cycles' website foregrounds the FDA and European Commission certification standards, scientific studies to support the statistics on contraception, and Elina Berglund's background in science and engineering. Other fertility and pregnancy apps similarly appeal to science, technology, and data to suggest that their products align with official medical recommendations and standards for reproductive health. But as scholars have recently shown, many of the seemingly neutral, technoscientific structures embedded in pregnancy and fertility apps reinforce heteronormative, gendered understandings of pregnancy and fertility. Gareth M. Thomas and Deborah Lupton, Rachael Louise Healy and Maria Novotny, and Les Hutchinson all provide accounts of how pregnancy and fertility apps' tracking features often assume heterosexual, partnered users, emphasize statistical norms and medicalized risk, and promote self-surveillance of the pregnant/fertile body.[6] These arguments demonstrate that despite the language of "freedom" offered by pregnancy and fertility apps, these technologies often use data and tracking features to promote a vision of the pregnant body as a site of risk that needs careful monitoring and must conform to a medical timeline and a set of biomedical health norms.

Feminist health studies has repeatedly shown how the pregnant (and potentially pregnant) body has been a site of control and regulation by medicine for the last two centuries.[7] The expansion of medical power over the feminine body has been facilitated by the growth of the fertility industry, which is projected to be valued at nearly $50 billion by 2030.[8] With decreasing fertility rates, healthcare plans increasingly cover fertility-related procedures and testing, particularly for those with top-tier plans. However, even with these additional forms of support, fertility testing and procedures like in vitro fertilization (IVF) and egg freezing remain financially inaccessible to many Americans.[9] Digital health technologies like Natural Cycles aim to address this growing market of consumers with fertility concerns who lack the healthcare coverage to support more traditional forms of medical observation and intervention. While Natural Cycles profits from the growth of the fertility industry and medicalization, the expansion of medical power is masked by the rhetoric of "freedom" and the invocation of the "natural." For example, Natural Cycles' website foregrounds the promise of "hormone-free" birth control, and in a personal letter on the page, Berglund contrasts her product with fertility

support that is commonly "invasive . . . I . . . wanted to take a break from hormonal birth control to give my body a chance to get back to its natural state well before a pregnancy."[10] At the same time, the website stresses the science behind their technology and FDA approval. This medical authority is framed as a tool for users who no longer have to rely on the healthcare system to receive fertility support: "skip the pharmacy, no prescription needed."[11] Through self-surveillance features, the device claims to free the user from the structures of the medical system, but ostensibly extends biomedical methods for monitoring and regulating the body to the consumer.

While many "femtech" products expand and adapt biomedical monitoring systems associated with fertility and pregnancy, scholars and critics have overlooked how these apps influence individuals' perception of menstruation and the menstrual cycle more generally. There is a great deal of overlap between menstrual trackers, pregnancy apps, and fertility technologies; indeed, many of the apps include pregnancy sections or can be switched to "pregnancy mode" if the user becomes pregnant. However, this chapter will primarily explore menstrual-tracking apps to build on these fertility-related discussions by examining how biomedicalized and datafied models of the menstrual cycle can influence individuals' understanding of their cycles, bodies, and overall health.[12]

Like many of the technologies discussed throughout this book, menstrual-tracking apps promote the idea that self-tracking produces "empowerment" through self-knowledge and control over the body. The most popular apps, including Flo and Clue, are advertised as tools to understand the menstrual cycle and enable "you to take control of your health and learn more about your unique self."[13] Users "learn about themselves" by logging daily emotional and physical symptoms in addition to information about their periods, which ideally allows them to understand the impact of their cycle on their day-to-day lives and overall health. Thus, knowledge is constructed by transforming users' emotional, physical, and social experiences into data, rendering their symptoms trackable and comparable over time. In other words, these apps encourage women and people who menstruate to understand menstruation—and by extension, their health—through the framework of biomedicine and big-data analysis, which stress the value of regulation, statistical norms, and correlation.

Popular and scholarly criticism of menstrual technologies has largely remained focused on the inaccuracy of prediction algorithms as well as the affinity for pink interfaces and gendered address.[14] While most remain focused on how feminized iconography and word choice target straight

women, this chapter considers how the self-tracking and data-analytic features reinforce discourses of menstrual concealment and biomedical bodily alienation. I begin with descriptions of the interface aesthetics of Flo and Clue to show how their design encourages menstrual suppression through the use of euphemistic humor and iconography. While menstrual-tracking apps aim to make menstruation more transparent by educating women and people who menstruate about cycle phases and symptoms, I argue that their aesthetics rely on humorous and euphemistic icons to stand in for bodily processes that are socially considered as abject or disgusting. Jokes and euphemisms have historically served as a way to "talk around" menstruation, framing it as an unclean or impolite topic that should remain concealed or hidden. Menstrual-tracking app design extends this logic, reinforcing the perception that menstruation remains a "sensitive" or taboo subject.

I then describe the aesthetics of the cycle visualizations and analytics sections to consider how these apps use and promote the biomedical model of menstruation. Most menstrual-tracking apps use hormone-based models of the menstrual cycle, which break down the process into four primary phases. A visualization of this model almost always serves as the homepage for the app and is central to the data archive and analysis features. The four phases of the cycle are visually placed alongside self-tracking features to reinforce the perceived connection between sex hormones, menstrual cycle phases, and bodily experience. By situating menstrual-tracking apps in the history of premenstrual syndrome (PMS), I show how this visual model promotes an understanding of the hormonal body as the cause of distress or disturbances to the cyclical norm, leading to a separation between the "true self" and the menstrual body. The analytic sections are meant to show clear connections between emotional and physical experiences and phases of the menstrual cycle, which can lead individuals to understand their lives through their fluctuating hormones. Much like discourses of PMS, the hormonal body emerges as the locus of distress, which can lead individuals to invalidate their emotions or blame hormonal fluctuations for any physical or emotional discomfort. By giving such explanatory power to biological processes that remain out of the individual's control, these apps frame the body as an unruly and uncontrollable cause of a range of complex emotional and physical experiences.

While this chapter illustrates how the existing aesthetics and tracking features risk reinforcing biomedical bodily alienation and stigmas surrounding menstruation, I end by considering how the technologies might

be adjusted to promote a more reflexive understanding of menstrual health. Reproductive health research increasingly relies on big-data methods and analytics to determine what constitutes "healthy" in the scientific and public spheres alike. In response, many scholars warn that hyper-reliance on data threatens to efface social and cultural context, a tendency particularly dangerous for the fields of health and medicine.[15] At the same time, the recent phenomenological, ethnographic work of Laetitia Della Bianca illustrates the multiple forms of embodiment and selfhood that emerge through datafied and self-tracking practices that resist simply reading menstrual-tracking technologies as tools for the medicalization of the reproductive body. She argues that fertility tracking "processes shape multiple distributions of the self, through which users align multiple elements, including their embodied self, datafied cycle, relations with others, biomedical knowledge, experiential knowledge, bodily sensations, and others."[16] Sociological studies likewise question the complex set of embodied experiences that emerge in PMS, showing how medical recognition of psychological and physiological experiences can serve as a critical source of validation, particularly for those who have historically been overlooked or dismissed due to gendered stereotypes. So, while data can often obscure or suppress individual experiences and cultural and social context, it nonetheless holds immense epistemological value for intuitions, the public, and individuals alike. In their study of PMS and women's experiences, Jane Ussher and Janette Perz ask how to remain critical of the social and scientific constructions of menstrual distress without dismissing the lived experiences of those who suffer from premenstrual symptoms.[17] Likewise, through phenomenological descriptions of my experiences with menstrual-tracking apps I ask how to remain critical of the biomedical, determinist structures of these apps while still recognizing that they can serve as critical tools for people who menstruate to make sense of their embodied experiences and sense their body's natural fluctuations and changes throughout a menstrual cycle. With these concerns in mind, I end with a call for collaborations between humanists, scientists, and designers to redesign these apps to support reflexive relationships to the body and promote research on historically underexplored issues of sexual and reproductive health.

