Exploring the Impact of Collaborative Games on Perceived Interpersonal Closeness in Romantic Partners

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February 2, 2024

Abstract

Our research investigates the role of a collaborative video game on the perceived interpersonal closeness of romantic partners before and after playing three rounds of the game. We examined the dyadic two-player game Overcooked!2. In a study (n=18) we assessed in-game collaboration through in-game actions, as well as perceived closeness through the Inclusion of Other in Self (IOS) scale before and after the game. Our results found no significant change in perceived closeness between the partners of the sample. Further research with other tools and a larger sample size might find other outcomes.

keywords: *Social Signal Processing, Collaborative computing, Human-Computer Interaction, Co-op, Game, Overcooked! 2*

1 Introduction

Understanding how collaborative gaming experiences, particularly in familiar, influence relationships is a complex but intriguing inquiry. Scholars have explored the simulation of real-world collaborative environments through video games [1–4], with an emphasis on professional and public spaces. However, the significance of gaming experiences at home remains less studied.

This research delves into the dyadic gaming dynamics within the first space, focusing on the impact of the game Overcooked! 2 on interpersonal relationships. Overcooked! 2, a digital game released in August 2016, simulates the chaos of a kitchen, encouraging collaboration between 2 to 4 players [5]. The game's intense, time-limited challenges create a dynamic environment, earning it the colloquial nickname 'Break Up Kitchen' due to its potential to strain familiar relationships [6].

Despite the collaborative nature of Overcooked! 2, limited research has explicitly considered the role of interpersonal closeness in collaborative behaviour during gameplay [7]. This study aims to address this gap by examining how the game affects relationships, proposing a hypothesis that closer partners demonstrate better collaborative performance and experience better social outcomes [8].

Understanding the phenomenon of Overcooked! 2 impacting relationships holds crucial implications for collaborative gaming dynamics and broader insights into human-human and human-agent interactions in digital environments [9]. By exploring the correlation between closeness, game performance, and social outcomes, this research contributes to a deeper understanding of the intricate dynamics within collaborative gaming scenarios.

The following sections explore related work, outlining the importance of interpersonal closeness in relationships [10, 11], and delve into previous research on Overcooked! 2 to provide context for the study. This research seeks to bridge gaps in existing literature and shed light on the nuanced interactions between interpersonal closeness, game performance, and social outcomes in Overcooked! 2.

1.1 Background

Understanding the dynamics of human collaboration in simulated environments has been a focal point for scholars, particularly within the domain of video games. This exploration has been divided into three interconnected sections: Gaming as simulation for real-world environments, delving into the gamification of home spaces; Relationship science, drawing upon theories of interdependence and closeness; and Understanding Romantic Relationships through Gameplay Analysis, which explores the communicative and non-communicative aspects of

in-game behaviour.

1.1.1 Games as simulation for real-world environments

In exploring the simulation of real-world environments to understand human collaboration, scholars have extensively considered video games as a means of simulation, both for professional applications and leisure experiences [12]. The focus has predominantly been on studying simulations of human collaboration in the professional and public spaces [1]. As the privatisation of physical public spaces progresses [1], a shift towards multiplayer gaming has been established, encompassing massively multiplayer games and competitive eSports [2, 3]. While gamification in professional settings has been extensively studied [4], the home remains an under-explored terrain.

Within the home, gamified situations occur in co-located experiences, involving in-person gaming among family and friends within familiar surroundings [8]. This setting distinguishes itself from remote collaboration, offering a unique lens into collaborative dynamics. Studies in schools have demonstrated that co-located simulation of learning environments enhances collaboration in the classroom [9]. Furthermore, players sharing the same physical space tend to be more involved, engaged, and competent, experiencing lower tension and increased positive affect [13]. In most real-world co-located settings, gaming occurs between familiar individuals [7].

Simulated collaborative tasks among closely associated individuals have the potential to impact dyadic coping, especially evident in romantic partners engaged in collaborative gaming. Research suggests that increased frequency of video game collaboration correlates with higher perceived positive effects on romantic relationship satisfaction [14]. The significance of familiarity is underscored by its positive influence on communication and collaboration [10, 11]. The close bond between individuals enhances emotional expression, contributing to resilience in adverse situations, such as the intensity of competitive scenarios [15].

