

Do Smartphones Create a Coordination Problem for Face-to-Face Interaction? Leveraging Game Theory to Understand and Solve the Smartphone Dilemma

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Smartphone use changes the landscape of social interactions, including introducing new social dilemmas to daily life. The challenge of putting down one's smartphone is an example of a classic coordination problem from game theory: the stag hunt game. In a stag hunt game, there are two possible coordination points, one that involves big payoffs for both partners (e.g., working together to hunt large game like stag) and one that involves smaller payoffs for both partners (e.g., individually hunting small game like rabbits) but is safer because it does not require that your partner choose that option as well. This is similar to the challenges of putting down smartphones to have a face-to-face interaction: you and your interaction partner might both prefer the higher payoff option of having a face-to-face interaction, but neither of you wants to put down your phone and risk not having anything to do in the meantime. It is also discussed how new technological innovations are changing the payoffs of face-to-face conversation versus side-by-side smartphone scrolling. Insights that come from applying game theory to this “social media dilemma” are discussed here and potential solutions that come out of a game theoretic analysis are offered.

other—to have a conversation where you each share and listen to one another—but, if you put down your smartphone you will be left with nothing to do while you wait for your interaction partner to (hopefully) put down their phone as well so that you can have a conversation. Your companion faces the same dilemma: they might also prefer to interact with you than with their smartphone, but they are loath to put it down and have nothing to do while you scroll your social feed or respond to your email. Habit or fear of missing out (FOMO) keeps you both hooked on technology, while you miss out on the face-to-face interaction you could be having with each other.

If we take the abstract features of this situation and map it onto game theory, we can see that this situation is an example of a classic problem in game theory, a coordination game. In a coordination game, both partners do better if they choose the same outcome (e.g., driving on the same side of the street). More specifically, this dilemma

1. Smartphones Present Us with a Coordination Dilemma for Face-to-Face Interaction

Smartphone use is no doubt an evolutionary novelty, but it nevertheless recapitulates an age-old problem: the classic coordination dilemma. Imagine this not uncommon scenario: You are on your smartphone checking your email or social feed and across from you sits your friend or partner, who is similarly engaged (Figure 1). You might both prefer to interact with each

is an example of a specific kind of coordination dilemma called the stag hunt game (Figure 2a). The stag hunt game is different from the more well-known prisoner's dilemma game, in that the highest payoff in the stag hunt game is mutual cooperation/coordination, as opposed to the highest payoff being for exploitation, as it is in the prisoner's dilemma game. In the stag hunt game, there are two possible coordination points, one that involves big payoffs for both partners (e.g., working together to hunt large game like stag) and one that involves smaller payoffs for both partners (e.g., individually hunting small game like rabbits). It may seem, at first glance like a “no-brainer” to choose the stag hunting option, but there is a catch: if one individual chooses to hunt stag while the other chooses to hunt rabbits, the stag hunter ends up with nothing to eat and while their partner ends up with at least some rabbits. The critical point is that it takes coordination to effectively hunt stag, while rabbits can be hunted by individuals who are not coordinating their behavior.

This is the fundamental dilemma in the stag hunt game: it is risky to choose to hunt big game unless you know that your partner will also choose that option.^[3] This parallels the dilemma we face when we sit together with somebody and have the option to have a face-to-face conversation (hunting big game together)

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Figure 1. Staying engaged in smartphone usage when both partners would achieve a higher social payoff from having a real-time, face-to-face interaction, is an example of a modern-day coordination problem; one that recapitulates the payoffs in the classic stag hunt social dilemma game. The human brain has evolved to derive huge amounts of social knowledge, and interpret subtle cues in communication from face-to-face interaction.^[1] Over thousands of years, such interactions have been critical in establishing and sustaining bonds with others, enabling instinctive but complex phenomena such as gossip or humor to be jointly experienced and enjoyed. The ability to achieve these high payoff face-to-face interactions is now more difficult because of this “social media dilemma”: coordination is now required to shift attention from the digital social world to face-to-face interactions. Reproduced under the terms and conditions of the Creative Commons Attribution 2.0 Generic license.^[2]