Managing Excess and Excretion

With more than 153 million users worldwide, Flo is the "#1 app for women's health."[18] Flo's central interface is focused on the period count-
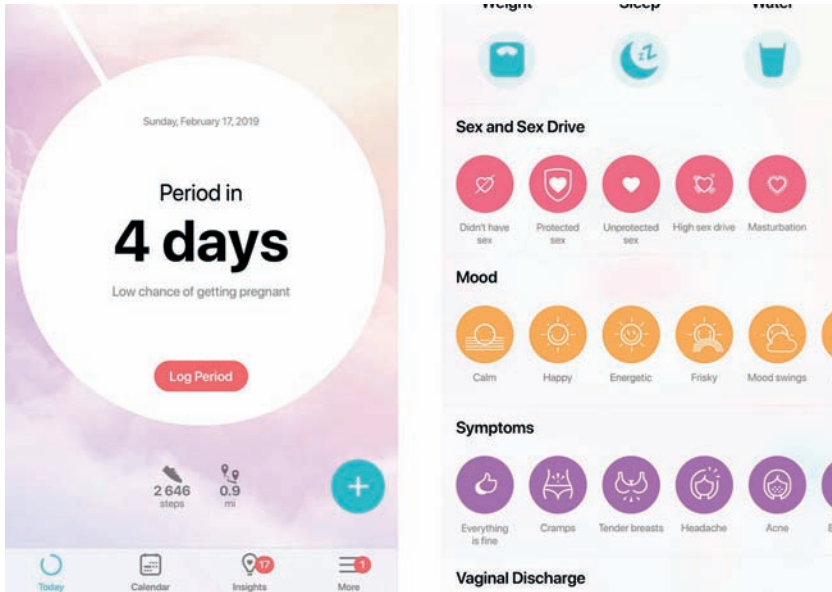
Fig. 2. Flo's central interface and log use "palatable" jokes and iconography to visualize symptoms and the cycle timeline. (Flo Health, Inc., "Flo," Apple App Store, vers. 4.31, 2019, accessed March 2019.)

down (Fig. 2), where a large circle floats over the background of fluffy pink clouds counting down the days to ovulation. The text below informs the individual of their risk of getting pregnant, and a red button allows them to log the dates of their latest period. Most of the interactions occur through the daily log, accessible through the small turquoise "plus-sign" icon on the bottom right of the screen. Selecting the icon reveals a pop-up window where individuals are meant to log daily activities and emotional and physical symptoms. In addition to spaces to input weight, sleep hours, and water consumption, the log interface is broken down into categories ranging from "sex and sex drive" to "mood" and "physical activity." Each offers a variety of cute, emoji-like icons with corresponding labels that can be selected and logged on a given day. For example, "sad" is coupled with a tiny rain cloud, and a balloon represents "bloating." Like most menstrual-tracking apps, Flo uses polite symbols to track bodily abjection, including various droplet icons to stand in for the heaviness of flow, an animated toilet with a lock representing constipation, and a roll of toilet paper for diarrhea. The visualization of symptoms becomes increasingly abstract as

it represents the range of options for vaginal discharge, presenting qualities such as "sticky" and "creamy" through white and purple circles.

Menstrual-tracking apps are often deemed progressive for acknowledging the variety of symptoms that surround menstruation.[19] For example, Flo gives as much emphasis to diarrhea—a less openly discussed condition—as it does to bloating or cravings. By placing diarrhea, nausea, and constipation alongside more commonly recognized menstrual symptoms, these apps employ the logic of "period talk," which seeks to demystify the range of emotional and physical processes associated with menstruation and empower individuals by "[allowing] the speaker to draw on a well-established and pervasive axiom of perceived silence. In the disruption of this silence, the speaker can explore, disrupt and test the gender norms that surround menstruation, and more generally."[20] Flo and other menstrual-tracking apps would seem to disrupt this silence by acknowledging the presence and persistence of fluids and excretion, undermining the highly sanitized rhetoric of hygiene that surrounds menstruation. Ideally, by "talking about" these symptoms, menstrual-tracking apps work to undo some of the shame associated with menstrual abjection.

Indeed, Clue, an app celebrated for its progressive gender-neutral color scheme and address, claims that its use of language and iconography is explicitly designed to break the silence and linguistic suppression that have historically been upheld by menstrual euphemisms: "Clue bypasses cultural discomfort by speaking plainly and refusing the use of euphemisms. Sex is called 'sex,' not 'the baby dance.' Menstrual bleeding is called 'bleeding,' not 'Aunt Flo.'"[21] Clue is one of the few apps that continually revises its log iconography to offer the most transparent and neutral representations of behaviors and bodily processes to avoid gender stereotypes and menstrual shame. For example, its website details the decision to change its sex icons to address a more inclusive audience. Originally, sexual activity was visualized through two contrasting images of lounging stick figures with the "protected sex" figure wearing a tie. Following complaints that the figure coded masculine and reinforced heteronormativity, Clue revised the icons to an image of a flip-flop sandal for "unprotected sex" and rain boots for "protected," which were designed to be humorous, "but with emotional intelligence."[22]

Despite Clue's efforts, the app's design and emphasis on humor tie it to menstrual jokes and euphemisms, which are often used to reinforce the idea that menstruation is a taboo subject. Sociological studies have illustrated how euphemisms, jokes, metaphors, and other linguistic codes support the

perception that menstruation (and by extension the menstruating body) should remain "hidden" because it is "disgusting," "unclean," and "dirty."[23] Euphemistic references to blood, an unwelcome guest ("Aunt Flo"), and distress ("the curse") all subtly support the perception that menstruation is both unwelcome and unpleasant for both the person who menstruates and the public alike. While vulgar and graphic references ("shark week") directly support the perception of menstrual abjection, polite euphemisms likewise uphold the sense that menstruation is a topic that should not be discussed directly or publicly. Even terms like "period" help create distance between the speaker and referent, reinforcing the idea that menstruation is a "sensitive topic" that requires both linguistic and physical concealment.[24]

Both Flo and Clue's use of cute or humorous icons might be compared to menstrual jokes: they transform the symptoms and experiences that were once perhaps considered gross or uncomfortable into funny, palatable animations that often dance and wiggle on selection. Numerous scholars have argued that menstrual jokes and euphemisms serve as ways to discuss the taboo topic, and consequently reveal both stereotypical and subversive[25] understandings of menstruation and femininity.[26] In her analysis of Tampax's "Mother Nature" campaign, Camilla Røstvik describes how Tampax's marketing company drew on feminist cultural analysis of menstruation to create humorous advertisements for their products. The series of print and video ads depicted menstruation as "Mother Nature," a middle-aged "she-devil, decked out in green Chanel and high heels," being fought off by strong "Alpha girls" using Tampax products. The visual gags and funny taglines promoted a more diverse image of young, female menstruators, but simultaneously reinforced negative stereotypes of menstruation and femininity through the characterization of the Mother Nature character.[27] Whether they aim to intervene in or reinforce existing understandings of menstruation, both euphemisms and jokes operate as ways to indirectly address the unfamiliar or uncomfortable topic. For example, in her discussion of menstrual jokes, Victoria Newton describes how humor is used to navigate the unknown: "Joking about a subject which is not fully understood dissipates anxieties, but also offers a method of talking about something that [the speaker] and others are experiencing, without divulging how much they do or do not actually know."[28]

Menstrual jokes and euphemisms can function as a socially acceptable way to address menstruation without the speaker revealing their relationship to the taboo subject, offering a "safe" space for discussion. The funny icons of Flo or Clue may similarly offer a source of relief:
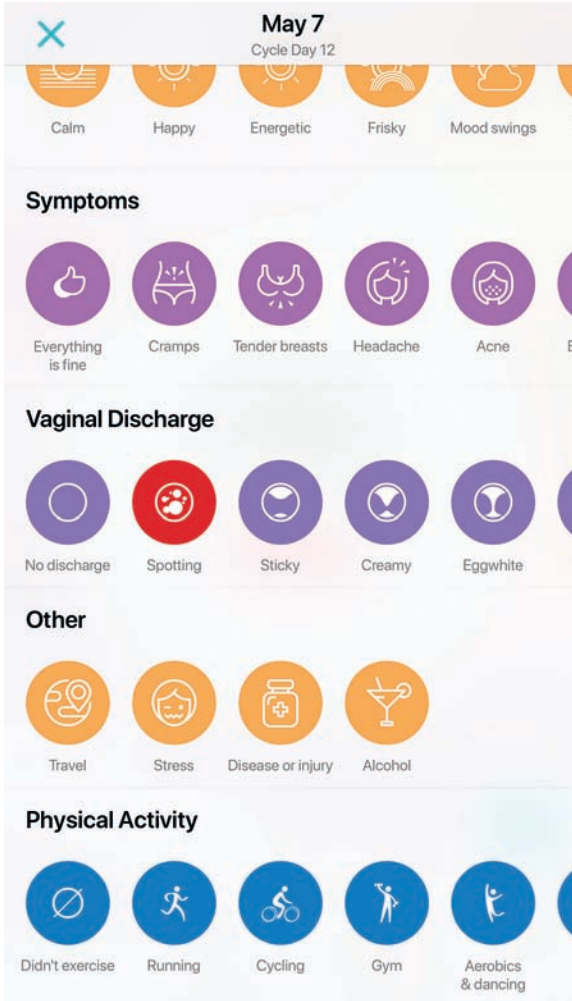
Fig. 3. Flo's vaginal discharge icons animate when they are selected. (Flo Health, Inc., "Flo," Apple App Store, vers. 4.31, 2019, accessed March 2019.)

individuals can track the presence of these symptoms while remaining at a mediated distance through the visual abstraction of their experiences. For example, opening Flo's log prompts me to reflect on my emotional and physical experiences. I swipe through the "vaginal discharge" options and select "no discharge," an icon showing a white circle over a purple background (Fig. 3). This prompts a tiny white circle to burst from the center of the icon, momentarily filling it in and contracting inward. I find this encounter both strange and satisfying as my attention very quickly

moves from my own embodied reflection to the animation. During this interaction, I don't necessarily have the sense that the icon or animation reflects the physical symptom or my experience; rather, I'm focused on the sense of gratification that comes when a selection effectively transforms bodily abjection into an animated abstraction. Vaginal discharge no longer seems to refer to my own bodily excess, but the oddly satisfying array of moving, circular animations.