1.1.2 Collaboration in Romantic Relationships

Understanding how romantic partners collaborate in a relationship finds its roots in the interdependence theory developed by Thibaut and Kelley [16]. This theory describes how the structure of outcome interdependence shapes motivation and behaviour within couples. When there is a chance or motivation for interdependence between two individuals, it fosters cognitive, affectionate, motivational, and behavioural closeness [17]. Notably, higher levels of mutual interdependence are associated with lower stress levels in couples, particularly when stressors originate from external factors [18].

There are various means to measure mutual interdependence or closeness between partners, with Stephens et al. [15] underscoring the importance of con-

sidering psychological relations for understanding closeness. The 'Inclusion of the Other in Self' (IOS) scale is highlighted as a valuable tool for evaluating social closeness, offering an accessible and visual means to assess the subjective sense of mutual interdependence and therefore interpersonal closeness between individuals [19]. This perspective is essential for comprehending social dynamics and experiences in diverse situations, including gaming scenarios such as playing Overcooked! 2.

As mutual interdependence can impact how individuals perceive and engage in gaming behaviour, examining the effect of the in-game cooperative behaviour can unravel interesting information on the relationship between in-game behaviour of participants in Overcooked!2 gameplay. In the domain of relationships and gaming, the intersection of dyadic coping between romantic couples and Overcooked! gameplay has been explored by the study of Velez et al. [20], where dyadic coping was examined by letting participants play a game of Overcooked!2, subsequently analysing their performances on cooperative puzzle tasks. It was found that [verbal] communication might not have an effect or even benefit dyadic coping after the game. This spurs the case into an alternative avenue of research, focusing on in-game behaviour as a parallel to verbal communication instead.

1.1.3 Understanding Collaboration through Gameplay Analysis

Communicative behaviour might be reflected in video gameplay and may therefore be measured to infer cooperative behaviour [21]. The mechanics in gameplay, such as signalling boredom by running around aimlessly, or jumping to get attention, can be classified and analysed for team coordination as suggested by Toups Dugas et al. [21]. Cooperative gameplay has been found to predict an increase in trust in corresponding gameplay-partners, as well as more cooperative behaviour[22]. But not all game behaviour has a communicative purpose, video game designers include many non-communicative purposes of in-game behaviour.

Establishing a clear taxonomy of such in-game behaviour is a daunting but important task for its analysis. Take for example the League of Legends taxonomy made by van Rhenen et al. [23], which uses card-sorting with individuals who are highly experienced in the game. Yet it takes a lot of time and resources to do so, which is why others extend from existing taxonomies. Therefore this study will extend a taxonomy on Overcooked!2 in-game behaviour by iterating on Bishop et al. [24]'s findings, and following up to their implications by extending upon it.

Figure 1: Game Environment of Overcooked! 2

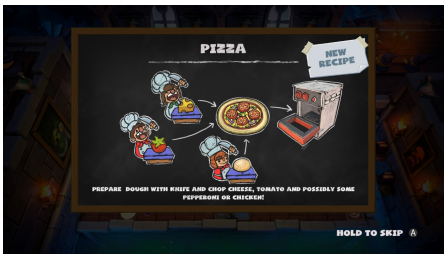

Figure 2: Game Instructions per Overcooked! 2 level

2 Research Question

RQ: Does a collaborative dyadic game of Overcooked! 2 impact perceived interpersonal closeness between romantic partners?

This research questions aims to assess whether there is an impact on perceived interpersonal closeness in couples when playing the game Overcooked! 2. As well as, to investigate how collaborative behaviour contributes to the overall performance with respect to a couple's interpersonal closeness.

Understanding the interplay between interpersonal closeness levels and collaborative gaming success has implications for game design, social dynamics within gaming communities, and broader discussions on the intersection of technology and teammate relationships.

By digging into this research question, this study aims to shine a light on an area of collaborative gaming in an environment that hasn't been explored much. It's all about laying the groundwork for future research and giving some practical insights for game designers, developers, and interpersonal relationships.

In this study, the collaborative game setting will be the cooking simulation game, Overcooked! 2 [5]. Such a game simulates a stress-induced, collaborative experience whereby players will work together in order to prepare dishes in a chaotic, dynamic, kitchen. Overcooked! 2 has a series of set levels where the setting remains constant, having the same level when played more than once; this allows the game to act as a controlled variable where mediation analysis can be performed, hence being one of the reasons for choosing this particular game.

