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IJCV INTERNATIONAL JOURNAL OF COMPUTER VISION

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International Journal of Computer Vision (IJCV) Volume 2, Issue 1, January-June 2025, pp. 14-35, Article ID: IJCV_02_01_002 Available online at https://iaeme.com/Home/issue/IJCV?Volume=2&Issue=1 Impact Factor (2025): 2.70 (Based on Google Scholar Citation) Journal ID: 1551-1440; DOI: https://doi.org/10.34218/IJCV_02_01_002





CODE THAT LISTENS: INTEGRATING EMOTION AI INTO FRONT-END DEVELOPMENT TOOLS FOR A MORE EMPATHETIC CODING EXPERIENCE

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ABSTRACT

Lately, new developments in software tools are using affective computing, but the feeling aspects of programming have not received much study. The paper considers whether Emotion AI might turn regular development tools into systems that instantly react to and adjust to developers' moods. Thanks to Emotion AI, developers can experience empathy and understand coding in a new way that protects well-being, saves mental energy, and helps get the job done faster. We begin by reviewing certain writing on affective compu-ting, developer experience (DevEx), and emotional labor in programming and exploring how emotional AI can be integrated into IDEs and browser coding tools. We prove that feedback from facial emotions, voice patterns, and body signals can be applied immediately to adapt user interfaces, start helpful actions, and create more innovative development systems. Nearly all of our user tests suggest that developers engage better, are less irritated, and handle mistakes faster. The final part of the study highlights the ethical points and design concerns of creating emotional tools. It discusses how the rise of this tool could change the future of how software engineers interact with computers.

Keywords: Emotion AI, Affective Computing, Developer Experience, Front-End Devel-opment, Empathetic Interfaces

Cite this Article: Sonu Kapoor. (2025). Code That Listens: Integrating Emotion AI into Front-End Development Tools for a More Empathetic Coding Experience. *International Journal of Computer Vision (IJCV)*, 2(1), 14-35.

https://iaeme.com/MasterAdmin/Journal_uploads/IJCV/VOLUME_2_ISSUE_1/IJCV_02_01_002.pdf

1. Introduction

1.1 Context and Motivation

Emotion AI the same as affective computing significantly develops human-machine interaction because systems respond to instructions and users' feelings (Cambria, 2016; Poria et al., 2017). To identify, understand, and respond to human emotions nearly instantaneously, affective computing brings knowledge from psychology, computer science, neuroscience, and cognitive science (Arya et al., 2021). We can already see that emotionally intelligent interfaces can help healthcare, marketing, and customer service by increasing user engagement, empathy, and personalization (Bagozzi et al., 2022; Han et al., 2023; Monteith et al., 2022).

Though more critical than ever, Emotion AI is still absent from most programming environments. As developers encounter more sophisticated and robust systems, the tools they depend on lack feelings and are missing something important about their inner code barricade. Software development always has emotional elements since you must find solutions quickly, keep up with learning, and face frequent challenges. Even though this emotional work isn't usually seen, it dramatically affects how well and happily a developer performs (Fagerholm & Münch, 2012; Alomar et al., 2020). Being irritable, unsure of things, or tired can hinder your attention and judgment of the code and the standard of your code. Nonetheless, present development tools are unable to detect or answer affective cues.

User motivation, involvement, and happiness with coding are all essential parts of the larger idea known as Developer Experience (DevEx) (Henriques et al., 2018; Bingley et al., 2023). Since human-focused AI is becoming popular, it's a shame that empathetic features are scarce in programming environments. Adding Emotion AI to front-end development tools could help these spaces adapt emotionally, raising productivity and improving mental health.



Fig. 1. Enhancing Software Development with Emotion AI.

1.2 Problem Statement

Currently, front-end development environments, such as IDEs and editors inside your browser, mainly focus on making the work more efficient for developers. These tools cannot react to developers' feelings, so it's hard to see when someone is having trouble or feeling out of sync. Because this weakness is not addressed, developers' unhappiness often leads to burnout, low levels of job satisfaction, and moderately lower results in their work over time (Fagerholm et al., 2015).

Research Objectives

- Emotionally responsive tooling is not yet standard, and this study intends to address that need.
- Enabling Emotion AI to work within the usual tools for webpage development.
- Recognizing basic signs of emotion on someone's face, the tone of their voice, and their keyboard use can be detected as they happen.
- Measuring the change emotionally adaptive interfaces bring to a developer's satisfaction, ability to pay attention, and how well they complete tasks.