In the case of Flo and Clue, the discreet animations allow individuals to indirectly acknowledge forms of menstrual abjection. But confined to the private space of the app interface, they do little to break through public or even personal pressures to keep bodily excess and excretions concealed and controlled. Consequently, like menstrual jokes and euphemisms, they reinforce the social suppression of bodily excretion and continued discomfort with the ordinary emotional and bodily experiences of menstruation. Though jokes and other forms of "period talk" may break down certain social barriers that prevent acknowledging taboo topics, they often simultaneously reinforce the concealment of those topics. Sociologist Sophie Laws describes linguistic codes that are both produced by and perpetuate "menstrual etiquette," the set of practices and rules around menstruating bodies and public menstrual discourse. She argues that polite and coded language for menstruation perpetuates the etiquette of cleanliness, discretion, and concealment that encourage people who menstruate "to uphold the taboos against themselves through their own behaviors of silence and concealment."[29] Newton similarly describes how the humor of a menstrual joke is often located in the recognition of the taboo: "laughing at it, we are acknowledging that the content of the joke is not an acceptable thing to mention, or do, in everyday life. Thus the joke reinforces existing gendered power structures, ideologies, codes of conduct, societal norms, and values."[30] Indeed, sociological studies on perceptions of menstruation among women and girls have reported the use of humor as a key strategy "to manage their unease, to talk around menstruation."[31] The log interfaces of these apps operate through a similar structure; the tiny toilets and balloons politely poke fun at the presence of the symptom, while still reinforcing the fact that these are topics not to be discussed directly; combining acknowledgment with abstraction and humor, they suggest that these natural bodily processes should remain suppressed.[32]

The emphasis on symbols and polite iconography is related to an investment in discretion: iconography helps distance individuals from their bodily excess and helps encode this process into a private symbolic system.

This practice is not new; rather, menstrual-tracking apps are an extension of analog systems of menstrual tracking that typically take the form of personal calendars and notation systems. Many individuals who menstruate keep track of their menstrual cycles through visual or linguistic codes. For example, a dot or an "x" can serve as a way to mark the days of a menstrual cycle on one's personal calendar. Menstrual-tracking apps essentially digitize this notation system to ideally offer a more private and consolidated space for monitoring.

However, in the largest study to date on menstrual- and fertility-tracking apps, Epstein and colleagues found that participants often still expressed fear of menstrual disclosure through their tracking apps.[33] Like calendars, phones operate in a semipublic space, vulnerable to wandering eyes, and participants noted this through their discussion of the relationship between the app's design and sense of privacy: "I used to be embarrassed when other people looked at my phone and saw a bright pink tracking app."[34] The fear of the prying eye "decoding" the pink app on her interface led this participant to switch to Clue, an app that explicitly avoids feminine iconography. Clue's app icon shows a series of red overlapping circles that form a flower or atom-shaped graphic on a white background. The name, "Clue," similarly obscures the program's relationship to menstruation, which allowed her to "feel more secure in letting other people handle my phone." Others echoed her sentiment, detailing attempts to rename their trackers or to suggest that apps use a more neutral design approach: "no one will guess what it is because it looks like an average app."[35]

Across accounts from participants, there is a persistent fear of others discovering that they are menstruating or that they track their menstrual cycles. Numerous scholars have discussed how people who menstruate, particularly cis women, have been conditioned to conceal menstruation. Studies of advertising and menstrual hygiene products, ethnographies of adolescent girls and women, and phenomenologies of menstruation have all demonstrated how society has encouraged the suppression of menstrual acknowledgment.[36] Across these accounts, scholars emphasize how women, from their "earliest awareness of menstruation," are essentially told "do not discuss your menstruation. . . . Keep the signs of your menstruation hidden."[37] For feminist scholars, this imperative is essential to upholding the regulation of feminine bodies, encouraging women to police their behaviors and appearance under the guise of "personal hygiene."[38] Femininity thus comes to be defined as the absence of the abject fluids that emerge in ordinary life, leading women to reject and resent their body's natural processes.[39]

The analysis of the log interfaces and participant accounts places menstrual-tracking apps in the history of consumer menstrual technologies, in which retailers and companies have continuously struggled to "promote and sell products that people are embarrassed to be seen buying."[40] The menstrual hygiene industry has been central to upholding the perception that menstruation and the menstruating body are abject and require careful management and concealment. But by stigmatizing all signifiers of menstruation, including their own products, companies undermine conspicuous consumption practices.[41] In the 1920s, companies aimed to solve the menstrual-market paradox by selling wrapped boxes of their products, allowing individuals to discreetly purchase their products at their local stores without any anxiety or embarrassment. Reflecting on these practices in 1958, one Kotex executive remarked, "to some extent, I think we led women to feel that packaging is related to this whole subject by deliberately hiding it, making it something that has a social stigma attached to it."[42] As the testimony from Epstein and colleagues' study suggests, menstrual-tracking apps face similar challenges, despite the language of transparency and empowerment. Both Clue and Flo, for example, disguise their primary function through abstract icons: the Flo icon that appears on the dashboard of a smartphone features a white feather over a pink background, and Clue's generic icon likewise resists any connection to menstruation. Thus, while menstrual-tracking apps sell themselves as essential tools for individuals to learn and demystify the menstrual cycle, in practice they often function as tools for concealment—new forms of wrapping that mask menstrual disclosure.

Though concealment most immediately refers to managing markers of abject menstrual fluid, from avoiding leaks and stains to the use of products designed to be discreet and uphold standards of Western cleanliness, it extends to the suppression of *any* symbolic, physical, or social markers of menstruation. Menstrual jokes and euphemisms are examples of menstruation being concealed linguistically, providing a verbal means to reassert the menstrual taboo and reinforce its suppression. menstrual-tracking apps allow individuals to continue to suppress symbolic and linguistic markers of menstruation, not only through the use of euphemistic humor but through the emphasis on discretion and privacy. So, while apps like Clue and Spot On (Planned Parenthood's menstrual-tracking app) employ a gender-neutral color scheme in an attempt to address a more inclusive audience, they are consequently also useful tools for menstrual concealment.[43] Indeed, Clue's name and

app icon avoid any direct reference to menstruation, offering the ideal means to conceal menstrual monitoring.

Descriptions of these apps' log and design features reveal how they reinforce the perception that menstruation is an entirely private experience of self-management.[44] The tracking features of the log interface are meant to provide discreet means of tracking symptoms and, ideally, of anticipating bodily excretion and excess. Tracking over time supposedly allows individuals to predict, manage, and perhaps suppress bodily excess and excretion, privately and personally. The logs function as a way to monitor physical and emotional changes, and by detecting patterns, they may allow individuals to better conceal traces of their menstrual status.

Biomedical Cycles

Logging personal data over time through these apps results in a substantial archive of daily behaviors, physical symptoms, moods, and activities. For both Clue and Flo, this archive informs the predictive algorithm and is meant to give individuals a resource to track patterns and disruptions in their cycle, monitor average cycle or period length, and anticipate upcoming periods. For example, individuals can scroll through the calendar section of the app to locate the beginning of their last cycle, or even go forward several months ahead to see when they may expect future periods. Some have anecdotally reported using these features to plan their vacations or activities around predicted windows. And like other analog forms of menstrual tracking, the app is most often used to monitor late periods as an indicator of pregnancy.[45]

Menstrual-tracking apps use biomedical hormone-based models of the menstrual cycle to predict future windows for menstruation, ovulation, and PMS. The biomedical model breaks the typical menstrual cycle down into four primary phases—menstruation, follicular, ovulation, and luteal— each designated by shifts in hormone levels that are understood to trigger corresponding physiological reactions in the ovaries, fallopian tubes, and uterus. The information collected through menstrual-tracking apps is processed through an algorithm based on this biomedical model to predict specific windows for ovulation and menstruation. While researchers have ascribed particular hormone levels and ratios to each corresponding phase, it's incredibly difficult for menstrual-tracking apps and research studies alike to know for certain whether individuals are currently in the follicular, ovulation, or luteal phase. Indeed, research on the menstrual cycle has

faced the challenge of studying the effects of these three phases precisely because they often lack identifiable physiological changes:[46] the exact phase can only be identified through daily hormone-level testing.[47] Instead, the biomedical model and menstrual-tracking apps use approximate windows to gauge these phases, based on the model twenty-four- to thirty-eight-day cycle, with ovulation typically occurring fourteen days following the first day of menstruation. Clue's "information" section explains that the "fertile window" includes the six days before ovulation and twenty-four hours after, but warns that pregnancy can happen outside of this predictive window.[48] In addition to the four-phase model, Clue offers examples of more accurate ways to help determine ovulation—including monitoring discharge, basal temperature, and at-home luteinizing-hormone testing—but it warns users that the app does not currently incorporate this kind of data "into its predictive algorithm for your fertile window."[49] This warning is meant to clarify that the cycle phase breakdown is not personalized (outside of menstruation) to the individual user, but instead is based on statistical models for typical hormone fluctuation patterns.

Despite warning individuals that the biomedical model may not align with their unique menstrual phases, the interface design of menstrual-tracking apps often reinforces the four-stage model. For example, Clue's home screen features a circular arrow graphic, which is segmented and color-coded to designate specific phases. The start of the arrow graphic is shaded red to designate menstruation, and the middle section is shaded blue to designate the "fertile window." Clue does not label the follicular and luteal phases, but the inclusion of the fertile-window section visually breaks the cycle graphic into four distinct sections. These phases are then accompanied by supporting information sections that provide short summaries of each of the four phases, including descriptions of the hormonal processes and any possible physiological changes.[50] Flo's calendar view of the menstrual cycle similarly breaks down the cycle into color-coded phases: red designating the menstruation phase, blue the fertile phase (Fig. 4). Both of these interfaces use bold color-contrasting models to communicate the biomedical model, encouraging individuals to consider menstruation as part of an ongoing four-phase process.