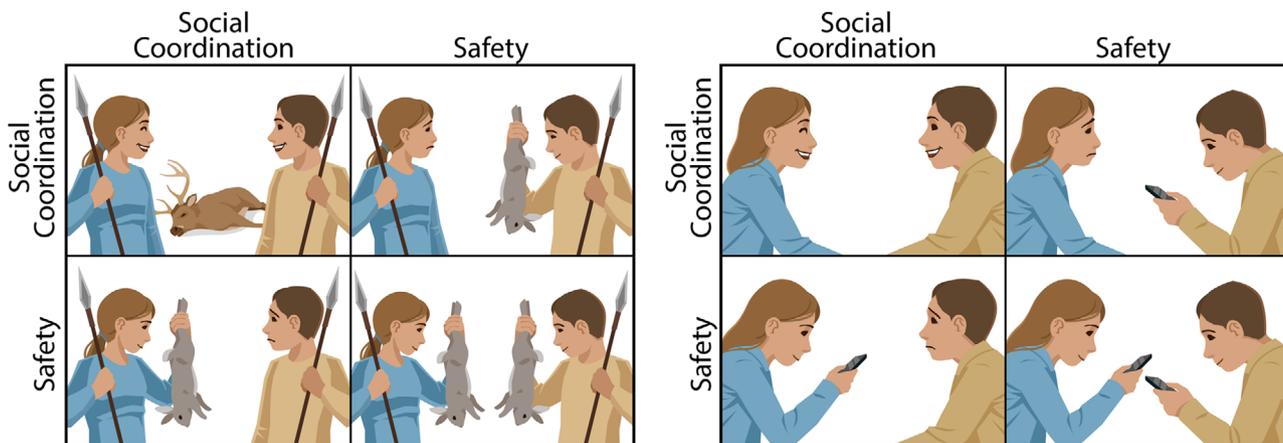


Figure 2. The payoff structures in the stag hunt game and smartphone dilemmas are strategically equivalent. a) In the stag hunt game, both partners get the highest payoffs from coordinating to hunt stag (coordination/coordination), but risk the lowest payoffs if they hunt stag while their partner opts to hunt rabbits (coordination/safety; safety/coordination). If both hunt rabbits (safety/safety), both get an intermediate payoff, making rabbit hunting the safe option. b) The stag hunt game is similar to the dilemma we often encounter with smartphone use. Both partners get the highest payoff from coordinating to have a one-on-one conversation (coordination/coordination) but risk the lowest payoffs if they put down their smartphone while their partner opts to continue using their smartphone (coordination/safety; safety/coordination). If both partners use their smartphones (safety/safety), they get intermediate payoffs.

or scroll our smartphones or tablets (hunting small game separately). And despite, potentially higher payoffs from a face-to-face conversation in the moment, we may often end up with a suboptimal outcome—both scrolling our smartphones to dredge social media often for little gain—because of a failure to coordinate (Figure 2b). In larger groups, we can face a similar dilemma, making it a challenge to achieve shared attention on a common goal because of the lure our email or social media feed. This is

an example of a multiplayer coordination problem, and the stag hunt game can generalize to dilemmas in larger groups like this where coordination of a whole team is required for success.

What this means is that many of us face this classic game theoretic dilemma daily as we pick up our smartphones rather than interacting with the people in front of us—over the breakfast table, waiting for a meeting to start, sitting at a cafe—many of us stay engaged with our smartphones, searching for morsels

of knowledge, social observation, or positive feedback. FOMO drives us to engage with our phones, and if we do put down the smartphone and look up, there is a risk that we will not have anybody to engage with because everybody else is glued to their own screens.^[4] Social norms appear not to have developed to support coordinating our behavior to switch to face-to-face interaction when we are engaged in our smartphones. The question of how we will manage smartphone use in our social interactions is a critical one as technology continues to develop, making our devices more and more compelling.