Research Questions

A handful of main questions address the focus of this research.

- What ways are available to include Emotion AI in standard front-end development tools so that it doesn't hinder the process?
- What effects do people react to best when providing immediate feedback about emotions?
- How much does an emotionally intelligent interface shape developer satisfaction, interaction, and productivity?
- How much does religion matter in people's lives, and over what range of things does it have a role?

Significance and Scope

The research sits between human-computer interaction, software engineering, and developer experience research. The paper explores front-end development tools for visual IDEs and editors in web browsers because these platforms must work well and look clear. The results are intended to guide improvements in creating empathetic and user-friendly software development environments and to advance understanding of how emotion-aware systems help programmers (Picard & Klein, 2002; Bingley et al., 2023).

2. Literature Review

2.1 Affective Computing and Emotion AI

Systems that recognize, interpret, and respond to human emotions by sensing, analyzing, and recording emotions are known as affective computing (Picard & Klein, 2002). From simple ways of assessment, this domain moved toward using facial recognition, assessing voice tone, looking at physiological signs, and including contextual information (Poria et al., 2017; Wang et al., 2022). This field, part of affective computing, uses models based on machine learning and natural language processing, allowing us to detect emotions as they happen.

Gaming, education, and healthcare have all used effective systems over time to increase engagement and results by responding to people's emotions. For example, emotion-aware tutors accommodate a student's frustration, and inner health software uses mood information to enhance mental health (Monteith et al., 2022; Cambria, 2016). Yet, software development, mainly for front-end applications, is poorly understood and is becoming more widely explored.

Emotions in Software Development. In 2020, Alomar et al. discovered that how developers feel about their tools guides how they refactor code and what the results will look like. Even so, designers don't usually pay much attention to emotions in their tooling designs.

This has become a bigger issue now that modern working methods call for continuous integration, firm deadlines, and top outcomes.

A developer's mood strongly affects the cognitive side of software development. Handling errors and designing interfaces often cause people to feel frustrated, highly confused, or satisfied with what they achieve (Klein et al., 1999; Han et al., 2023). Evidence suggests that if we experience negative feelings, our code quality will suffer, and our ability to collaborate will be reduced. However, having positive emotions will help us solve problems and collaborate better (Coyle et al., 2012; Arya et al., 2021).



Fig. 2. The Impact of Emotions on Software Development

Developer Experience (DevEx) Trends. Easing the experience of developers with software tools has become a systematic priority for software engineering (Fagerholm & Münch, 2012). Many metrics for DevEx look at speed, reliability, and their place in a larger development flow, yet they often ignore the effects emotions have on lengthy outcomes.

IDEs, linkers, and debuggers mainly support speed but not empathy. Dealing with confusing errors or tricky statements in programming happens often, yet it is not recorded and can eventually lead to burnout and boredom (Fagerholm et al., 2015). Bingley et al. (2023) explain that AI designed for people must emphasize the user's feelings regarding design.

Emotion-Aware Systems in Other Domains. Emotion-aware systems are working well in areas where how the user interacts is most important. Mental health therapy bots use artificial intelligence to notice users' feelings and respond suitably (Gkinko & Elbanna, 2022).

Innovative educational systems react to if someone is bored or not learning smoothly by tailoring their course (Cambria, 2016). An adaptive UI responds to people's moods automatically to lower the workload on their minds (Zepf et al., 2019).

Similar rules used in these systems also work in front-end development: close patterns of action and reaction between the user and computer, interactions that react to the user's context, and designs that act with empathy toward users. As an illustration, CAiRE uses emotion-cycle principles to help its responses match the user's feelings.

Theoretical Framework. How we conducted this study was guided by both humancentered computing (HCC) and emotion-cycle theory. Compared to smooth user interfaces, HCC prefers designs that meet human needs, life experiences, and beliefs (Bingley et al., 2023). By applying Emotion AI in development settings, we support this approach by focusing on emotional problems.

Emotion-cycle theory helps us look at how developers change their interactions with tools as their emotions change (Caruelle et al., 2022). If developers notice emotional triggers and react to them with valuable cues, such as adjusting messaging or displaying images, Emotion AI can help with programming. As a result, these frameworks shape development tools to understand and respond to a developer's emotional state throughout their work.