Though these models are most immediately used to predict menstruation and ovulation, they simultaneously support a cycle-based approach to overall health. Menstrual-tracking apps often promote the idea that the menstrual cycle functions "as a vital sign . . . [it] can tell you about your health and wellness just like your blood pressure, heart rate, or pulse."[51]
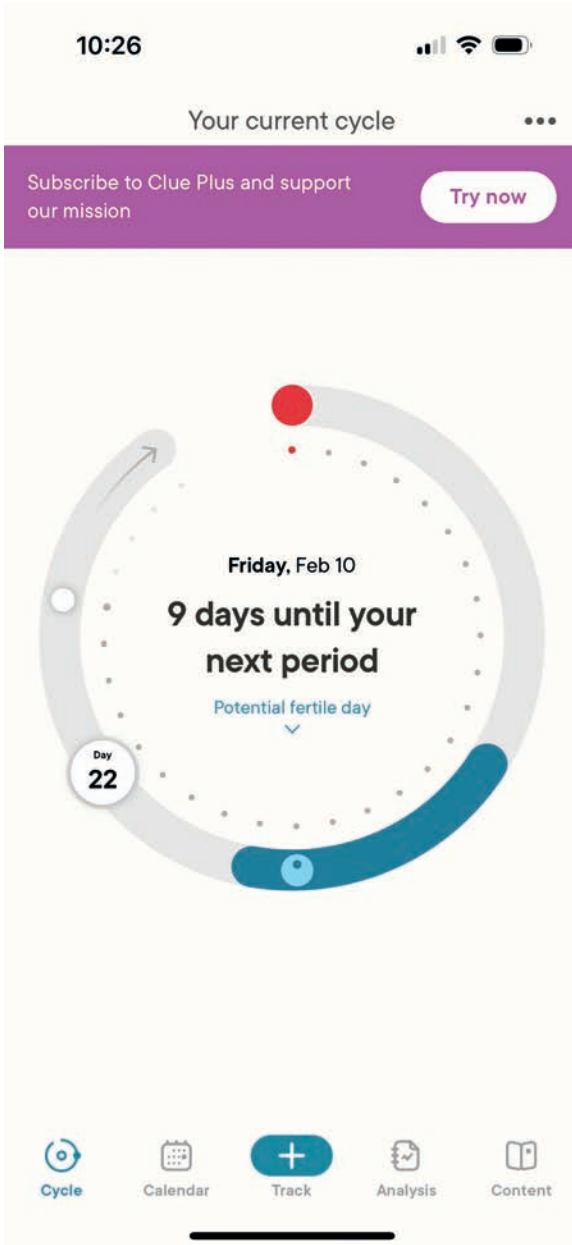
Fig. 4. Clue's central interface color-codes the menstrual and ovulation phases of the cycle to visually segment the cycle into the four phases. (BioWink, "Clue," vers. 103.0, accessed February 2023.)
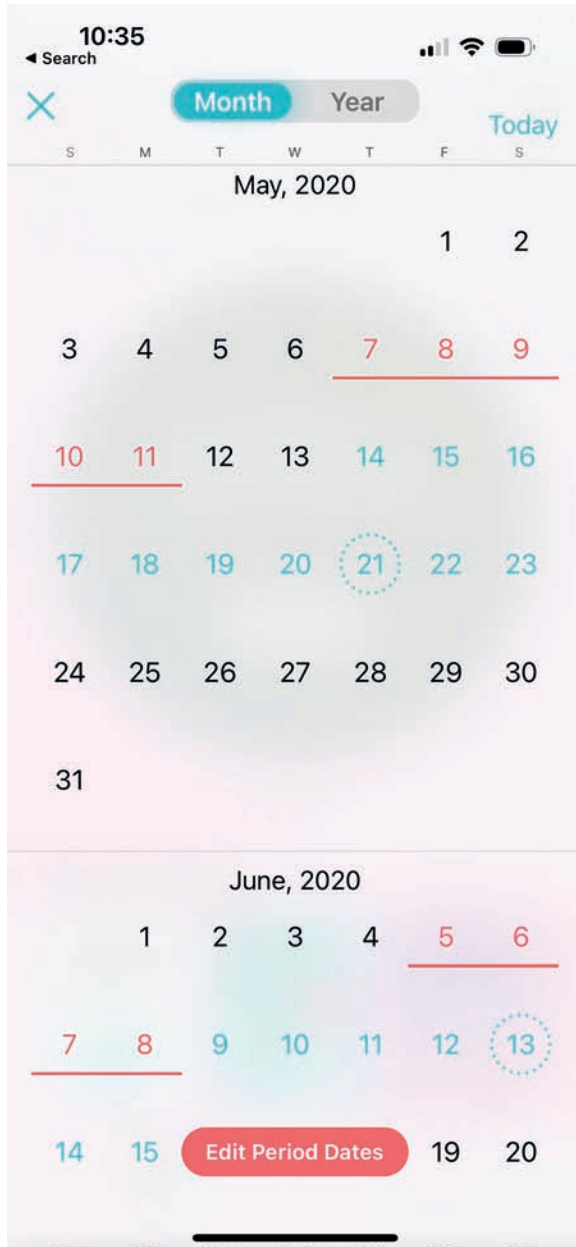
Fig. 5. Flo's calendar view marks ovulation and menstruation days to visually separate the cycle into four phases. (Flo Living, "Flo," vers. 4.31, accessed July 2021.)

Company websites and supporters of this understanding often stress how changes to the menstrual cycle can indicate a range of issues, including immunological problems, hormonal imbalances, nutritional deficiencies, and allergies.[52] Individuals are encouraged to track as much information as possible to not only learn how their body reacts throughout a cycle, but also to use the four phases as a baseline to monitor any changes or disruptions. The cycle, according to Clue, is an essential barometer of overall health: "[it] can let you know when everything is working as usual, when your body is going through a change, or when something is not as it should be."[53] Numerous health institutions claim that regular periods are an indication that "your body is working normally," while deviations from this norm "may be a sign of a serious health problem."[54] Atypical emotional and physical reactions are meant to serve as potential indicators of other health issues: "ovulatory disturbances . . . are an important but clinically silent risk factor for ill health."[55] App developers and medical researchers have framed menstrual-tracking apps as critical tools to support this mode of health monitoring, and ultimately support ongoing research into the effects of all four phases of the menstrual cycle.[56] Indeed, by datafying the symptoms, they seem to offer an accurate and accessible way to monitor correlations between an individual's cycle and their physical and emotional well-being.[57]

However, some sociological studies have criticized this biomedical framework, arguing that these apps set norms and baselines that fail to consider the diversity of cycle timelines and experiences.[58] While most cycles do last twenty-four to thirty-six days, scientists and physicians note the range of factors that can cause disruption to this model, including stress, diet, or social circumstances that do not necessarily indicate a major health problem. The highly regulated, cyclical structures of the algorithm cannot account for these types of deviations; instead, they focus on whether a menstrual cycle is early or late, and frame variations in a cycle as an indicator of pregnancy (or of a potential health problem). Lupton and Healy have argued that the use of the biomedical model of menstruation reinforces the idea that menstruation is a function of fertility. As a result, these apps appear to extend historical models of menstruation, where the menstrual cycle is described as a process that aims to result in pregnancy.[59] In this context, the appearance of menstruation risks being understood as a "failed pregnancy," a breakdown in the function of the system.[60] Locating fertility tracking apps in a broader cultural concern around women's infertility, Celia Roberts and Catherine Waldby claim the use of quantifi-

cation and biomedical models of fertility renders it an asset, or "a material resources controlled and managed by the woman herself with the expectation of future value."[61] This leaves the reproductive body vulnerable to commodification, supporting the expansion of markets devoted to monitoring, preserving, and supporting the promise of a future healthy and successful pregnancy.[62]

While the medical model supports understanding menstruation through pregnancy, it also promotes regularity *throughout* the menstrual cycle, framing *any* violation of the norm as a potential problem. Thus, this model risks expanding the medicalization of the reproductive body, as the follicular and luteal phases increasingly come to be understood through the logic of illness. The emphasis on regularity across the cycle phase risks promoting an extension of the homeostatic model of health, where health is understood as consistency, uniformity, and regularity. While a cycle-based model of health acknowledges the shifts and changes that occur during a menstrual cycle, those shifts are part of a larger pattern that functions as the norm or standard—a vital sign—by which an individual should gauge their overall health.