One of the challenges of achieving face-to-face interaction in the presence of smartphones is that social media platforms offer endless feeds. Users do not reach a physical barrier, such as the last page of a newspaper, that provide a strong stopping cue.^[5] Additionally, the algorithms behind each online search give the user a sense of immediacy and control, as if the internet is an extension of the searcher,^[6] because query responses are designed to be returned within 0.1 s (or roughly the same response time of our nervous system's sensory response).^[7] This endless feedback seems to cause people to constantly check their feeds, creating an addiction to checking the sites with behavioral symptoms.^[8–12] So significant is this issue, that Facebook is trialing a new feature allowing people to self-monitor their usage, to “help make sure people's time on Facebook is well spent”.^[13] This requires a user to opt into self-awareness and engage with self-monitoring and control which may be difficult as the relationship between users and technology is linked by a continual positive feedback loop.^[14] Whether you take the perspective that this addiction is one caused by tech companies trying to get us “hooked” on their products^[5,15] or one of our own making,^[16] it is clear that the coordination problem of the social media dilemma still remains.^[17]

In its most abstract form, this dilemma arising from the availability of media is not new. Traditional forms of media, such as newspapers, books, and magazines have long presented a similar opportunity for an individual-based activity that might sometimes interfere with opportunities for what could be a mutually beneficial social interaction. But there is something about the opportunities afforded by a smartphone that make it different from traditional print media: it offers users the opportunity to persistently graze on content on endless feeds, it pushes content to users, and it offers social validation via “likes” and other positive feedback from the extended social world. These characteristics of the smartphone contribute to its pull and, it has been argued, the habit of checking the smartphone leads to problematic usage,^[18] and becoming engaged with it once we pick it up.^[19]

The dilemma of whether to interact with media or interact with the person sitting across from you at the table has evolved dramatically in the last decades, and it is continuing to evolve as technology continues to advance, providing us with useful services and rewarding content that can more effectively lure us away from social interactions that might ultimately be more important for our health and wellbeing.

Personal interaction with the smartphone can draw users into content consumption as a solitary and immersive pursuit, for example requiring a greater degree of focus that interaction with traditional print media. Users seem to be more easily experience a cognitive flow^[20] through the smartphone^[21] where there is complete absorption to the extent that time becomes distorted for the user.^[22] The smartphone provides an almost infinite content

choice for the committed surfer that can be consumed in “snack” sized portions multiple times per day.^[23] In contrast, reading a newspaper at the breakfast table signals precisely what is being consumed, being easy to pause or resume, enter into conversation, and catch interactions such as a glance or smile along the way. Traditional print media also provides those all-important decision points for stopping.

2. The Stag Hunt Game Can be a Useful Abstraction of a Complex Real Life Smartphone Dilemma

The real life dilemmas underlying social media use are of course more complex and multifaceted than can be fully captured with the stag hunt game. The stag hunt game captures the central tension between the safety of getting small payoffs in an individual-based activity (hunting rabbits/scrolling a feed) and the uncertainty of a potentially large payoff in an activity that requires social interaction and relying on others (hunting stag/attempting a conversation) (see Figure 2). However, the stag hunt game does not fully capture the complexities of the smartphone dilemma: it does not capture the potential diversity in payoff structures for scrolling versus interacting, it does not capture long-term costs and benefits of choosing face-to-face interaction versus side-by-side scrolling, and it does not capture the possibilities that players have to share information in the real-life smartphone dilemma.

2.1. Caveat 1: Payoff Structures in the Smartphone Dilemma Do not Always Strictly Map onto the Stag Hunt Game

One important limitation of the stag hunt game in capturing the smartphone dilemma is that the payoffs do not always map onto the game theoretic formulation. For example, there may be situations where two individuals actually prefer to scroll side-by-side on their smartphones at the breakfast table rather than having a conversation. This could be because the value of the information from their smartphone is high (for example, receiving an important communication or reading an enjoyable story) or because the value of interacting face-to-face is low (perhaps the parties feel like they do not have much to say to one another or they are uncomfortable talking to each other). We are not suggesting that smartphone use always leads to the stag hunt coordination dilemma, but rather that the payoffs often are a parallel with the stag hunt game.