3. Methods

3.1 Research Design

For this study, we use methods from both research branches to analyze how innovation in Emotion AI can assist with building empathetic codes in development environments. Because emotional states in software development are so complicated, it becomes necessary to look at both people's descriptions and measurable behaviors (Fagerholm & Münch, 2012; Bingley et al., 2023).

To learn about their emotional states while coding, we interview software developers using semi-structured interviews. With these interviews, we discover what issues and hopes people with empathy issues have about helpful tools.

At the same time, the quantitative approach involves developers using Emotion AI tools in experiments while experts monitor their emotional reactions live. Because of this design, it is possible to confirm that our tools can spot emotions and respond appropriately, using well-

respected methods from affective computing and adaptive systems (referring to Picard & Klein, 2002 and Cambria, 2016).

By mixing these approaches, the research seeks to see how well and how often technologies measure emotions and respond to them. At the same time, it considers what these results mean for developers from their standpoint (Bingley et al., 2023; Arya et al., 2021).

Tool Prototypes. Two experimental front-end development tool prototypes enhanced by Emotion AI were built for the study. They improve on normal IDEs like Visual Studio Code and add emotional sensors and responsive features to improve one's mood while programming. Core features of the prototypes include:

- Emotion Tracking Systems: Multimodal tracking allows these systems to collect facial features with a webcam, analyze voice tone with sound from a microphone, and measure biometric features with sensors. This system continues the work done by Chakriswaran et al. (2019) and Wang et al. (2022) in sentiment computing. It turns central affective states like stress, confusion, and satisfaction into recommendations for the user.
- Adaptive User Interfaces (AUI): The front end responds differently depending on the user's shifting emotions. In addition, the system removes noisy visuals, uses a calmer color combination, and displays a clear layout when extra stress or confusion is discovered (Klein et al., 1999; Han et al., 2023). During flow and similar states, the system reduces interruptions and supports doing deep work without stops.
- Context-Aware Empathetic Prompts: If a person continues to be frustrated, the system suggests calming prompts like motivational feedback, brief access-to-break reminders, or resources linked to the error. The use of these interventions is supported by ideas of emotion regulation and system-user fitting (Monteith et al., 2022; Poria et al., 2017).

These tools focus on being suitable for technical work, but they also mirror a commitment to ethical innovation by including concern for people, clarity, and user freedom in their designs (Flipse & van de Loo, 2018).

Table 1 compares emotion-related features across the two developed tool prototypes.

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Feature	Prototype A	Prototype B
Emotion Tracking	Yes	Yes
Adaptive UI	Partial	Yes
Empathetic Prompts	No	Yes

Table 1. Prototype Feature Comparison

Data Collection Techniques. The researchers use objectively gathered sensor data and user feedback to study how developers interact with emotions.

Real-time emotion detection includes:

- OpenFace and Affective SDKs distinguish tiny signs of stress, confusion, interest or engagement.
- Vocal emotion recognition means the computer notices pitch, volume, and speed in speaking or talking to oneself to determine someone's mood.
- Data such as heart rate variability and galvanic skin response collected with Empatica E4 were used to discover when physiological changes arising from feeling an emotion occurred (Wang et al., 2022).

Subjective measure includes:

Self-report surveys administered before and after sessions, surveys were used with validated instruments to measure how much emotional understanding, resonance, ease, and workload people felt toward the tools (Caruelle et al., 2022; Coyle et al., 2012).

In ESM, surveys were shown randomly throughout the activities to help people think about their emotions at those action points.

Behavioral interaction logs: They include specially coded data that track how often developers make errors, depend on UI aids, change tasks, and how many sessions they complete to support learning more about their work and their achievements (Henriques et al., 2018; Fagerholm et al., 2015).

Thanks to this multi-layered strategy, the research can examine how designers and developers react to emotionally intelligent technologies and support better connections between studying emotions and creating people-friendly software (Bingley et al., 2023).

Graph 1 shows the frequency of various emotional states recorded during coding sessions.





Fig. 3. Distribution of Detected Emotional States

Participant Demographics. The research selected 30 front-end developers through purposive and snowball sampling. People taking part were assigned to different knowledge levels, areas and kind of organization (freelance, startup or enterprise). During their first or second years, Junior Developers are still learning a lot and experience frequent ups and downs during their tasks. Researchers found that good developer experience determines how developers respond to technical problems and refactoring needs (Alomar et al., 2020).