More recently, menstrual-tracking apps' cycle models have faced criticism for their ties to natural family planning practices associated with the Catholic Church. Fox and colleagues locate the apps in a history of analog cycle-tracking technologies that have been used by religious institutions as a form of natural birth control. Only in the 1980s did these models begin to strip off their religious associations, promoting monitoring as a method to resist pharmaceutical and medicalized models of contraception.[63] Drawing on feminist health principles, more recent, secular supporters of cycle- or fertility-awareness models often claim that this approach is essential to counteracting bodily alienation. Cycle awareness functions as a kind of "body literacy," as individuals learn to read and interpret the "signs and signals of [their] menstrual cycle."[64] Closely monitoring the body's slight changes, from discharge to energy levels and muscle tension, encourages individuals to become increasingly attuned to daily shifts in their bodies. Menstrual advocates frame this practice as a form of "cultural resistance," a way for people who menstruate to "rely less on institutionalized health care and more on their own resourcefulness."[65] Cycle awareness thus directly counteracts the mind-body split "that is ultimately damaging to women's health locus of control . . . and makes them vulnerable to cultural bias . . . and medical misogyny."[66] At the same time, the secular form of cycle awareness is often supported by medical practitioners who see this practice not

as resistance to institutional care, but as a supplement. Remaining attuned to and tracking shifts across the duration of the menstrual cycle helps individuals advocate for themselves as they learn about the biomedical model of menstruation and its effect on their bodies.[67]

The awareness-based model of health monitoring contrasts with many of the goal-based self-tracking technologies discussed throughout this book. In goal-based tracking, data archives are used to provide benchmarks for improvement, while incentive and deadline structures encourage individuals to modify their behaviors accordingly. Control through these self-tracking technologies entails using data to change present behaviors to meet future outcomes. Menstrual-tracking apps, by contrast, are not designed to allow people who menstruate to change or influence their actual menstrual cycles. Rather, self-tracking is largely "observational": "In menstrual cycle tracking . . . women primarily *observe* what they are tracking with little or no control. . . . Rather than trying to change the outcome of being tracked, women track to learn how to adjust their thoughts and behaviors around it . . . observing can help explain symptoms and even identify causes."[68] Indeed, Epstein and colleagues found that the primary function of the app for most individuals was not contraception or getting pregnant, but a desire to gain an understanding of overall health that emerges from the patterns and correlations discerned through the archival and analytic features of the apps. For example, studying the personal archive may reveal a pattern of bloating on the second day of a period, or mood swings during ovulation. Observing these types of patterns will ideally allow individuals to anticipate emotional and bodily changes, and even to make small adjustments to habits or behaviors accordingly.

In other words, "control" is not located in the physiological process of the menstrual cycle, but in the ways that individuals adjust or manage their social and behavioral patterns around their cycle. In her ethnographic study of fertility-tracking apps, Della Bianca found that individuals used self-tracking and data as mediators for their experiences, to interpret, navigate, and understand shifts in their bodies according to their cycles.[69] This approach to menstrual management has also been found in studies that explore women's perception of PMS symptoms. In their 2012 study, Jane Ussher and Janette Perz found that women who monitored and anticipated their PMS symptoms often developed coping and management strategies for any emotional or physical changes. Women described how they would modify their behaviors, including decreasing stressors or removing themselves from social situations to reduce situations that result in premenstrual

anger or irritation. Locating these testimonies in a broader cultural analysis of menstrual discourse, Ussher and Perz describe this strategy as a form of self-silencing supported by "monitoring and regulating their environment, in order to regulate their premenstrual emotional reactions."[70] In other words, the testimony suggests that individual responses—self-silencing—functioned as a "solution" for social and cultural norms that deem PMS distress as a problem.

The biomedical model of the menstrual cycle offers a structure to support these monitoring and self-management systems, which are only further reinforced and expanded through menstrual-tracking apps. By breaking the cycle into four visually distinct phases, and providing supplementary information about the physiological and chemical changes in the body, these apps promote a biomedical way of seeing menstruation. Combined with self-tracking, menstrual-tracking apps provide a system through which individuals can monitor their behaviors and reactions to hormonal shifts, and make adjustments accordingly. In other words, menstrual-tracking apps promote the biomedical model as a tool for self-management, where menstrual awareness can be mobilized to control and suppress the threat of social disruption.

Life as Cycle

While the cycle visualizations help support a biomedical way of seeing menstrual health, the analytic sections of menstrual-tracking apps encourage a biomedical way of understanding the body more generally, and indeed of understanding life itself. Almost all menstrual-tracking apps include analytic sections that offer statistical information on cycles and timeline features designed to reveal patterns and correlations. Flo's "graphs and reports" section, for example, organizes the data according to a range of categories, including cycle length, period length, and intensity. Each of these options offers a visualized breakdown of a single month's data, mapping the cycle through a horizontal bar, color-coded to indicate the various phases. Individuals have the option to view these graphs alongside the logged emotional and physical symptoms (Fig. 6). For each month, a cycle timeline spans the width of the screen, sectioned off in red for days menstruating and blue for ovulation, with a list of symptoms below and corresponding yellow dots to mark the days they were logged. Looking at these visualizations, individuals can easily see connections between the phases of their cycle and logged symptoms. A cluster of yellow "headache" dots
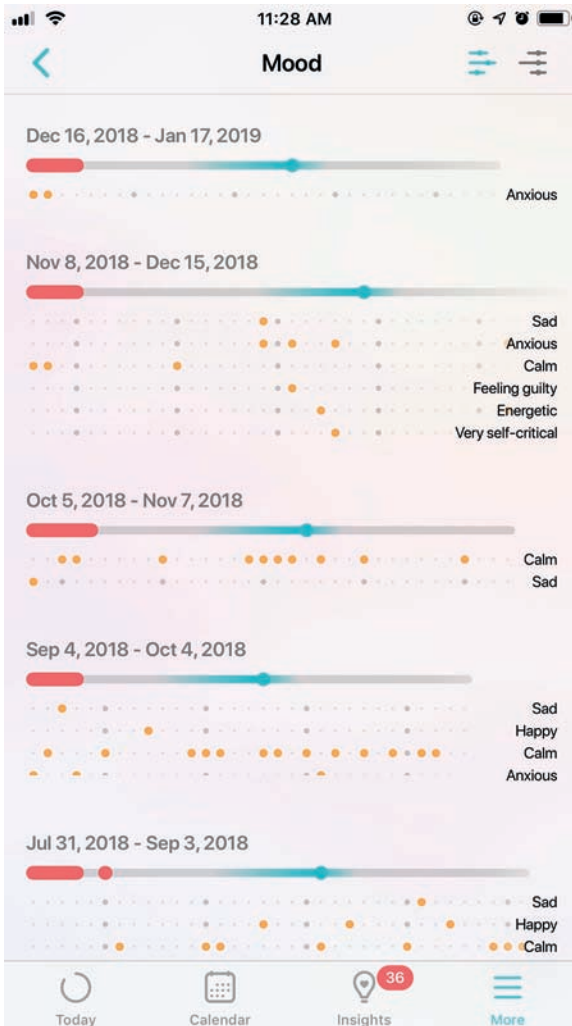
Fig. 6. Flo's analytics section maps emotions alongside cycle phases to reveal correlations. (Flo Health, Inc., "Flo," vers. 4.31, 2019, accessed November 2019.)

below the period section suggests a connection, or the repeated appearance of "craving" dots two days before ovulation may reveal a correspondence between the cycle phase and this symptom.

While the design of Flo's interface may suggest clear connections between a user's cycle and symptoms, it's very difficult to know for sure whether these behavioral and emotional patterns can be linked to specific phases of the menstrual cycle. Though scholars and journalists continually warn that "correlation is not causation," the design of these apps

encourages individuals to *assume* a causal relationship between menstrual cycle phases and logged symptoms. For example, I have logged my data in my Clue app for the past four years, and my archive has revealed a correlation between stress and ovulation. Clue's analysis section breaks each cycle into a vertical timeline, with the phases and dates running along the left side of the screen, and logged symptoms noted to the right (Fig. 7). Comparing data across multiple months through these visualizations has revealed a pattern of "stress" dots next to the ovulation section of the timeline. In this visual framework, I'm encouraged to see a direct relationship between my emotions and the unseen biological process: to read stress as an indicator of ovulation or ovulation as a cause of stress. While I may have logged stress on days I was ovulating, Clue doesn't give me the choice to include exterior social conditions that may have contributed to this experience.[71] Instead, the layout of the analysis section suggests causality without considering the range of other professional and social factors that shape my emotional states.

Looking at Flo and Clue's analytic sections encourages individuals to see the patterns as seemingly transparent, factual archives of their health. By extension, the correlations presented in these sections appear all the more authoritative. The aura of authority is further supported by supplementary information sections, including pop-up windows, as well as the wealth of resources through the company websites, which offer basic information about the science of menstruation drawn from medical and scientific texts. Flo, for example, tries to make scientific material more "approachable" through a chat interface with a "Flo Health Expert." If an individual's period is late, Flo will send them the message: "Hi there! Based on Flo's predictions, your period is late. If you'd like, we can look for a possible cause together."[72] The chatbot proceeds to ask questions and offer the individual a limited set of multiple-choice answers, and continually reminds them that Flo is supported by scientific research. This feature aims to simulate the experience of chatting with a medical representative, reinforcing the sense that the information and interfaces the apps provide are informed by reproductive health experts. Clue, which describes itself as "scientific and straightforward,"[73] foregrounds its partnerships with academic institutions and medical researchers, proudly displaying university crests and links to published studies using data collected through the app. While the lengthy terms and conditions, and the fine print of some supplementary information sections, state that companies are not sources of medical authority and encourage individuals to consult their physicians,

Fig. 7. Individuals scroll vertically through Clue's analytics timeline to see cycle correlations. (Biowink, "Clue," vers. 5.13, accessed November 2019.)

they all simultaneously rely on the aesthetics and rhetoric of biomedicine to assert their value.