2.2. Caveat 2: The Stag Hunt Game Formulation Does not Capture Long-Term Costs and Benefits

This brings us to another point about the limitations of the stag hunt game to fully capture the smartphone dilemma we have described. In the real life scenario, involving a choice between face-to-face interaction with a friend and side-by-side scrolling, the stag hunt game payoffs do not capture the long-term cost that might come from choosing the side-by-side scrolling option. They also do not capture the potential long-term benefits that might come from effectively coordinating to put down

smartphones and have a social interaction with the person in front of you. The payoffs received extend potentially beyond the immediate game itself, and into the future.

2.3. Caveat 3: In the Smartphone Dilemma, Individuals Can Share Information

Another critical difference between the formal stag hunt game and the smartphone dilemmas is that the stag hunt game, as it is typically operationalized in game theory, involves no communication between the players. But, in real-life interactions, such as those involving the lure of smartphone scrolling, individuals have the opportunity to share information. For example, they can discuss and implement plans to put down their smartphones and interact face-to-face if that is what will give them the highest payoff. That brings us to some of the possible solutions to this smartphone dilemma that come from game theory.

3. Game Theory Suggests that We Should Coordinate Putting Down Our Smartphones

To what extent can we leverage our understanding of game theory to solve this problem of not achieving desired face-to-face interaction because of the “safety” of mindless scrolling? Can the logic of the stag hunt game lead us to solutions that will help us have more face-to-face interaction? Our smartphones offer an infinite stream of media often leading us to hunt for metaphorical rabbits on our own while we pass up the chance to hunt big game together. One important insight that comes from applying game theory is this: In order to achieve the higher payoff coordination in a stag hunt game, you and your partner have to simultaneously switch from the lower payoff coordination point (i.e., hunting rabbit or scrolling your email/social feed) to the higher payoff coordination point (i.e., hunting stag or having an interactive conversation), otherwise the first individual who switches suffers.

This suggests some possible solutions to this social media use dilemma. One is for individuals (i.e., partners, friends, family members) to coordinate about when and where to use and not use their smartphones (e.g., putting them away at the dinner table, in the car or at meetings). Another is to check in about setting a time limit on smartphone use and stopping at the same time so that there is an opportunity to begin a social interaction without one individual being tied to their smartphone.

4. The Smartphone Dilemma is Evolving as Technology's Role in Our Lives Continues to Expand

4.1. Advertisers and Media Platforms are also Players in the Game

One of the ironies of the smartphone dilemma is that our smartphones actually provide a tool for media platforms and advertisers to collect data about us^[24] that then allows them to present targeted content^[25,26] that makes our smartphones even more compelling to us,^[27] further reinforcing our smartphone

engagement. This allows platforms and advertisers to benefit from our increasing addiction to social media,^[26] meaning that business models based on advertising are incentivized, or at least may benefit from problematic smartphone behavior. As such, media platforms have a great deal to gain from pulling us away from our immediate opportunities for social interaction and luring us into feeds where we will encounter advertisements and other content that is aimed at behavior change (sometimes this change is good for us,^[28–30] but other times it is detrimental to us.^[18,31,32] Such is the volume of notifications that users are becoming adept at defining strategies to manage the overburden of smartphone notifications^[33] and both interruptability and user engagement is predictable.^[34]

Some aspects of technology that we have become very dependent on, such as GPS, are now being utilized for targeted advertising and location monitoring. Now, our smartphones can use our GPS location not only to assist with monitoring locations (e.g., the location of children, the elderly, individuals on parole, and even more mundane things like real time traffic reports),^[35,36] but also to send specific advertisements for activities, stores, and restaurants near you at any time whether you want this or not.^[37–39] Recent reports have indicated that U.S. companies who use location data reported increased effectiveness of their marketing campaigns, increased customer engagement, and increased sales as a direct result of using location-based marketing strategies.^[40,41] Corporations and businesses have a stake in the social media dilemma, and will continue to profit from players in the game continuing to scroll through social feeds and see the advertisements.