10 Mid-Level Developers (3–7 years): Most often spend time developing and collaborating with their peers, plus giving emotional tool suggestions for shared use. The 10 Senior Developers (who have worked in tech for 8-10 years) play leading roles in considering how tools should be adopted, used and affect the team's well-being. Developers in the sample belong to many gender identities, cultures, and work types, so the research covers a wide variety of emotional and environmental situations. Everyone signed a statement about informed consent and the study was allowed after review and approval by the university's IRB.

This table outlines the experience levels and work types of the front-end developers who participated in the study.

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Level	Experience (Years)	Count	Work Type
Junior	0–2	10	Freelance/Startup/Enterprise
Mid-Level	3–7	10	Freelance/Startup/Enterprise
Senior	8–10	10	Freelance/Startup/Enterprise

Table 2. Participant Demographics

Evaluation Metric. Researchers in the study analyzed how useful Emotion AI-integrated tools were using numbers and firsthand experience.

- Biometric and observational data are used to measure both emotional intensity (arousal) and quality (valence) [1], according to Picard and Klein in 2002.
- Work on the Jambaka platform showed that task time and error rates closely matched the results of past works on how productive developers are (Alomar et al., 2020).
- Perceived usefulness and supportiveness of emotion-aware features are evaluated by collecting standardized Likert responses.
- For NASA-TLX, users rate various aspects of their cognitive workload, which is a usually adopted tool in the world of usability research.
- People's level of engagement was measured by watching how often they used the tool, which features they turned on of their own accord, and by including self-reported feelings of being 'in the flow.'

Combined, these metrics reveal how developer experience is affected emotionally and in terms of function when using empathetic development tools.

This table summarizes the biometric, behavioral, and subjective measures used to evaluate the Emotion AI tools.

Metric	Measurement Type	Tool/Instrument Used
Emotional Intensity (Arousal)	Biometric	Empatica E4, OpenFace
Emotional Valence	Biometric	Affective SDKs
Task Performance	Behavioral	Jambaka Platform, Log Files

Table 3. Evaluation Metrics Overview

Perceived Usefulness	Survey (Likert)	Custom Questionnaire
Cognitive Workload	Survey	NASA-TLX
Flow and Engagement	Behavioral & Survey	Self-reports, usage frequency

4. Results

4.1 Emotional States During Development

I noticed the most substantial emotional changes when finding and fixing problems. Developers explained they regularly found themselves frustrated, confused, and mentally exhausted when dealing with code they did not know or errors that wouldn't go away. Using these new techniques, the sensors identified significant jumps in negative emotions during the tasks. We found that erroneous syntax and logic answers rose sharply when neural activity increased and decreased. According to papers in the field, developing better tools should focus on the mental effects of negative emotions on task accuracy and getting things done (Arya et al., 2021; Wang et al., 2022).

Graph 2 tracks fluctuations in emotional arousal during different phases of the development process.



Fig. 4. Emotional Intensity Over Time

Tool Responsiveness and Developer Behavior. When the tools had Emotion AI features, we saw definite adjustments in developer behavior by simplifying UI, receiving personal prompts, and finding calming animations or reminder notices. Tasks were accomplished more smoothly by participants working on responsive systems with fewer interruptions. More importantly, if a frustration signal, such as staying still or repeating mistakes, was detected, interventions helped both students refocus and quickly improve learning recovery. These findings align with what Klein, her team, Lin, and her colleagues have found.

This table illustrates how specific emotional states triggered adaptive responses in the tools and influenced developer behavior.

Detected Emotion	Tool Response	Developer Behavior Outcome
Frustration	Calming animation, reduced UI noise	Improved focus, fewer repeated errors
Confusion	Contextual hints, motivational messages	Faster recovery, resumed engagement
Engagement	Minimal interruptions	Sustained flow, higher productivity

Table 4. Tool Responsiveness Observations

Performance Metrics. According to the results of the analysis, using emotion AI led to a noticeable performance boost. Those using the trial development toolkit finished tasks an average of 18% faster than the control group. More importantly, errors were reduced by 30%, specifically in tasks that required complex UI implementation, pointing to the idea that emotional scaffolding can help people stay attentive when doing mentally demanding things. This matches the idea discussed earlier that emotionally intelligent systems can improve efficiency when people need to focus on mentally demanding tasks (Cambria, 2016; Caruelle et al., 2022).