Additionally, conducting such an experiment in real-world settings may prove to be a difficult and time-consuming process; therefore, having a simulated environment that can achieve the same effect is best for the scope of this project. Having such a simulated collaborative environment can also lead to new social

relationships, and may deepen existing relationships [25].

2.1 Hypotheses

The following hypotheses will be tested throughout this research.

- $\mathbf{H}_1$ Interpersonal closeness is positively related to performance.

Existing studies suggest that familiarity enhances collaboration [10, 11]. Drawing on this knowledge, it can be hypothesised that couples who are more familiar with each other are likely to exhibit better collaborative performance in Overcooked! 2. Moreover, the expectation is that this heightened familiarity will extend beyond the game, resulting in more positive social outcomes.

- $\mathbf{H}_2$ Collaborative in-game behaviour is positively related to performance.

Collaborative behaviors in a co-located gaming setting are crucial for success [13]. Considering the chaotic and fast-paced nature of Overcooked! 2, effective communication and collaboration are likely to impact overall performance. Therefore, it is hypothesized that participants who exhibit better collaborative behaviors during gameplay will also demonstrate higher performance in the game.

- $\mathbf{H}_3$ Changes in interpersonal closeness between pre- and post-game assessment are correlated to collaborative in-game behaviour.

Building on the idea that collaborative gaming experiences can influence interpersonal dynamics [14], this hypothesis puts forward a connection between changes in interpersonal closeness and collaborative in-game behaviour. The assumption is that positive changes in closeness will be associated with more effective collaboration during gameplay, while negative changes may result in less effective collaboration.

3 Method

We undertook a study of interpersonal closeness and in-game behaviour. The first study was accompanied with short survey questions for inferring familiarity with the game, perceived proficiency in it and perceived closeness between each other. Gameplay was recorded and a taxonomy of in-game behaviour was extended for in-game behaviour annotation. The study was approved by the Human Research Ethics Committee (HREC) of the TU Delft.

3.1 Participants

Of the eighteen people (F= 44%, M=56%) who participated in the study 72% were from the age range between 18 and 24, and 28 % in the range of 25-34 years old. All participants were European.

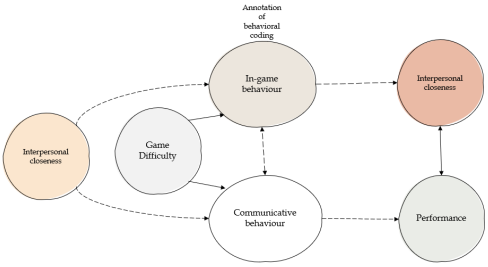

Figure 3: Relationship Diagram

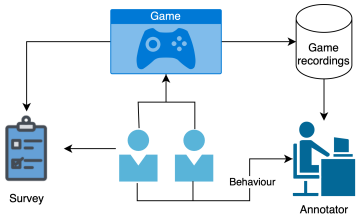

Figure 4: Experimental Approach

3.2 Materials

To conduct this research, a few components will be needed. Firstly, a gaming setup: A console or personal computer with Overcooked 2 [5], two controllers and an environment to set up. Furthermore, a capture card is needed to record the game-play and an annotation tool to perform the necessary annotations on communicative and in-game behaviour.
In addition to physical hardware, the familiarity and affinity with the game, as well as the IOS scale pre- and post-gameplay will be asked in a questionnaire. For convenience, an online form was presented to participants for this purpose, practically combining the questions.

3.3 Experimental setup/approach

Inclusion criteria for this research are that participants had to be in a romantic relationship. Before the experiment participants were assigned an anonymous identifier of 5 digits, and then they were asked about their familiarity and self-decided proficiency in the game.
To experiment, for each pair of participants, the following steps will be carried out:

1. Participants fill in a personal consent form and a pre-game questionnaire to determine levels of interpersonal familiarity.
2. Participants play the tutorial of the game and 1 practice round.
3. Participants will play the game
    - Game-play will be recorded for each level played.
    - Participants will play a variety of set levels multiple times.
        - For each level, a practice round will be played to allow the participants to gain understanding of the particular level.
4. After playing the game, the participants will fill-in a post-game questionnaire to gain insights of their gaming experience.