4.2. Wearables and Implants Contribute to the Commodification of Attention and May Exacerbate the Smartphone Dilemma

Other technological advances such as microchip implants are becoming more common,^[42] fusing biology and machine. In fact, wearable technologies are already being used to help children with cognitive, emotional, and motor disabilities learn in a more targeted and child-centered fashion.^[43,44] As humans use wearable devices and implant technology for cooperation and morality,^[45–47] the benefits of becoming a “cyborg” can outweigh the costs. For example, these technological advances can be valuable for monitoring medical conditions and administering medication.^[48] However, these technologies also make us vulnerable to potential problems from targeted advertising, particularly if strong data protection is not systemically embedded with deployment of the technology. It is now possible for advertisers to receive information from wearables, for example, targeting ads to individuals with a certain time frame after they have finished a run.^[49,50] Imagine how the problems of targeted advertisements could be exacerbated if implants have access to more sensitive data, such as heart rates and hormone levels (something that tech companies like Apple are actively advertising against).^[51]

Radio-frequency identification (RFID) chips provide ways of monitoring both objects and people. It is likely that they will eventually allow us to identify objects (e.g., an iPhone using Apple's Find My Phone application or keys using attachable technology like Tile [<https://www.thetileapp.com/>]), and locate them with knowledge of the device's history, such as when it

was last in a specific location, and what condition it was when it last was sighted.^[52] RFID is not just useful for locating objects, but may be implanted into a person and used to monitor blood alcohol levels, heart rates, body temperature, to store personal data, and carry out mundane tasks such as opening a door or turning on lights.^[52,53]

These technological advancements have the potential to further disrupt face-to-face relationships through distraction, particularly if we move away from smartphones and towards technology that uses location based advertising and RFID to augment personalized advertising that we see in the physical environment, such as projected on screens and billboards. It may become even harder to coordinate “hunting stag” in the social media use dilemma, as we become more and more immersed in technological advances and unable to redirect our attention away from our phones and back towards face-to-face relationships. In fact, these technologies could change the very nature of the game theoretic dilemma that we face when deciding between face-to-face interaction and side-by-side scrolling: once our smartphones become so compelling that we completely prefer them to interactions with other humans, then the highest payoff for both parties would come from side-by-side scrolling, turning the stag hunt game on its head.

This apocalypse of face-to-face relationships is not completely science fiction, however augmented reality devices such as smart glasses, which incorporate cameras, microphones, and GPS receivers with digital information and projects the results onto the user's visual field, are already being beta tested in consumer situations^[54] with individuals who are more open to new experiences and perceive there to be benefits from the technology being the most likely to wear smart glasses.^[55]

4.3. We Can Develop Technology Consistent with Our Goals and Values

There is market incentive to produce technology that interferes with face-to-face interaction. This means that there is an increasing need to develop technologies that will help support and maintain face-to-face interaction, if this is something that we wish to cultivate and preserve as a society. This is one of the goals behind the “ethical design” movement^[56,57] and the related “time well spent”^[58] and “downgrading” movement,^[59] both of which recognize that greater intentionality is needed if we are to use our electronic devices in the ways that are most meaningful and valuable to us.