The aura of science and medicine, in combination with the analytics sections of menstrual-tracking apps, supports a biomedical way of understanding bodies, behaviors, and emotions. The organization of the archival sections not only breeds awareness of the four phases, but encourages individuals to understand the relationship between their cycles and personal experiences. Epstein and colleagues frame the correlations and patterns that emerge through these apps as transparent self-knowledge: "Menstrual

cycles affect and are affected by other aspects of women's lives. Apps for tracking menstrual cycles should support women in identifying these connections."[74] They cite testimony from participants detailing the way these apps helped them explain their emotional and physical behaviors:

> I was consistently . . . depressed right before it happened. I would be really unhappy and grumpy, and then I'd get my period. . . . [K]eeping track of it, then, when I remembered to look at a calendar, I'd be, "oh, this is why I feel like this."[75]
>
> Sometimes I'm really emotional and irrational and I can look at my tracker, see that my period is due in a week or less and chill out and realize I'm PMSing instead of having real feelings.[76]

The sentiments expressed by participants are common ways individuals understand and speak about their menstrual experience, particularly emotional and physical symptoms that are framed as deviant. As in the second example, these justifications often serve as a way to ascribe negative emotions to an individual's uncontrollable cycle phases. Through self-tracking, participants were able to attribute their experience to the phases of the menstrual cycle, using this information as a way to justify and even dismiss their feelings or behaviors.[77] While the study is ultimately critical of these apps, it emphasizes how the algorithms and structures of the app can be improved to support this structure of knowledge production, reinforcing the menstrual cycle as a central cause of emotional and physical experiences.[78]

Thus, any atypical behaviors or reactions risk becoming pathologized or interpreted as indicators of an underlying health problem. While individuals are advised to use the "vital sign" understanding of menstruation to monitor overall health, the testimony above shows how individuals are more likely to understand any change as a product of unseen and uncontrollable shifts in their hormones or cycle. This perspective does not encourage individuals to see themselves as "sick" or "unwell," but it does create the sense that the "true self" is distinct from the hormonal body, subject to fluctuations caused by the menstrual cycle. In other words, despite efforts to reunite body and mind, the biomedical cycle-awareness perspective that underlies menstrual-tracking apps risks encouraging bodily alienation by promoting the perception that individuals are powerless against the hormonal body.

Historically, the uncontrollable hormonal body has been used to reinforce standards of femininity[79] and suppress women's role in society.[80]

Shortly after the discovery of hormones, researchers became focused on chemicals linked to sex-specific reproductive systems, leading to the development of the field of endocrinology and sex-based hormone research. This turn marked a shift away from psychological or neurological interpretations of many diseases toward biochemical processes. Most notably, the discovery of hormones helped undermine nineteenth-century pathologies of hysteria, which often located the condition in the nervous system or psychology. However, as scholars have noted, the discovery of hormones didn't lead to the rejection of hysteria; instead, many of the physical and emotional symptoms associated with the condition were explained through biochemical processes that eventually became attached to symptoms associated with PMS. In 1931, Dr. Robert Frank published the first known article describing "premenstrual tension," which links emotional and physical distress before menstruation to the buildup of female sex hormones.[81] His early work laid the foundation for linking sex hormones to emotional and physiological distress associated with the menstrual cycle, which would later be reinforced and expanded through the work of Dr. Katherina Dalton. Dalton is credited with establishing the term "premenstrual syndrome" in the 1950s, which she attached to the deficiency of the progesterone hormone before menstruation.[82] The shift from "tension" to "syndrome" was a critical "step forward in the medicalization of women's menstrual cycles," framing the physiological and emotional responses to sex hormones as a problem (to be fixed by medicine).[83]

Frank and Dalton's theories of hormones and PMS have since been dismissed, but their work helped establish a biomedical framework for the uncontrollable menstruating body. Deviations from "normal" behaviors or emotional states become attributed to unseen and uncontrollable chemical processes supposedly unique to the female body. This led Dalton and Frank to argue that their work provided scientific evidence that women should remain out of the workforce.[84] Subject to the hormonal body, they claimed that women are not in control of their emotional or physical reactions and therefore should face restricted access to society. Though hormone theories of PMS often worked to justify gendered exclusion, they were also used as evidence for the absolution of guilt. Dalton's work, in particular, shifted toward the legal implications of the biomedical model, going as far as to argue that hormones could turn women into criminals. Throughout the 1960s, her publications were used to support numerous legal cases in the UK, including, most famously, a trial where PMS was successfully argued as a defense for murder.[85] By the 1970s and '80s, scholars

and scientists increasingly dismissed this highly gendered understanding of PMS and the hormonal body more generally. However, much of the damage had already been done: PMS as a condition had been firmly established in popular discourse through popular magazines, self-help, and pharmaceuticals designed to treat the condition.[86]

Dalton and Frank's hormonal body is often invoked when people who menstruate turn to biomedical models of the menstrual cycle to absolve personal guilt. The statements from the Epstein and colleagues study illustrate how the logic of the unruly hormonal body has been internalized, functioning as a way for people who menstruate to justify any "atypical" or "abnormal" behaviors, reactions, and emotions. Indeed, since the 1950s, biomedical models of the menstrual cycle have been framed in positive terms, offering an explanation—a hormonal cause—for any behaviors that violate personal or social norms. Unlike Dalton's legal defenses, which suggested women were entirely out of control of their bodies, the popular application of the biomedical model is invoked to shift focus away from the menstruating person, to the unruly menstrual body. In her history of dysmenorrhea research (menstrual cramps), Louise Lander details how the biomedicalization of cramps not only helped enfold menstrual research into the "doctrine of medicine," but shifted the perception of accountability. Popular medical texts on cramp prevention promised to help women "realize that it's not your fault if you suffer from menstrual pain. There is a chemical basis for menstrual pain and women who suffer from it are neither neurotic nor weak."[87] Sociological studies on women's experiences of PMS have shown how this rhetoric of blame, responsibility, and guilt has become incorporated into the way individuals understand their bodies and behaviors. This most often emerges when women use PMS as an "excuse" to violate feminine social norms and to avoid forms of domestic labor.[88] But as a result, these feelings and behaviors are often invalidated, seen as simply products of hormones, rather than legitimate experiences generated from a range of intersecting social, cultural, *and* biochemical factors.

By locating the source of physical and emotional disruptions, the biomedical model is sometimes framed as resistant or empowering because it gives women license to express themselves outside of the social codes of femininity. Elizabeth Kissling describes PMS as a kind of "safety valve" that allows women to "reject" the demands of femininity, labor, and motherhood. It offers a socially acceptable and medically "approved way for women to temporarily escape their responsibilities."[89] Indeed, in their analysis of studies on PMS, Joan C. Chrisler and Paula Caplan note that PMS

may be the "only time that some women 'allow' themselves to be angry . . . because they can attribute their anger to their hormones rather than to any of the many things that could legitimately anger them"[90] Thus, popular discourses often frame the biomedical model in positive terms because it seemingly allows individuals to preserve a sense of their "normal self" against the deviant emotions and behaviors that result from uncontrollable biochemical processes.[91] Likewise, menstrual-tracking apps couch this biomedical understanding of the body and self in the language of empowerment: once an individual sees the relationship between their cycle, behaviors, and emotions, they can "better prepare for them and better manage them."[92] For example, Della Bianca's study recounts how one participant used the fertility app as a lens through which to understand her day:

> The very first thing you do in the morning sets a tone for the day. . . . [The measure] helped me to get to a better question faster. So, if I feel irritated . . . it helped me to get to "OK, why am I feeling this?" faster, so I can avoid being a big jerk. And accusing others of being a big jerk . . . I'm going to adjust the day today. Or I'm just not going to talk to these people today because I'm not going to be nice [laughs]. (Robin, age 42, US)[93]

Like sociological studies of PMS, this testimony speaks to how cycle awareness can function as a way for individuals to navigate the pressures and stresses that contribute to distress. Here, cycle awareness is framed as a potential source for not only self-knowledge (or policing), but also as a resource for communicating with others—a tool for negotiating the relationship between the reproductive body, the self, and others.[94]

Ultimately, a focus on management within the biomedical model risks reinforcing the perception that the hormonal, reproductive body is "disordered, unruly, and deviant, [and] the outcome of . . . self-policing is a direct assault on the woman's corporeality."[95] The hormonal body is framed as the enemy of social order[96] and even of the "true self," as individuals understand the body as something to monitor and manage.[97] Menstrual-tracking apps risk extending the scientific logic of the hormonal premenstrual body to include all stages of the menstrual cycle. Today, people who menstruate often blame their feelings on PMS, on an unruly body they can't control at particular times of the month. Rather than contextualizing their experiences in terms of social standards of femininity, stress triggers, or a range of other factors, menstrual experiences are reduced to "markers of pathol-

ogy."[98] Neatly organized alongside my cycle timeline, Clue's interface encourages such logic. With a glance, I'm inclined to correlate my social, physical, and emotional experiences with the phases of my menstrual cycle: to see my stress as a product of ovulation, a biochemical process I cannot necessarily feel, access, or control. In their current design, the aesthetics of menstrual-tracking apps encourage individuals to see their lives through their menstrual cycles—to reduce feelings, physiological conditions, and behaviors to unseen biological processes.