Successful Productive [24]	**Additional Productive**	**Additional Unproductive**
Picking up an ingredient	Throwing an ingredient	Trashing an ingredient/dish
Chopping an ingredient	Setting up an ingredient	Setting up an ingredient
Cooking an ingredient	Mechanism Used[1]	Making dubious food[2]
Plating an ingredient		
Serving a plate		
Washing a dish		
Placing a clean dish on a table		

Table 1: Collaborative Chef Actions; Positively weighted productive chef actions taken from Bishop et al. [24], Additionally proposed chef actions: Productive & Unproductive

5. The recorded game-play will be annotated and labelled based on what in-game collaborative behaviours were observed.

The experiment can be visualised on figure 4. After having annotated the data, and filled out questionnaires, exploratory data analysis can be carried out.

3.3.1 Annotation process

Similar to the approach by van Rhenen et al. [23], a taxonomy of social in-game behaviours is required for the in-game collaborative behaviour to be measured. The testbed of Bishop et al. [24] labels and discovers in-game actions that facilitate collaboration by the name of Productive Chef Actions. As the authors suggest, we will use a revised adaptation of their *taxonomy* for gameplay actions, counting one action for each successfully prepared ingredient, which means that for negative Chef Actions we will subtract points.

Each level of the game was meticulously chosen for certain collaborative actions to be included, where further particular collaborative actions for these levels could be taken. Therefore, a set of additional actions were introduced; these include both productive and unproductive actions. The unproductive actions are built ontop by Bishop et al. [24] indicated in their discussion for future research. For the full list of collaborative actions, refer to table 1.

For each productive chef action performed by *any* partner within the couple, a single point will be incremented for that action. Therefore, analysis can only be performed on the couple-level rather than the individual-level. Similarly, for any unproductive chef action performed by any partner within the couple, a single point will be decremented for that action. By the end of the level, all points will be tallied and summed together; this will repeat for each level the couple plays. Thereafter, the scores for each level played will be aggregated by their average. The exact annotation process could be achieved by using a continuous-time annotation tool, such as Covfee [26]; however, for simplicity of

this project, the annotations were done manually within a spreadsheet.

3.4 Measures

Between two people, interpersonal familiarity looks at the bilateral closeness of one person versus the other person. There are extensive surveys on how to do this, and their ideas stem either from network theory [15] or from psychology [10]. However, after the comparison of a handful of extensive questionnaires Gächter et al. [19] found that a visual tool that promises to perform just as well in classifying interpersonal closeness between two individuals called the Inclusion of the Other in Self (IOS) scale. It is a scale from 1 to 7 with visual Venn-diagram depictions of the self and others, as seen in figure 3.4 [27].
The participant will answer according to their perception of themselves and the other on a scale from 1 to 7, corresponding to the diagrams of the figure. Before the experiment, participants will be reminded and advised to not disclose their scores with each other until after the experiment.

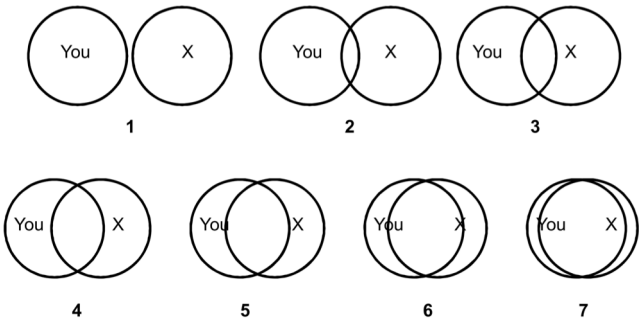

Figure 5: Inclusion of the Other in Self (IOS) Scale [27].

3.4.1 Communicative Behaviour

A controller mediator that describes vocal communication between teammates. This variable directly affects in-game behaviour, as it measures the number of times communicative actions are performed by teammates. Examples would include requesting a food item to be thrown towards a participant or shouting at another. Adding this variable will not be in the scope of the project, as this would require annotation processes, and/or speech classification tasks. We advise future research to investigate the variable.

[1] In Overcooked! 2, some tasks require the team-mate to press a button, or access a lever, to either open passages, move platforms, or change machine states.