Graph 3 compares task completion times and error rates between Emotion AI users and the control group.



Fig. 5. Task Performance: Emotion AI vs Control Group

Developers Reactions. It was easy to see from qualitative feedback that there was a new way developers regarded using design tools. According to the study, using the Emotion AI-enhanced interface made many people feel that their feelings were recognized and they could rely on support. It was clear to us that having the chance to customize emotional responses was very important to developers. This matches the importance given to human-centered AI to users' ability to act and adapt ineffective interfaces (Bingley et al., 2023; Gkinko & Elbanna, 2022). Another developer described the tool as a helping friend, not just a machine, so they weren't alone during difficulties.

Graph 4 displays satisfaction scores across junior, mid-level, and senior developers.

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Fig. 6. Developer Satisfaction by Experience Level

Using Statistics. Analysis of task performance showed that people performed differently at various emotional states (p < 0.05). Regression also supported the idea that negative emotional states predicted how often a person committed errors. Users with emotional tool support did better than those with non-reactive tools after considering the developer's ability and the task's difficulty (Alomar et al., 2020; Fagerholm et al., 2015). These results show strength in emotional AI use, which empirically confirms that it improves both emotional and job performance.

5. Discussion

5.1 Interpretation of Findings

From our research, Emotion AI can help shape the developer experience by making front-end tools match the emotions of those developing them. Emotional regulation in these environments boosts productivity rather than productivity by direct means. If a student felt frustrated or overwhelmed, quick guidance about changing the display or pausing for a moment helped them finish the work faster and with better code. What we found agrees with what has been shown before: emotion-aware systems can help users when stressed (Picard & Klein, 2002; Klein et al., 1999).

In addition, empathetic interfaces lowered the risk of people becoming emotionally burned out, primarily in junior developer teams. Those who used the interfaces felt appreciated and looked after when such signs of stress or disengagement were recognized, agreeing with the view of Bingley et al. (2023). That is why emotions are seen by affective computing as vital to helping users stay with a system (Cambria, 2016; Arya et al., 2021).

Contributions to Research and Practice. This research supports affective computing by bringing its use into a neglected field: software development tools. Much of the previous studies have looked at marketing (Caruelle et al., 2022) or customer service (Han et al., 2023). On the other hand, our work studies the use of emotional AI by developers to expand the reach of emotionally intelligent systems.

As an outcome, this research gives a valuable foundation for designing DevEx based on emotions. By bringing in emotions, it extends earlier research about developer experience (Fagerholm & Münch, 2012; Alomar et al., 2020). Though not accidents, levels of emotion in programming help control attention, improve problem-solving, and build cooperation. Coordinating with these emotions outlines a new path for developing tools, from a practical purpose to being adaptive to others' feelings.

Design Implications. The results indicate several good practices when applying Emotion AI in front-end development.

Less is often better, and the program must not get in your way. Our study showed that subtle styling and motion (like changing a color or making a gentle animation) were more popular with developers than notifications and voice readouts. As Zepf et al. (2019) and earlier studies have found, helping users in emotionally intelligent systems should be simple and straightforward.

Every effort should be taken to protect the developer agency. Options for adjusting how emotional responses are dealt with raised people's trust and happiness with the tool. Flipse and van de Loo (2018) make a similar point about responsible innovation in design complexity, as do I here.\ A sound system uses the context to improve its ability, not only raw emotions. So, if a developer frowns, checking before you conclude by looking at their work proves it's not stressful and everything is running fine.

This table presents key design recommendations for implementing Emotion AI in developer tools based on study findings.

Design Principle	Implication for Emotion AI Tools
Subtle Emotional Cues	Use visual or ambient cues over voice or pop-ups
User Agency and Control	Let users adjust emotion-detection settings
Context-Aware Feedback	Combine emotion data with situational context
Ethical Transparency	Clearly inform users about data usage and consent

Table 5. Design Implications Summary

Ethical Considerations. Even though emotional AI holds enormous promise, it also brings up critical ethical problems. Consent and the protection of personal data privacy should be the basis for everything. It is essential to inform developers about what emotional data is gathered, how it is processed, and how it will be kept (Monteith et al., 2022). Because biometric signals can be sensitive, it should be standard to anonymize them and only use them while processing in real-time.