Indeed, the Eve app takes this logic a step further, offering daily "cyclescopes" that people can use to explain away or anticipate feelings and behaviors through their menstrual cycle phases (Fig. 8). Every day, they can open the app and learn about the biological stage of their cycle and its influence on their emotional and physical well-being. The app uses gendered language, often addressing the user as "Girl," and couples the cyclescope with a funny pop-culture gif. Many of these "scopes" draw upon menstrual stereotypes, including the emotionally unstable, chocolate-obsessed PMSing woman. Likewise, the hormone-centric MyFlo Period Tracker fully embraces a biomedical understanding of life by asking individuals to use their cycle and hormone fluctuations to determine how they go about their days. Through self-tracking, users are meant to "get in sync" with their cycle by coordinating all of their habits, behaviors, and choices according to their cycle phases: "use your cycle to choose what's easiest for you at the ideal, the most optimal time for your brain and body."[99] The app helps determine how the user should live their life by giving recommendations about whether they should "go out or stay in," eat raw versus cooked food, or whether it's "mommy time vs. playing with the kids." By organizing your life around the biomedical body, MyFlo claims, you can be "symptom-free."[100] MyFlo and Eve are perhaps the most extreme and gendered versions of the menstrual tracking and fertility apps, but the cyclescopes and recommendation systems perfectly distill the vision of self-knowledge offered across menstrual-tracking technologies: if I track my cycles long enough, I can discern a direct cause-effect relationship between my bodily and emotional experiences and my cycle. With this information, I can perhaps anticipate disruptions to social order, but ultimately, I'm at the disposal of my hormonal body, which remains out of my control. Propped up by the authority of biomedicine and big data, this image of self-knowledge offered by menstrual-tracking apps risks promoting a biologically deterministic understanding of the self, body, and health.
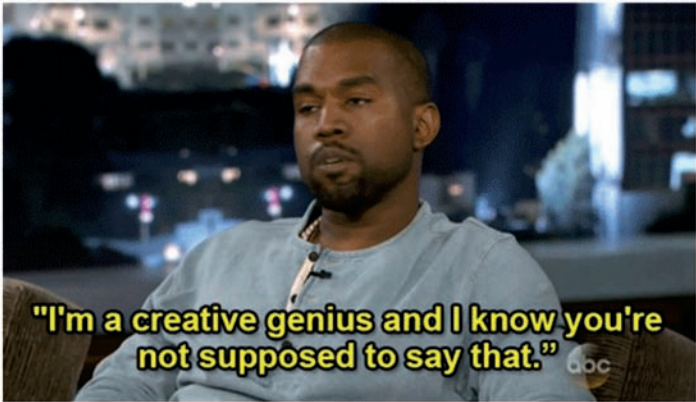
Fig. 8. Eve's "cyclescopes" are available to individuals each day. (Glow, "Eve," vers. 2.15.5., accessed November 2019.)

In their current design, menstrual-tracking apps use the biomedical model of the menstrual cycle to promote the idea that the menstrual body is something that should be carefully monitored and managed across all phases, at all times. At the same time, it suggests that the hormonal body remains out of an individual's control, distinct from the true self, and ultimately at fault for any deviations from the norm. Menstrual-tracking apps thus participate in the "mixed messages" of menstruation, which often move between framing the cycle as a source of sexual and reproductive power (a sign that the body is healthy and capable of reproduction) and the linguistic and symbolic promotion of menstrual concealment.[101] Aided by self-tracking technologies and supported by statistical analysis, individuals find themselves in an impossible position: caught up in the need to monitor and suppress traces of menstruation while their body and emotions are still continually driven and determined by their uncontrollable menstrual cycle. As a result, these apps continually oscillate between two poles: seeking to empower individuals through self-knowledge while still reinforcing the perception that menstruation is an uncontrollable abject process that should be managed and suppressed. In this sense, menstrual-tracking apps reinforce a central contradiction of femininity, in which individuals are both responsible for self-management, yet cannot control the deviant feminine body.[102]

Rethinking Menstrual Management

The power of the biomedical model of menstruation and PMS discourse has been solidified by the inclusion of premenstrual dysphoric disorder (PMDD) in the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-4*).[103] Often conflated with PMS in popular literature, PMDD includes a huge range of symptoms but requires individuals to present specific psychological symptoms, including depression or anxiety, and places greater emphasis on severity and intensity. Though PMS and PMDD remain diagnostically distinct, the addition of PMDD to the *DSM-4* helped increase the credibility of PMS in popular discourses on menstrual health.[104] In other words, PMS, by proximity, took on the aura of medical authority established by the *DSM-4* edition.

However, countless studies have shown there is ultimately no hormonal or physiological basis for PMS.[105] Researchers continue to struggle to understand the direct cause of monthly emotional and physical distress, while the list of symptoms associated with these conditions continues to

expand, now surpassing 100 behavioral and emotional markers. To meet the basic diagnostic criteria, these symptoms simply need to "occur i*n any combination at any time* during the second half of the menstrual cycle."[106] By these standards, nearly every person who menstruates meets the criteria for diagnosis, reinforcing the perception that they "suffer" from a reproductive health condition. Thus, some scholars argue that "PMS is a form of social control and victim blame that masks itself as value-free."[107] The lack of empirical evidence and the vague list of symptoms have led scholars to argue that PMS is essentially a social construct[108] or "culture-bound syndrome . . . a constellation of signs, symptoms, and/or experiences that have been categorized as a dysfunction or disease in some societies and not in others."[109] But labeling PMS, or any forms of menstrual distress, as a product of culture risks undermining the very real forms of discomfort and emotional shifts experienced throughout the menstrual cycle, as well as the role of medical diagnosis in how individuals understand their bodies, emotions, and behaviors.[110]

While it's easy to attribute the self-alienating, negative perceptions of menstruation to biomedical models of reproductive health, numerous studies on the experience of PMS, PMDD, and menopause have shown how medical definitions and data tracking can function as essential forms of validation.[111] Likewise, more recent work in human-computer interaction (HCI) design has examined how menstrual-tracking apps can participate in ongoing processes of "sense-making" of the menstrual experience. With these considerations in mind, I end by offering two ways to think productively about the future of menstrual-tracking technologies: as a personal tool for menstrual reflexivity that can potentially push back on biomedical understandings of the body and health, and as a resource to aid underexplored areas of reproductive health research.

Recent work by Jane Perz, Jane Ussher, and colleagues has sought to complicate constructivist readings of PMS by taking a "critical realist epistemological standpoint," which aims to "recognize the materiality of the body, and other aspects of experience, but conceptualizes this materiality as always mediated by culture, language, and politics."[112] Their methodology takes experience seriously while still always acknowledging that experience exists in a specific cultural and historical context. Examining women's accounts of PMS and the menstrual experience, Ussher and Perz argue that individuals do not necessarily experience PMS as a "fixed illness," "but rather an ongoing process of negotiation with levels of distress." Part of this negotiation is facing the cultural pressures to suppress

the menstrual body and maintain standards of the feminine body. However, this does not necessarily lead directly to pathologization or self-alienation; instead, it may often create forms of self-awareness that can encourage negative interpretations of the body and self but also can allow women to acknowledge and cope with real physical and emotional distress.[113] Rather than critiquing women's PMS self-diagnosis, Ussher and Perz advocate for acknowledging women as "PMS sufferers,"[114] which "*both* evokes connotations of the monstrous feminine and makes meaning of women's distress through legitimizing their experiences as 'real' and something that may require support."[115] In other words, the language of "sufferer" shows how PMS through cultural and biomedical models of menstruation can encourage instances of bodily alienation and self-condemnation, but also acknowledges the range of menstrual experiences and takes seriously the lived distress of people who menstruate. For Ussher and Perz the multiple and often contradictory ways women understand PMS and their menstruating body open up the space for "Western women [to] . . . resist cultural discourse associated with PMS, reject self-pathologization, and avoid or ameliorate premenstrual distress."[116]

Through an emphasis on data tracking and analytics, menstrual-tracking apps can similarly create complex structures of self-alienation and self-reflection. After several years of menstrual tracking, I've found myself slipping into a biomedical way of thinking about my body promoted by the app's aesthetics, but these moments do not necessarily slip into self-alienation or menstrual suppression. While I would not identify myself as a "PMS sufferer," I have found that I experience some pressure and light cramping just before the start of menstruation. There will be moments when I feel my pelvis tighten, as though filled with air, or feel a pulsing pressure just below my navel. This isn't necessarily painful—it's more discomfort I'd liken to feeling too full, but displaced toward my lower abdomen. Initially when I experienced these pressures, because they did not correspond to menstruation I assumed they were gastrointestinal disruptions. Their arrival may prompt me to think about what I've eaten and when, in an attempt to understand my body's reaction to particular foods. But through menstrual tracking, I've come to associate these bodily sensations with the impending arrival of menstruation, indicators that my body may be preparing to shed the uterine lining. By reading these bodily sensations through my menstrual cycle, I am ostensibly operating through the logic of the biomedical model as I attribute my body's behaviors to internal processes out of my control. But in these moments of discomfort, my incli-

nation isn't to explain away or blame my body; it's more of a noticing of my menstruating body, a novel way I'm paying attention to how my menstrual cycle prompts attention to my body.