[2] Food that is not requested by any of the target recipes.

path	coef	se	pval	CI[2.5%]	CI[97.5%]	sig
Collabs ∼X	2.285366	4.458124	0.635220	-10.092372	14.663104	No
Y ∼Collabs	0.002315	0.050355	0.965541	-0.137494	0.142123	No
Total	0.878049	0.148985	0.004145	0.464399	1.291698	Yes
Direct	0.930097	0.129969	0.005619	0.516478	1.343716	Yes
Indirect	-0.052048	0.918395	0.312000	-0.380570	6.060606	No

Table 2: **Mediation Analysis Results towards Closeness**
X: Closeness levels before gameplay; M: Collaborative Actions; Y: Closeness levels after gameplay.

3.4.2 In-Game Behaviour

A controlled mediator that describes collaborative tasks in-game. Most actions performed in Overcooked! 2 are considered collaborative tasks; therefore, this is an iterative measure denoting how many times a particular task has been carried out per participant.

3.4.3 Game Difficulty

A subjective confounder variable, that denotes the difficulty a particular level of the game induces. Accounting for level difficulty will allow for greater insight in the behaviour one has when playing the game, as well as how it may affect communicative behaviour. However, such a subjective measure would require a validation study to denote which levels are considered difficult, and/or give a ranking; due to the time limitations of this study, this variable will not be measured within the experiment.
The final game difficulty will be designed as a categorical measure that will be controlled for easy, medium, and hard. However, since this measure will not be within the study, further research on definition and measurement will not be explored. There is room for this in the future work.

3.4.4 Performance

An objective outcome variable, that denotes how well a level was conducted, measured by the score of the level. Can be denoted with a continuous score, or a categorical measure between 1 to 3 stars. Performance is measured simply by the score of the level, and how many stars (out of 3) were achieved by each set of participants. Therefore, this can be seen as a categorical outcome, or a continuous outcome, depending on how statistical methods get carried out.

4 Results

Most participants were unfamiliar with the game, see figure 6, and not many participants considered themselves proficient in the game if they were.

path	coef	se	pval	CI[2.5%]	CI[97.5%]	sig
Collabs ~X	2.285366	4.458124	0.635220	-10.092372	14.663104	No
Y ~Collabs	10.768155	2.156966	0.007532	4.779456	16.756853	Yes
Total	43.829268	48.681385	0.418850	-91.331925	178.990461	No
Direct	20.482802	20.499785	0.391345	-44.756664	85.722268	No
Indirect	23.346466	148.649673	0.620000	-211.011200	258.514859	No

Table 3: **Mediation Analysis Results towards Performance**
X: Closeness levels before gameplay; M: Collaborative Actions; Y: Game Score.

Only 22% of participants changed their initial pre-game IOS response in comparison to the post-game response. From that, half of those differences changed one step positively, and half of them changed one step negatively. However, the study found no significant difference in pre-game perceived closeness between participants (paired two-sample t-test: $M \approx 5.17, SD \approx 1.09$) and the post-game examination ($M \approx 5.22, SD \approx 1.166$); $t(18) \approx -0.44$, $p \approx .33$.

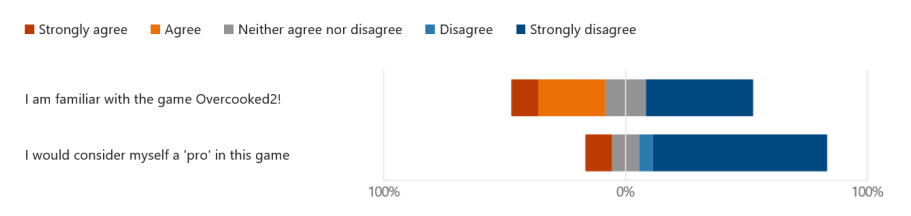

Figure 6: chart showing the confounder variables. Participants answered by checking a Likert scale from 1 to 5.

Table 2 and 3 show the results of statistical mediation analysis performed in order to determine any significance between the variables. Analysis was split between the two outcome variables: Interpersonal Closeness and Performance. It shows the any direct and/or indirect significance the independent variable may have on the dependent variable. X states the predictor variable, closeness levels measured with the IOS scale; M (or Collabs) states the mediator variable, in-game (collaborative) behaviour; and Y states the outcome variable. Each row indicates statistical significance between each variable: $X \sim M$, $M \sim Y$, $X \sim M \sim Y$ (`indirect`), $X \sim Y$ (`direct`) and the sum of both the indirect and direct effect - referred as the `Total` effect.