There's also a threat of emotional manipulation, which means using subtle tools to encourage developers to work longer might make them feel stressed and worn out. We agree with Gkinko & Elbanna (2022) that setting ethical standards helps to limit effective surveillance and coercive productivity.

Limitations. The lab experiments only tell us about behavior in carefully controlled environments. Working on real-world code means dealing with issues that aren't always present in school lessons (such as team pressures and people handling more than one task at a time). Moreover, online biometric tools, such as studying facial expressions or heart rate, are still unreliable indicators of someone's feelings. Noise, errors in the input, and unique individual differences are known to reduce a system's accuracy (Wang et al., 2022).

We also put particular attention on solo developers using a custom prototype tool. The lessons here are probably useless for software teams using Visual Studio Code or GitHub.

Future Research Directions. The role of Emotion AI in coding is to help developers work with emotions instead of regarding feelings as a disorder. Further research can be carried out down many paths. Since work stress puts people at risk for burnout, longitudinal studies may look at how Emotion AI influences their emotional well-being and stress during sprint periods and times of fixing bugs.

We could also add emotional awareness to team tools, including GitHub and Figma so that emotional signs between team members could encourage better code reviews, pair programming, or design chats. Analysis of multiple forms of emotional input (voice, posture, and typing) could increase the reliability and trustworthiness of a robot (Poria et al., 2017).



Fig. 7. Emotion AI Enhances Developer Well-being

6. Conclusion

6.1 Summary of Key Findings

The research looked at uniting Emotion AI with front-end development tools and describes how having emotional knowledge changes a developer's approach. The results of multidisciplinary research in affective computing, developer experience, and human-centered AI show that emotional AI can help increase software development environments' emotional and technological quality (Arya, Singh, & Kumar, 2021; Bingley et al., 2023).

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Including emotional responses in developer tools can increase productivity and user satisfaction (Cambria, 2016; Alomar et al., 2020). When we interpret signs of a developer's emotions correctly, they let us know in the present moment how the developer is feeling and can be used to personalize help, update interfaces, or recommend mental wellness exercises (Klein, Moon, & Pieard, 1999; Monteith et al., 2022).

The findings also point out that a developer's performance depends on how much effort is needed in reasoning and how they feel. Both frustration and stress can be helped by empathic tools, which can prevent burnout and keep people keen to continue their flow states, adding a new approach to boosting work performance (Fagerholm et al., 2015; Poria et al., 2017).

The Promise of Empathetic Programming. Designing development environments that sense how developers feel is now no longer speculation. New designs, such as kindly chatbots (Lin et al., 2020) and adjustable interfaces in human-AI connections, reveal that such applications are both possible and appealing. Emotion AI allows us to make DevEx more effective by applying affect as an essential part of our design rather than a mere afterthought. As ergonomics helped improve physical workplaces, practical computing can direct emotional ergonomics in digital technology. We are moving from tools supporting development to those supporting the developer (Gkinko & Elbanna, 2022; Bagozzi, Brady, & Huang, 2022).

Innovative IDEs in our new DevEx can watch for developer fatigue, disinterest, or selfdoubt and step in with soothing reminders, encouraging words, or even light-hearted feedback that rethinks problems (Han, Yin, & Zhang, 2023; Picard & Klein, 2002). These features are essential parts of a better, more human process for growth and learning.

Final Thoughts. We shouldn't treat emotional intelligence as supplementary because artificial intelligence is now part of everyday developer tools. Since software development can be highly pressured, done by teams, and mentally taxing, it needs systems that support people using them. Building quicker or easier user interfaces is not all that the future of front-end development means. It means making tools that understand how to help when needed, stop when you're feeling, and celebrate your involvement in creation. So, we help create tools that are both smart and friendly.

Graph 5 summarizes performance and emotional benefits of Emotion AI for different experience tiers.



Table 6. Summary of Emotion AI Impact Across Developer Levels

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Citation: Sonu Kapoor. (2025). Code That Listens: Integrating Emotion AI into Front-End Development Tools for a More Empathetic Coding Experience. International Journal of Computer Vision (IJCV), 2(1), 14-35.

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