More philosophically, it is worth pausing to consider how human relationships may be sustained and disrupted in future as technology continues to develop. Part of what makes us human is our high sociality,^[60,61] and we bond with one another through cues and senses that are primarily detected in a physical setting.^[62] But in the context of the smartphone and social media, we re-question what bonding may mean: does being a “friend” or being “followed” correspond to a bond? If somebody likes your posts, does this mean that they truly have a stake in your well-being? And how much of this activity is genuine as opposed to being the result of bots that may be the agents of yet other agendas that we do not fully understand?^[63] These are open questions for behavioral scientists, technologists, and futurists, but they are

also open questions that we all must grapple with as humans in an increasingly technological world. We must decide for ourselves what value we place on scrolling our feeds, and for many of us this value is fundamentally rooted in the extent to which scrolling our feeds genuinely keeps us connected to the world, connects us to those we love, and allows us to build new meaningful contacts and relationships. Even if we choose side-by-side scrolling over face-to-face interaction at the breakfast table, we need to know how genuine the apparent benefits are: whether the rabbits we are scrolling for truly there or whether they are—to some extent—an illusion that keeps us glued to our screens, allowing media platforms to harvest and sell our attention more effectively.

In the presence of powerful technologies that are ever present, can we develop behaviors and norms that protect the relationships that we value and to maintain our autonomy and decision making capacity when we are increasingly distracted? Recognizing the dilemmas that exist at their source, is a first step in establishing formal modeling tools and new technologies that could be of use for solving the smartphone dilemma.

5. Game Theory Can Help Us Design Technologies to Solve the Smartphone Dilemma

As technology advances, we may be increasingly vulnerable to the smartphone dilemma. But technology can potentially also be a tool for helping to solve this dilemma. By utilizing game theory and designing technology that leverages known solutions to the stag hunt game, we may be able to capture more of the potential benefits from social interaction. The key insight from game theory is that, in order to solve this smartphone dilemma, individuals must coordinate their behavior, putting down their phones at the same time. Technology may be able to help us achieve this.

One way to positively intervene is to utilize technology to identify when friends enter into the social media dilemma in each other's company. For example, we are developing a smartphone app that uses location services to identify when friends are within range of a physical conversation. This app would periodically create simultaneous notifications on both partners' smartphones and tablets asking whether they want to opt into a joint blackout for 2 min from now to have an in-person conversation. If both opt in, then their phones go blank at the same time. Our first goal is to test this app by measuring the quality of close relationships in couples who use this app, compared to a control group who does not use this app. Future research could also test the quality of friendships among friends who use this app. Other applications and areas for experimentally testing the viability of this coordination mechanism for escaping this “smartphone dilemma” include meetings and some educational settings.

Providing social nudges brings awareness in maintaining meaningful social interactions and relationships. This becomes more important as social technologies paradoxically edge out time and space that we would otherwise be using for face-to-face social interaction.^[64] Sometimes using social technologies can foster offline communications (e.g., when individuals with rich offline social networks use technology to foster and build these relationships),^[65] but often times social technologies

substitute for, and therefore diminish, the value of offline communication.^[66–68] Sharing joint experiences and dialogue in real-time, and not oversharing on social media,^[69] or only maintaining relationships through technology,^[65] are important parts of having healthy lives and relationships.^[70,71] Additionally, potentially negative side effects that can arise from maintaining online-only social relationships include fostering homophilic relationships which may have major implications for news and political information sharing.^[64]

As we move forward in an increasingly digital age, tools like game theory can help us to solve new problems that arise—like the smartphone dilemma that we have identified here—prevents us from capturing the benefits of face-to-face interactions. Luckily for us, the fundamental structure of this problem—and many of the other seemingly novel problems that we face in the digital age—maps onto well-understood game theoretic scenarios. This means that game theory already gives us the solutions for many of these problems. But it gives us these solutions in a general form that we need to translate into a specific implementation that matches the instantiation of the problem. Because the smartphone dilemma maps onto a stag hunt game—game theory tells us that the solution is coordination—and technologies like the app we are developing can help coordinate to have face-to-face interactions when the safer option would otherwise be to keep scrolling for rabbits and ignoring the big game right in front of our faces. Game theory can help us understand the new problems we encounter as we become increasingly immersed in digital media and it can also provide the general structure for solutions to these problems. Now it is just up to us to implement the solutions that game theory gives us so that we can enjoy the benefits of hunting big game and stop mindlessly scrolling for rabbits.

Conflict of Interest

The authors declare no conflict of interest.

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