4.1 Discussion

The results are not significant enough to refute or support the hypotheses posed. That is, the outcomes of the experiment are not changing significantly enough for a notable difference in closeness levels between pre- and post-game inquiries.

While the IOS scale is a reliable tool for interpersonal closeness inquiries in research, it might too static to capture differences in relationships during a simple short-duration situation. It might not be significant enough to pick up small differences in a sample as small as 18 participants. Perhaps a more applicable tool is the Situational Interdependency questionnaire as described by Gerpott et al. [28] which poses 30 questions which infer the social experience of a person with another after a certain impacting situation. Situational Interdependence in close relationships is linked to pro-relationship behaviours [28], which is why it might ameliorate research aiming to explain the social experience of playing a set of games of Overcooked.

The only statistical significance found was that between the in-game behaviour and the performance outcome; which is the direct claim of the second hypothesis (H_2). Therefore, the hypothesis need not be rejected, and can be built on in future work.

Further research should take into account the learning difficulty of the game levels and the communicative behaviour of participants. Apart from that, it would be interesting to look at the collaborative dynamic in certain couples to pick up certain roles according to proficiency and congruency, to investigate whether it applies to this couch-co-op game.

4.2 Limitations

Due to time limitations during the project's lifespan, it was limited to study only one mediator variable - the in-game behaviour (collaborative actions); measuring the communicative behaviour would require further annotation, and/or speech classification tasks. In addition, the confounding variable - Game Difficulty - was left out of the study. In order to define the difficulty of each level, a validation study would need to be conducted, as this was not provided by the game itself. Time limitations also prevented the desired number of participants, which in turn, led to a skewed demographic, where the majority age-range was between 18 and 24.

Furthermore, the three chosen levels were meticulously picked to include certain collaborative actions; however, the gaming experience of participants was greatly overestimated, leading to confusion regarding the levels. This also stems off the time restriction, as more practice rounds would have been included, as well as more levels per set of participants, if time allowed for it. Due to the lack of understanding the participants had towards the game, it would have been necessary to include more practice rounds to familiarise themselves with the game.

An additional limitation from this study is the choice of tools, since the differences in interpersonal closeness were not impacted significantly for the IOS scale to pick it up. Instead, to notice the result of such a situation, one should

perform the study with a questionnaire, or maybe a behavioural biometric tool (i.e. [29]), that is better at picking up small differences.

4.3 Lessons Learnt

As mentioned in section §3.3.1, the annotation process was aggregated together for each couple, meaning that any statistical analysis had to be done on the couple-level rather than the individual-level; this was an oversight prior to the experimentation phase, where, for each couple, the same ID was assigned to both partners. In doing so, it was impossible to link the individual's questionnaire answers to their character within the gameplay annotation process. Thus leading to perform statistical analysis on the couple-level only. In future work, it would be ideal to have an additional question within the questionnaire to identify the character in the game; this can be done by stating which colour the participant is playing as.

5 Conclusion

In this experiment, the impact of interpersonal closeness on collaborative gaming within Overcooked! 2 was explored, leading to results that did not yield significant changes in closeness levels pre- and post-game. While the Inclusion of the Other in Self (IOS) scale proved little variability for short-paced gaming situations, an observed correlation between in-game behaviour and performance outcomes validated our second hypothesis (H_2).

Acknowledging limitations, time constraints confined our study to one mediator, as well as having excluded the possibility of exploring game difficulty. The skewed age range of participants further constrained generalisability. Lessons learnt emphasised the importance of individual-level analysis for a better understanding of interpersonal closeness within couples.

Despite these challenges, our study contributes to collaborative gaming research, where future research should consider dynamic tools such as the Situational Interdependency questionnaire, explore game difficulty through a validation study, and delve into the communicative behaviour of couples within a gaming environment.

Though this experiment could not provide significant results, it still underlines the need for refined methodologies in understanding interpersonal relationships within gaming environments. Addressing limitations, as well as any lessons learnt, future research can be fine tuned to gain a deeper understanding in this field of research.

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