These moments of bodily self-reflexivity can be quickly undermined by situations in which I use the app to justify or explain my emotional reactions. There have been times when I find myself "overreacting" to a film or television show and have an inclination to turn toward my menstrual tracking app for an "answer." I'm not someone who often cries while watching media or reading, so when I find my eyes welling up and sense a pressure in my chest as my heart speeds up, I pause to deepen my breathing to slow it down. As I feel the pressure of my eyes as tears risk pooling over, I'll shift into a reflexive mode that questions the relationship between my bodily reactions and the content I'm seeing on the screen. These moments can create frustrations with my body, which feels somewhat out of control, uncontained by logic telling me the images on the screen aren't all that sad. Opening up my Clue app, if I see that I'm ovulating or close to menstruating, my reaction will feel "justified," explained through shifting levels of hormones as my body prepares for a physiological process of release. As someone who studies technology and gender, I'm fully aware of the dangers of seeing my emotions through this biomedical lens. I'm also conscious of how my frustration with my bodily reactions is probably the product of other stresses in my professional and social life, as well as my relationship to norms of femininity. But in these moments, there is simultaneously comfort in the biomedical explanation as a way to maintain my sense of self.

Menstrual-tracking apps can often prompt bodily reflexivity, but that reflexivity doesn't necessarily lead directly to biomedical resistance or subjugation. It's often an oscillation between both relationships to the body, resulting in feelings of ambivalence, blame, satisfaction, and empowerment. The range of bodily sensations, reactions, and feelings about the body cannot be reduced to specific formal properties or the goal of the app, nor to the "authority" the app wields over the user. Indeed, most menstrual-tracking users do not see the app as a source of authority capable of explaining their bodies or health: any sense of "self-knowledge" or power the app has is relative, shaped by "multiple elements, through which users themselves produce 'serviceable truths.' The data operate as an active mediator between the body and the embodied self."[117] My use of Clue to explain diversions from what I consider "normal" behavior or a "typical" bodily sensation is a negotiation between the information provided

by the app, and my bodily sensations, social pressures, and my sense of myself. The biomedical model, as well as the app, function as tools for self-reflexive practices, but do not necessarily determine my interpretations or understandings of my body.

In her phenomenologically informed study of fertility trackers, Della Bianca argues that the use of the biomedical model of menstruation and "the role of Biology (as the biomedical system of reference) and biologies (as experienced bodies) is ambivalent, potentially acting as both validating as well as invalidating entities."[118] To truly understand the role of biology and work to counteract the possibility of self-alienation, researchers must first acknowledge the "dual tension" between these two roles. This tension extends to the relationship between the function of the biomedical model in the design and interactive features of the apps, and their role in the perception of menstrual health and the future of menstrual health research. As I have argued, current designs do not necessarily acknowledge the diversity of menstrual experiences or frame physical and emotional changes as "natural" or "normal" parts of menstrual embodiment. However, by transforming self-reported experiences into data points, menstrual-tracking apps can help translate these experiences into a form of scientific evidence that has epistemological authority and cultural value in our society. Medical diagnoses and scientific explanations for physical and emotional symptoms can often function as an essential form of recognition for individuals, particularly those whose experiences have historically been dismissed due to gender, class, and racial bias.[119] While the datafied structures of menstrual-tracking apps should not provide diagnoses, they can provide visual and informational records—forms of acknowledgment—of an individual's menstrual experiences. Thus, the biomedical model continues as a troublesome mediator, capable of translating bodily experiences into powerful forms of evidence, and also into abstract processes that remain out of an individual's control.

As with PMS, the key will be avoiding negative and medicalized *interpretations* of menstrual experiences via the biomedical model. In other words, menstrual-tracking apps should seek to cultivate awareness and acknowledgment, and avoid diagnostic frameworks that reinforce norms, standards, and the homeostatic model of reproductive health. Fox and Epstein have sought to explore forms of menstrual self-tracking that encourage bodily reflection and trouble the biomedical models of the body as "wholly knowable and controllable."[120] Through interviews, they found that predictive algorithms and data structures did not always impose sta-

tistical norms on the body but could provide ways for individuals to cope and prepare for emotional and physical shifts. For example, in their study, Robert, a transgender man, describes how the prediction features of the menstrual-tracking apps often allowed him to mentally prepare for menstruation, which ultimately helped him resist the anxiety and self-rejection that typically accompanied his menstrual experience.[121] Fox and Epstein note, however, that the current structures of menstrual-tracking apps could not account for the changes in Robert's menstrual cycle once he began to take testosterone supplements, and consequently advocate for technologies that can be adapted and personalized to account for a variety of uses, gender identities, and menstrual experiences.[122]

In addition to creating more modular and adaptable technologies, menstrual-tracking apps could ideally support increased attunement to sensorial and emotional shifts that occur during the menstrual cycle. Rather than seeking to draw correlations between particular phases and logged symptoms, the act of self-tracking could be used as a way for individuals to recognize the small shifts in the embodied sensations that occur throughout the cycle, which may or may not be attributed to a specific phase, hormone fluctuation, or physiological process. There should be a way to incorporate the forms of noticing and attunement, such as the instance of cramping I described above, that don't automatically attempt to explain those sensations exclusively through my menstrual cycle. Ideally, an app could prompt reflexivity and allow me to reflect on the potential contributing factors, and to assess how these sensations affect my body as it moves through the world. Ultimately, my abdominal pressure is not disruptive, and therefore should not be pathologized or interpreted as an example of the discomforts of menstruation. It's merely an example of how my body shifts throughout a cycle.

Ussher and Perz found that participants who focused on "understanding" their menstrual distress, by becoming more aware and tracking patterns, were "less likely to self-pathologize," instead they simply recognized these shifts and cultivated strategies of "tolerance of negative premenstrual change, which was recognized to be temporary."[123] Menstrual-tracking apps could be used to support these forms of understanding by offering a tracking system that encourages individuals to "sense-make" bodily experiences by acknowledging change, distress, and small shifts in the body. By de-emphasizing the four-phase visualizations of the cycle, and encouraging strategies for self-reflexivity, these apps could help destabilize the perception of the homeostatic healthy body. Placing greater emphasis on embodi-

ment, by encouraging individuals to reflect on precise bodily sensations, can help cultivate a bodily awareness that pushes back against the dominant, biomedical understanding of the reproductive body.

At the same time that cultural understandings of menstruation need to shift away from preventative, biomedical models, countless menstrual experiences remain unexplained by modern science and medicine, including the prevalence of heavy flows for particular racial groups, extended amenorrhea, and even the exact cause of endometriosis. These conditions have received less attention and funding from the scientific and medical community because research often relies on subjective, reported experiences. Women's experiences, in particular, have historically been overlooked or dismissed due to gendered stereotypes that figure them as overly emotional. This stereotype is further influenced by other markers of identity, such as race and class.[124] While datafication can function as a way for individuals to feel that their menstrual experiences are valid and legitimate, it likewise situates these experiences within the biomedical paradigm. Datafication currently aims to convince individuals of the authority of the patterns and correlations that emerge through analytics. However, shifting focus to the use of this self-reported data in ongoing scientific and medical research can ideally help reduce the sense that these apps are transparent forms of medical or scientific authority. Instead, I would suggest framing individuals as collaborators, stressing the possibilities for participating in large-scale data analysis on menstruation. Current design practices frame the log and analytics sections as transparent sources of self-knowledge, but by foregrounding the act of participation in research, individuals may come to understand that the algorithm and insight features are still works in progress: tools that can be developed through active engagement in data science projects. A focus on collaboration could hopefully also work toward undoing the emphasis on individual management, and by extension, concealment. Framing engagement with the app through research collaboration would ideally help break down some of the barriers of expertise in a way that avoids placing responsibility in the hands of individuals and open up conversation between patients, researchers, and practitioners. For individuals, this could promote the perception that their experiences are significant contributions to emerging health research, and, it is hoped, reduce the shame and stigma surrounding discussions of menstruation.

Of course, this would require a dramatic rethinking of the way data sharing currently operates in most of these apps. Flo, for example, was recently outed for selling user data to Facebook, and indeed many of these

apps currently monetize through data mining and advertising.[125] The personal nature of this information necessitates better anonymization and new security protocols.[126] Moreover, clear definitions of privacy would have to be established to ensure that individuals are protected from healthcare or health insurance discrimination and legal ramifications, particularly in the US with the recent overturning of *Roe v. Wade*.[127] Through partnerships between app developers and research institutions, privacy and data-sharing policies could be developed to facilitate research efforts without violating medical privacy rights. For example, Clue currently partners with several universities, including Stanford and Oxford, sharing its data to promote menstrual health research. Through collaboration with Oxford, the research found no evidence for the myth of period syncing, which is often used to support highly gendered stereotypes about cohabitation among women and female friendship.[128]

With greater attention to individual privacy, these apps can begin to collect demographic information to help target specific populations and potentially reveal patterns and correlations related to factors such as behavior, geography, and family medical history. Currently, none of these apps solicit demographic information beyond age and sometimes location. Allowing individuals to provide information on race, ethnicity, dietary practices, family medical histories, and existing afflictions such as endometriosis could offer insights into specific menstrual health conditions.

The sheer scale of menstrual-health data archived by menstrual-tracking apps means that it could be used for future analysis. But to pursue these possibilities, major revisions must be made to the current design and data-collection features of these apps. While Clue's platform still requires adjustment, its work with universities offers a model for future research. Moreover, the emphasis on inclusive data science and academic research has made it the most highly recommend app by the American College of Gynecologists and Obstetricians.[129] As the second-most-downloaded menstrual-tracker in the Apple app store (as of September 2019), Clue suggests there is a financial and social incentive for companies to change the way these apps frame menstrual experiences.[130] Descriptions of the aesthetic experiences of menstrual-tracking apps can serve as a useful tool for interrogating the impact of these technologies, but true revision and change will require collaborations across individuals and researchers, health scientists, designers, and scholars.